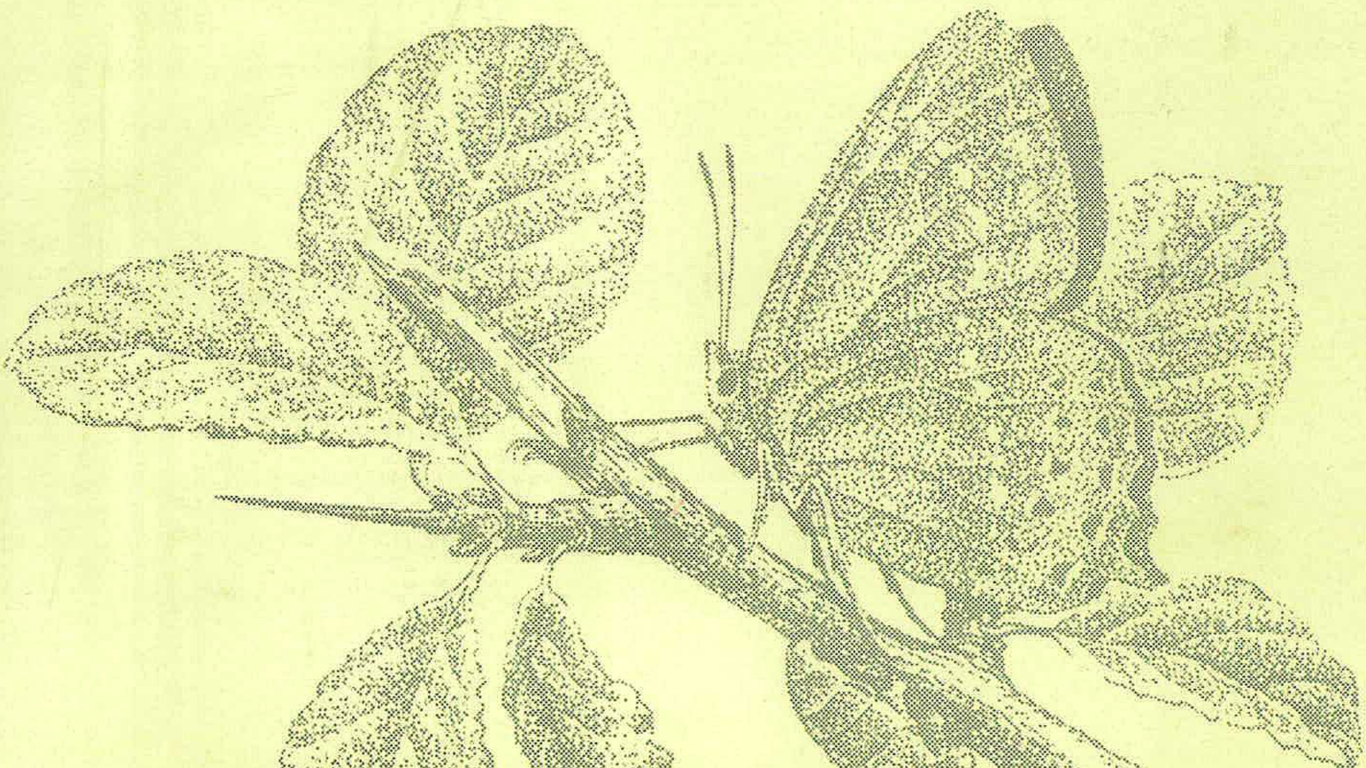
ENGLISH NATURE

Monks Wood

National Nature Reserve



40th Anniversary Symposium

23 July 1993

Proceedings of a symposium on

MONKS WOOD
NATIONAL NATURE RESERVE

THE EXPERIENCE OF 40 YEARS
1953-93

Institute of Terrestrial Ecology
Monks Wood
23 July 1993

Edited by
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PREFACE

For centuries Monks Wood was managed under the traditional coppice-with-standards system and its wildlife communities would have reflected the structural diversity and changes that such a system brings. At the end of the First World War, what can only be described as a catastrophic event occurred, however, when Canadian lumbermen almost clear-felled the wood over a period of a few years, so destroying that ancient, traditional system. (It is perhaps pertinent, though, to remind ourselves that such events can occur as part of the natural order of things, as in the storms of 1987). Since then the wood has, to a large extent, been left unmanaged to recover from the felling as nature wills it.

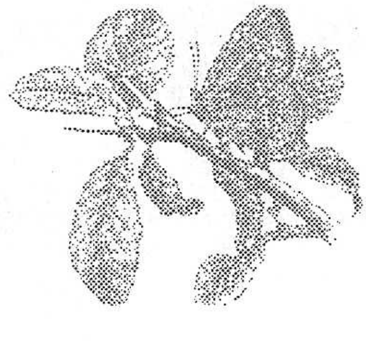
In 1953 and 1954, its 157ha was bought by English Nature's predecessor, the Nature Conservancy, and established as a National Nature Reserve. Today its largely high forest canopy is predominantly ash with pedunculate oak, and the diverse shrub layer includes hazel, midland hawthorn, field maple, wayfaring tree and guelder rose. Wild service tree is present in good numbers and, despite the ravages of Dutch elm disease during the 1990s, small leaved elm is still dominant in one area. Structural and habitat variety is enhanced by the ponds, streams, rides, glades and woodland grassland that occur within the wood and the reserve thus supports rich assemblages of higher plants, fungi, insects and other invertebrates. These are detailed for the period up until early 1973 in *Monks Wood: A Nature Reserve Record*, edited by Dick Steele and Colin Welch. This monograph is still the most detailed account of a nature reserve in Great Britain although sadly it is now out of print.

With 1993 being the 40th anniversary of Monks Wood as an National Nature Reserve, and the 20th anniversary of the publication of the Monks Wood monograph, George Peterken with a long interest in woodland ecology, and John Sheail with his specialist interest in historical ecology, proposed holding a one day conference to celebrate these anniversaries but also, and more importantly, to try and establish what has, or has not, been learnt about site management for nature conservation from those 40 years. Their proposal was readily accepted by Mike Schofield - then Director of English Nature's East Region and another with a long association with Monks Wood - and we were asked to organise the conference.

In their proposal, George Peterken and John Sheail had suggested five sets of questions as themes. These were adopted as the structure of the conference and are:

1. What has happened in the wood since 1953? How have natural events and management affected its structure and composition? How do the changes in the wood over the last 40 years compare with those of its previous history?

2. How has the wildlife changed? How have such groups as butterflies, deer, and flowering plants changed? Are there noticeable changes to the ride flora? Are we monitoring these changes adequately?



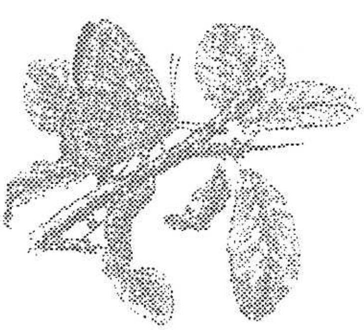
3. How has the reserve been used for research? How have the research findings affected management? Has management provided opportunities for purposeful research?

4. Have the objectives and management strategy of the reserve changed? How has management reacted to experience within the reserve, and to changes in the wider context of national land use and nature-conservation policies?

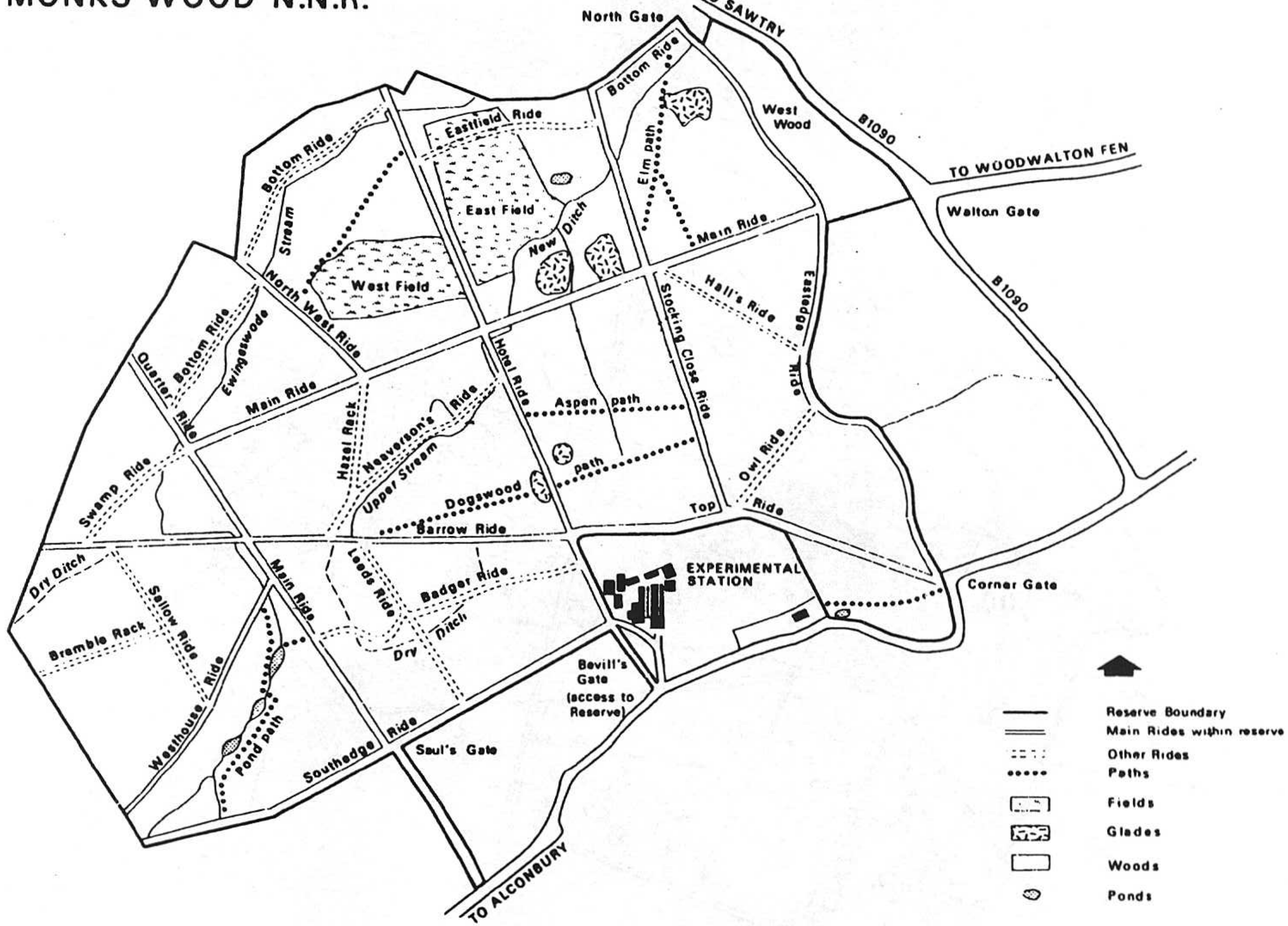
5. How much will future managers and researchers be able to learn about what has happened on the reserve during the last 40 years? How good are we at making and keeping records of what happens on the reserve?

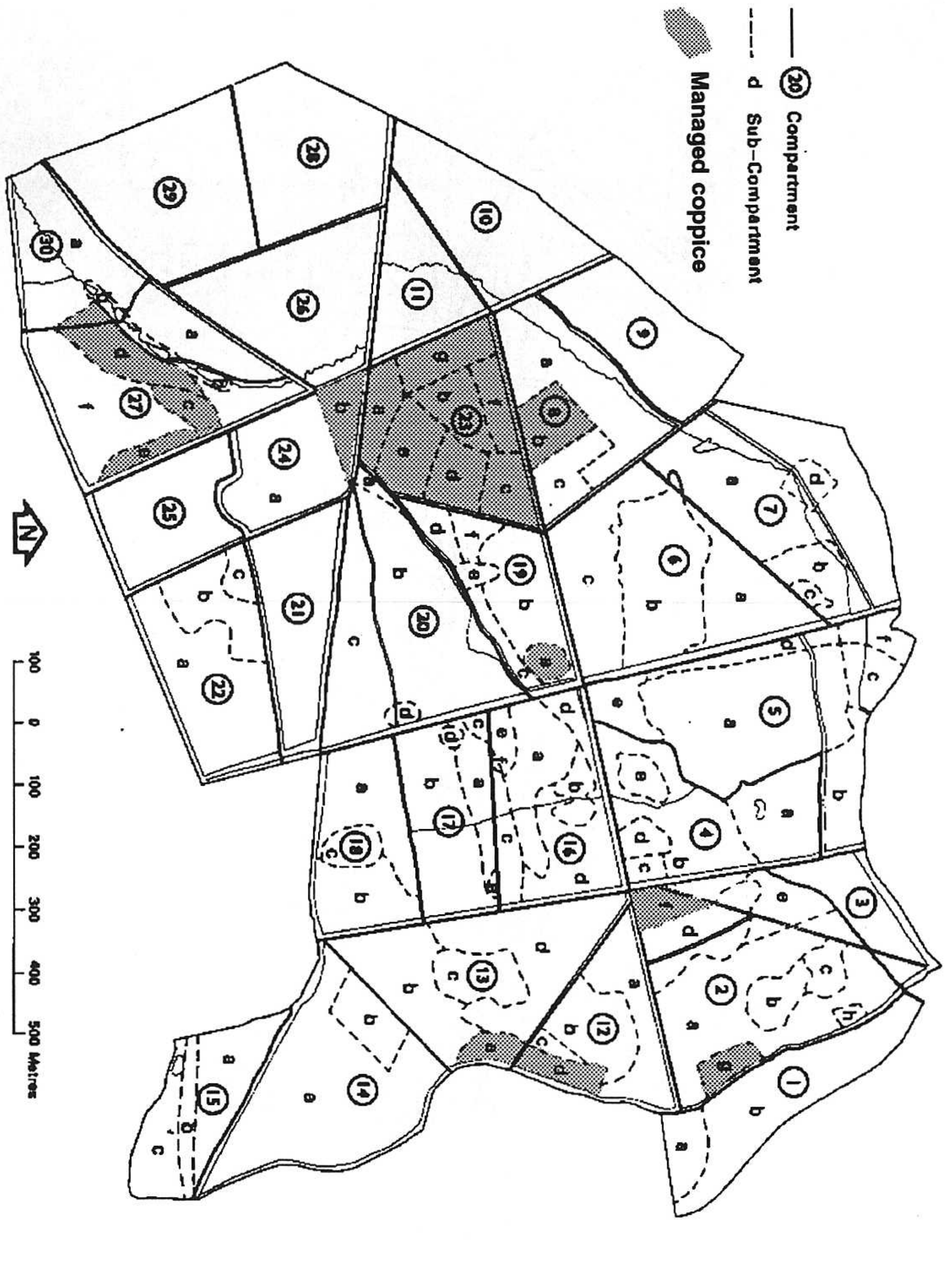
Invitations were sent to 39 past and present members of staff of EN and ITE who had had an involvement with the NNR since its establishment and 35 of those expressed an interest in attending. On the day 26 were able to attend and by common consent the conference was judged to be a success. The following proceedings present the papers given at the conference, together with a summary of the discussion upon them and a bibliography for 1973-1993 compiled by one of us (RCW) post conference. MEM was unable to attend the conference and he is grateful to Janette Plumridge for reading his two papers on his behalf. We are both grateful to Alan Pritchard for design, Mandy Vowles for the production of the figures and to Ann Waters for typing the report. We thank Peter Wakely and David Elias for the photographs.

Maurice E Massey
R Colin Welch



MONKS WOOD N.N.R.





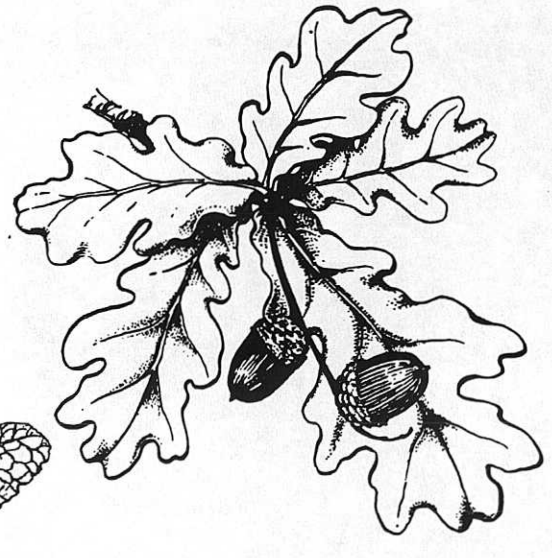
20 Compartment
d Sub-Compartment
Managed coppice
N
100 0 100 200 300 400 500 Metres

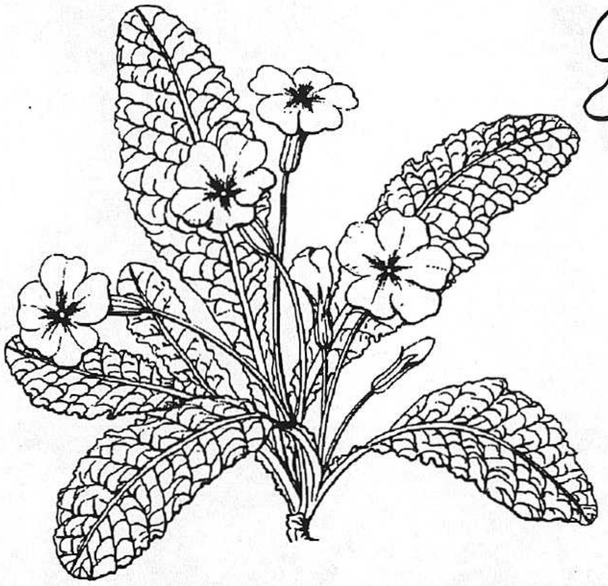
Chapter 1
What has happened since 1953?

**Natural changes in unmanaged stands within Monks Wood NNR-
G.F. Peterken**

**Tree growth in an Oak-Ash sample plot in Monks Wood 1964-1993 -
R.C. Welch**

Managed change - M.E. Massey





NATURAL CHANGES IN UNMANAGED STANDS WITHIN MONKS WOOD NNR

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INTRODUCTION

Change in natural woodlands is driven by (a) events or episodes, which are more-or-less discrete in time and (b) growth and interactions between species, which happen continuously. Much the same can be said of managed woodlands, though there the events are usually generated by managers, rather than natural forces.

Monks Wood, like virtually every woodland reserve, cannot escape influences from its surroundings, which generate semi-natural events. These are episodes which proceed in a natural manner, but which owe their origin in part to the actions of people elsewhere.

DISTURBANCE EVENTS

In Monks Wood the major natural and semi-natural events of the last 40 years are listed below. If the Event Record had been more complete and if I had had time to look at it, I suspect that a number of additional small events would have been found to fill the gaps between major events. The major events were:

A. Natural

Drought, principally in 1976 and 1990-91. The most conspicuous effect of the 1976 drought was to kill a large number of mature birch trees.

Storm, principally in 1987, I assume. A scatter of large trees was toppled, but no part of the wood was levelled.

B. Semi-natural

Elm disease, said to date from 1960 onwards, but which probably struck mainly in the 1970s, killing the trees in the mature elm clones.

Myxomatosis, said to be severe in 1973, but which presumably struck mainly in 1950s.

Defoliators, especially in 1980.

Deer browsing, sustained increase from 1985 onwards.

GROWTH

The reserve was a derelict coppice in 1953. The main record of natural change in its composition and structure was not started until 1985, when Christa Backmeroff, working on contract to the Chief Scientists' Directorate, of the then Nature Conservancy Council initiated four transects in

non-intervention compartments. Each transect was 20m wide and was subdivided into 30m sections along its length. All trees, shrubs and saplings which had reached 1.3m height were mapped and measured. We had hoped to resurvey these transects for this meeting, but in the event only a small part of the transect in compartment 18 was re-examined.

The basal area of unmanaged stands was 25-31m^2/ha (Table 1). This is close to the general range for virgin temperate broadleaved woods, which sometimes run up to 40m^2/ha.

Most parts of the wood are dominated by ash *Fraxinus excelsior*, maple *Acer campestre*, hazel *Corylus avellana* and pendunculate oak *Quercus robur* (Table 1), but at a small scale the distribution of these species is patchy. This is demonstrated by the distribution of basal area of the three main species in 10m x 15m quarter sections of the transect in compartment 18 (Table 2). At this scale the canopy species are conspicuously grouped.

The size distributions of the main species reflect their dynamics. Figure 1 gives the size distribution of three species in transect 18 in 1985. The oaks were mainly survivors of trees too small to fell in the 1920s. Maple comprises coppice regrowth after the 1920s. Ash is mainly coppice regrowth, but also includes a few trees not felled in the 1920s and some recent regeneration.

These size distributions vary to some extent about the wood. Figure 2 illustrates this with ash, which shows that the amounts of regeneration present in 1985 varied from one compartment to another. In fact, the patchiness already revealed in the distribution of canopy trees (Table 2) was also clear in the pattern of ash saplings in 1985. In transect 14, where ash saplings were commonest (Figure 3), the number of ash saplings reaching 1.3m height was strongly grouped.

Stand dynamics can be inferred up to a point from observations at one time, but only observations over time give a full picture. Resurvey in 1992 of the first (top) 90m of transect 18 enabled growth and mortality to be measured for the first time. Figures 4 and 5 give the results for ash and maple in this sample: each spot represents one tree or coppice stem, and the open squares show trees which died.

The usual pattern in undisturbed stands is for growth during a period to be proportional to size at the start of that period and for mortality to be concentrated in the smaller size classes, ie the larger trees grow fastest and the smaller tend to be excluded. Typically, there is immense variation between individuals.

Ash (Figure 4) shows fragments of this pattern. In fact, there is also some sign of the mature state setting in, where large trees grow slower than medium sized trees and mortality is also found in large trees. Maple (Figure 5) showed negligible mortality and growth shows no obvious relationship to size in 1985.

SUMMARY OF CHANGES IN THE STAND

Ash
- No individual trees died
- Some coppice stools lost a stem
- One large tree collapsed
- Growth rates extremely variable
- The patch of "abundant ash saplings" recorded in 1985 had vanished by 1992.

Maple
- Negligible mortality
- Growth rates extremely variable

Oak
- No mortality
- Very slow growth

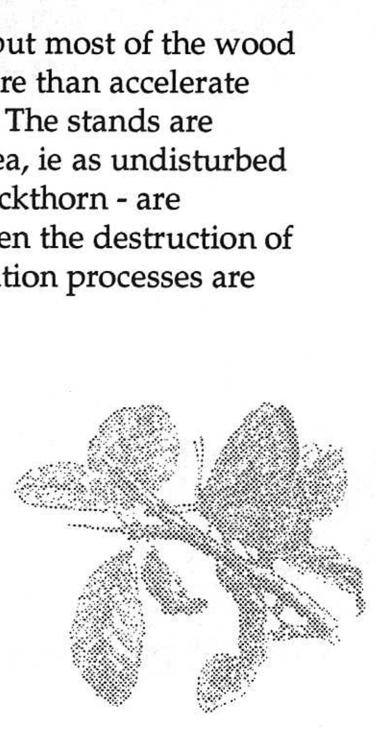
Hazel
- Rapid decay of old stools
- Resprouts have survived

Privet
- High mortality
- Survivors heavily browsed: bushes recorded as more than 1.3m high in 1985 were less than 30cm in 1992.

Blackthorn
- High mortality
- Some vegetative rejuvenation

GENERAL CONCLUSIONS

Stand development has been locally affected by disturbance, but most of the wood has been almost unaffected. The drought probably did no more than accelerate mortality that would have taken place over the next 20 years. The stands are thinning very slowly and have probably increased in basal area, ie as undisturbed stands normally develop. Underwood species - hazel and blackthorn - are predictably declining. The principal change since 1985 has been the destruction of privet undergrowth and groups of ash regeneration. Gap creation processes are



just starting as older ash become moribund and physically unstable.

LONG-TERM VIEW

Change in the 40 years of the NNR can be compared with the earlier change summarised in Peterken (1991). This shows change in the amount and kind of open space over 200 years, and demonstrates that the NNR management has generated a wood which is vastly different from the earlier coppice. Moreover, these changes roughly correlate with changes in the fate of species of butterfly, (see Pollard & Yates; Chapter 2 of this volume). Whilst this comparison cannot readily be related to the studies of stand development in unmanaged stands, it illustrates a need to view short-term changes in a longer context.

REFERENCE

Peterken, G.F. 1991. Ecological issues in the management of woodland nature reserves, pp245-272, In: Spellerberg, I.F., Goldsmith, F.B., & Morris, M.G., (Eds), *The Scientific Management of Temperate Communities for Conservation,* Blackwell, Oxford

Table 1 Monks Wood transects - Basal area of all transects by species (m^2/ha)

TRANSECT	17/18	14	9	29/30
Total (all species)	25.3	30.7	28.4	26.6
Ash	9.1	18	18.2	13.3
Maple	6.1	4.8	3.4	6.8
Oak	3	3.6	2.9	3.2
Hazel	1.6	0.8	1.7	0.7
Hawthorn	1.2	1.8	0.8	0.6
Midland hawthorn	2.3	1.5	1	0.7
Birch	0.3	-	0.5	-
Sallow	0.7	-	>0.1	-

Ash		Maple		Oak	
19	13	.	.	.	.
10	7	8	9	.	.
19	.	6	4	.	.
3	10	3	8	.	.
.	38	23	16	.	.
14	18	5	8	11	.
.	.	27	10	.	.
15	10	20	.	.	.
22	19	8	.	.	.
15	8	13	4	4	8

Table 2 Distribution of basal area for three major canopy trees in transect 18, by quarter sections (each figure gives a value for a section of transect 10m wide x 15m long)

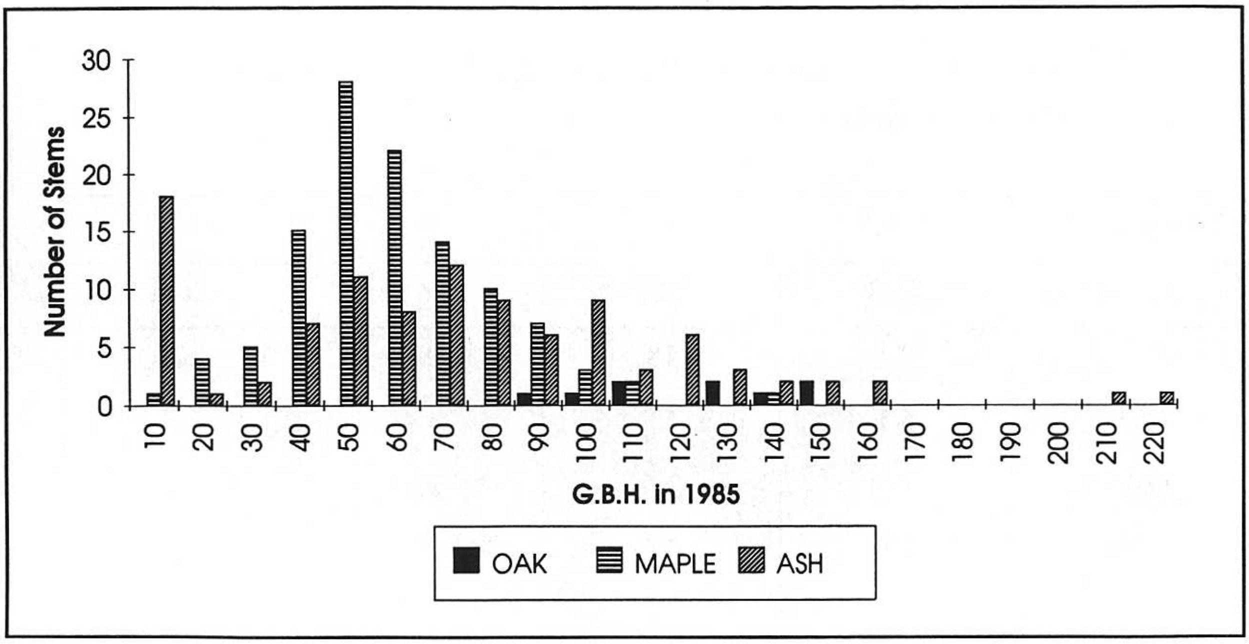


Figure 1 Abundance of three major canopy trees in 10cm girth classes in the transect through cmpt 18 during 1985

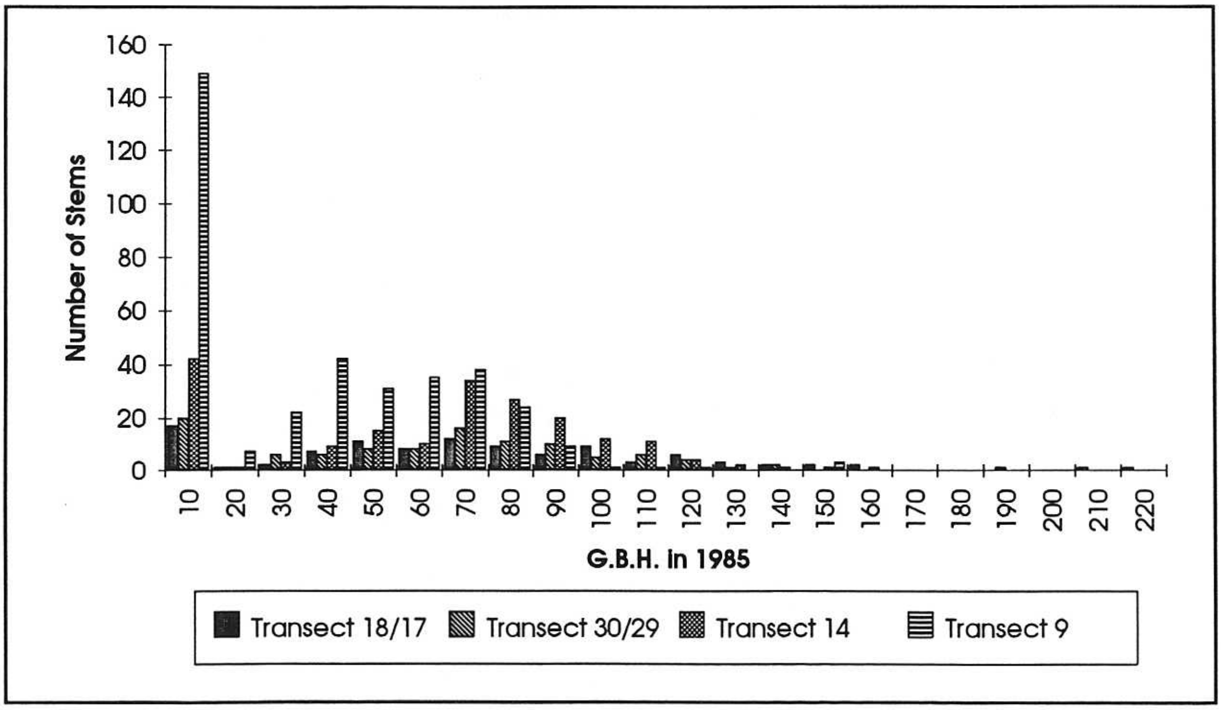
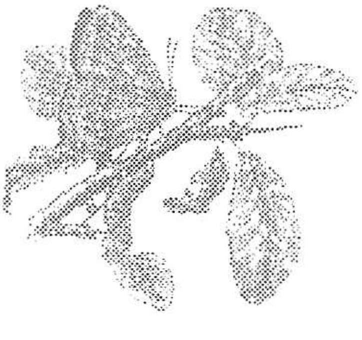


Figure 2 Abundance of ash stems in 10cm girth classes in the four transects in 1985



-	-
-	4
2	3
-	5
1	1
8	-
11	-
4	-
-	-
-	-
-	-
1	6
3	-
4	13
-	-
4	-
8	-
-	-

Figure 3 **Number of ash <10cm G.B.H. in transect 14, by quarter sections**

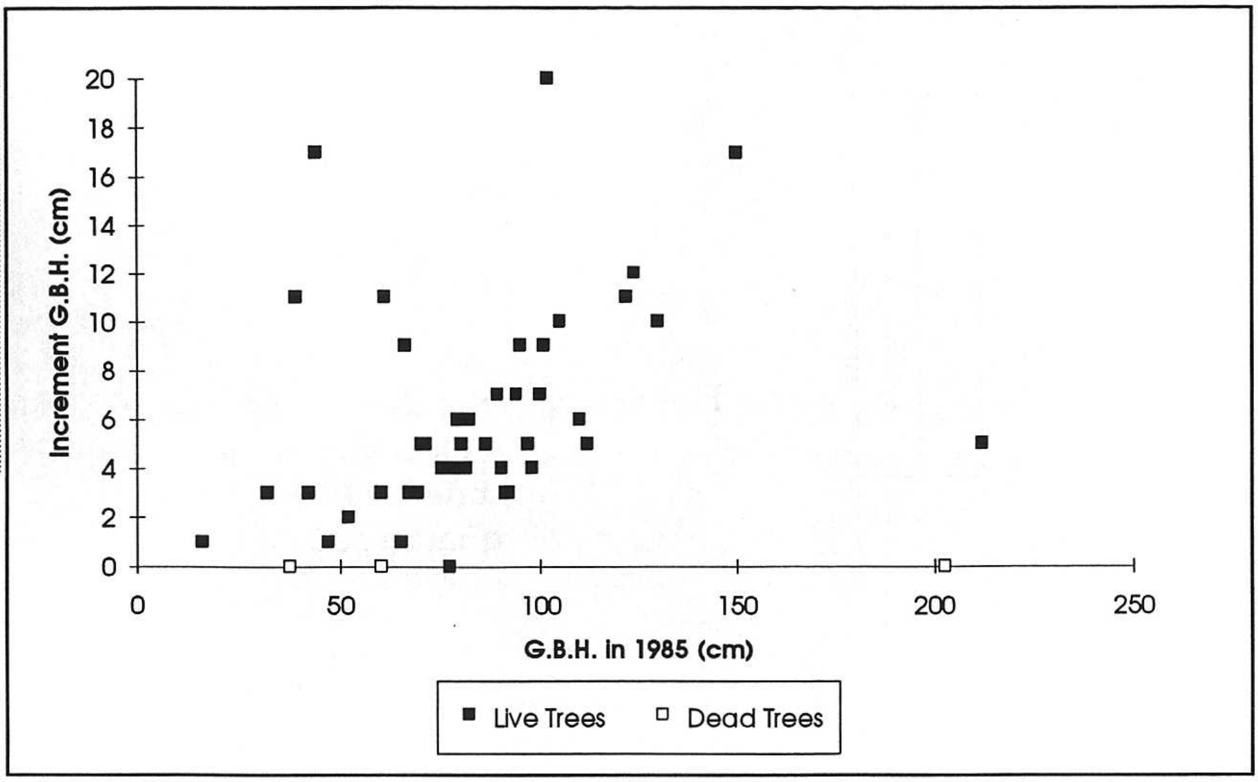


Figure 4 Increment of ash stems along first 90 meters of transect 18 between 1985 and 1992

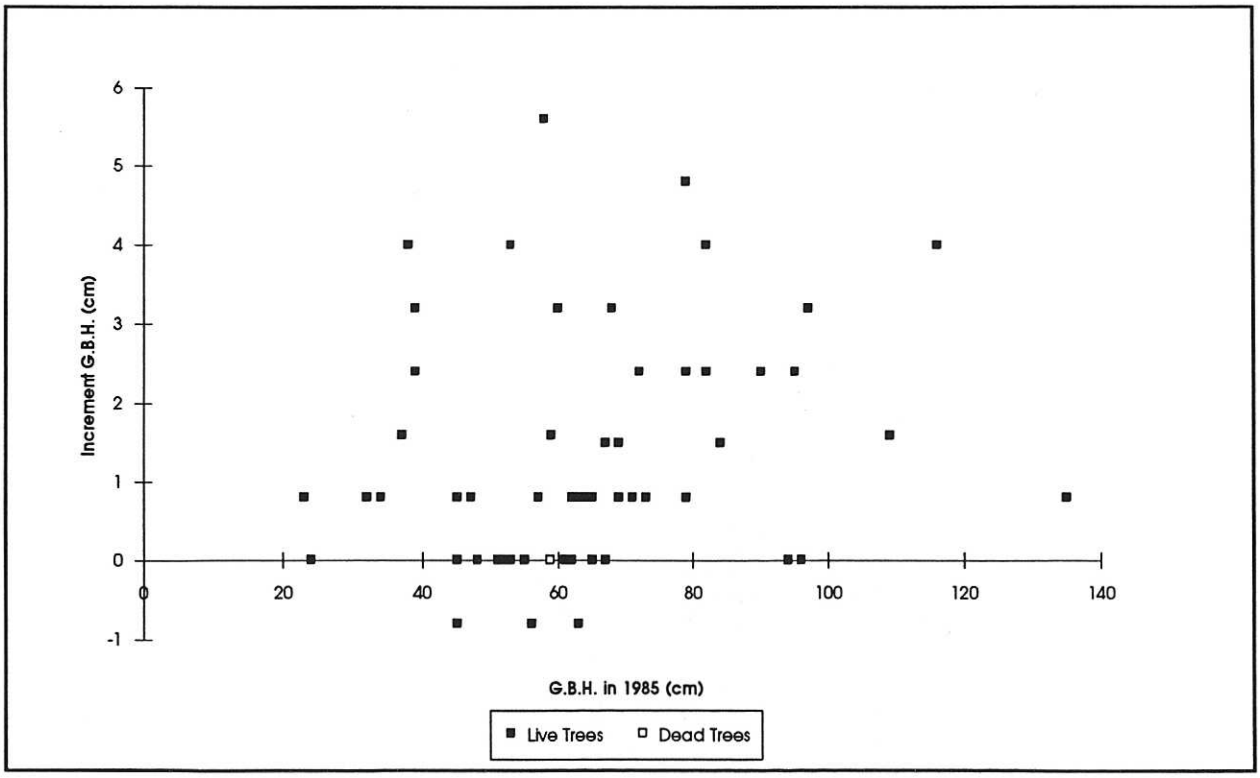


Figure 5 Increment of maple stems along first 90 meters of transect 18 between 1985 and 1992

TREE GROWTH IN AN OAK-ASH SAMPLE PLOT IN MONKS WOOD 1964-1993

R C Welch

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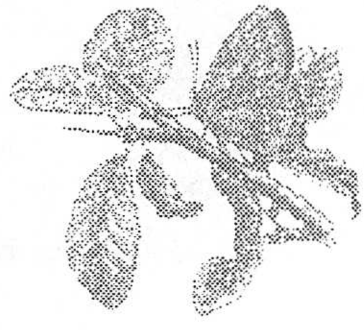
Steele (1973) described how most of the oaks in Monks Wood National Nature Reserve are standard trees with the finest specimens occurring in West Wood, on the eastern edge of the reserve, and in compartment 10 in the northwest sector of the wood. The latter compartment is poorly drained, and is liable to flooding in the winter months, which may have been the reason for these oaks escaping the ravages of the Canadian lumbermen after the First World War.

THE MONKS WOOD SAMPLE PLOT

Early in 1964 staff of the Nature Conservancy's Woodland Section stationed at Monks Wood Experimental Station established a sample plot in a stand of oak and ash in compartment 10. This plot measured 70m x 35m with an area of 0.245ha and, at that time, containing 203 tree stems of which 116 (57.1%) were ash *Fraxinus excelsior*, 32 (15.8%) field maple *Acer campestre*, 23 (11.3%) pedunculate oak *Quercus robur*, with 16 birch *Betula pubescens* and *B. verrucosa*, and 16 aspen *Populus tremula* each accounting for 7.9%. The percentage distribution of the 3 main tree species was found to be similar in other plots throughout the wood. The tree stems in the sample plot were marked with a double white band at breast height (=130cm above ground), numbered, and their girth at breast height (gbh) measured. Steele lists in Table 4 in Steele & Welch (1973) the girth, height and increment of the 10 trees of greatest girth for each of the above 5 species between the Spring of 1964 and Autumn 1968. All the trees in the sample plot were measured annually for a number of years but it was assumed that the data had been lost following the split-up of the Nature Conservancy into the Nature Conservancy Council and the Institute of Terrestrial Ecology in November 1973. Early in 1993, I learned that Dr A D Horrill, a former member of Monks Wood's Woodland Section now stationed at ITE Merlewood still had in his possession a table giving the gbh of 209 tree stems measured in the Spring of 1964 and during the Autumn of 1965 and 1966. Dr Horrill had returned to Monks Wood on 2 December 1975 and had located and re-measured 165 trees in the sample plot. Only one of the original 23 sample oaks had died and fallen by 1975 and numbered trees were identified in Horrill's list which correspond with the 10 largest oaks listed by Steele (1973).

MEASURING OAK IN THE SAMPLE PLOT

In order to obtain some indication of the incremental growth of trees in Monks Wood over a period of 29 years, I decided to investigate the possibility of re-measuring the trees in the sample plot prior to the 40th Anniversary Meeting in July 1993. An initial inspection indicated that the double white bands, between which the girth is measured, have persisted on a large number of trees. A few numbers are still distinguishable on the larger oaks but on many trees only parts of the number are discernable. No markers are present, if they ever existed, to indicate the limits of the sample plot, and Dr Horrill does not have a plan to show the location of the sample trees.



On 12 July 1993, 20 of the 23 oaks originally measured in 1964 were identified and re-measured (Figure 1). Two of these were dead but still standing. One had apparently died recently but the other must have died shortly after being measured in December 1975 as its gbh was almost identical to that recorded then.

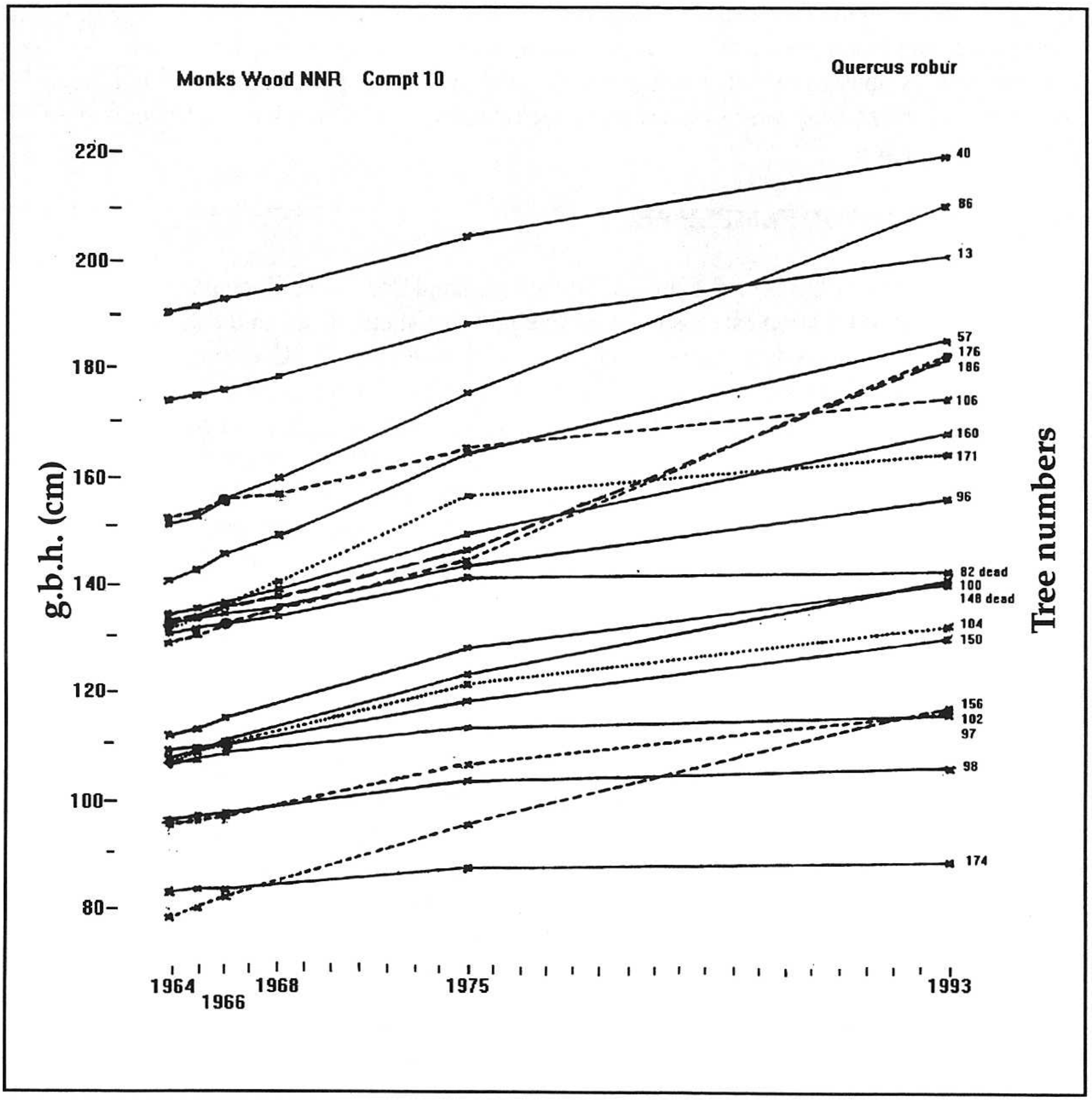
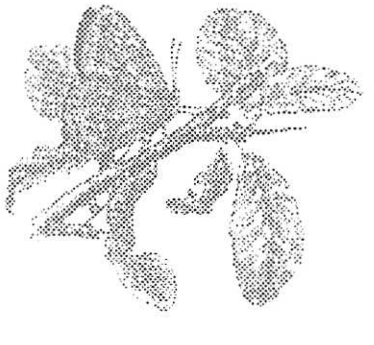


Figure 1 Quercus robur - girth measurements of 20 trees in cmpt. 10. 1964-1993

In the Spring of 1964 oaks in the sample plot ranged in girth from 78.5-190.5cm. Over the succeeding 30 growing seasons an increase in girth of 38.6% was recorded for tree 86. This amounts to an average annual increment of 1.94cm, although the mean for all oaks measured was only 1.1cm/year. Three of the 5 slimmest trees measured in 1964 had put on the least incremental growth, with tree 174 showing a mere 5.5% increase in girth over the 30 years, less than one tenth the rate of tree 86. However, tree 174 was the shortest of the oaks measured in 1964 by 2.5m and may have been adding height at the expense of girth over this period. Tree heights were not measured in 1993.



MEASURING ASH IN THE SAMPLE PLOT

Although many ash trees were located in the sample plot by the double white band around their stems, the reference numbers had become almost completely illegible over the years. 84 ash stems measured during July 1993 included a number of small unmarked stems arising from coppice stools. On the banded trees only the numbers 105 and 178 could be made out with any certainty. If their identification is correct then their mean incremental growth slowed from 1.25 and 1.33cm/year for the first 12 growing seasons 1964-1975 to 0.66 and 0.49cm/year for the following 18 years, 1975-1993. The maximum average incremental growth for the 96 ash stems measured by Dr Horrill in 1975 was 2.0cm/year, but the mean increment for all ash was 0.74cm/year over the first 12 year period.

As it has not been possible to correlate the ash stems measured in July 1993 with the earlier gbh records, the girth measurements from the 1964, 1975 and 1993 data sets have been ranked in 10cm girth size classes, ie 0-10, 11-20, 21-30 etc., to demonstrate the age profile of the trees in the sample plot (Figure 2). When the ash trees were first measured in the Spring of 1964 their gbh ranged from 17.0-91.5cm with 37.9% in the 21-30 girth class, and a median gbh of 35.5cm for all 116 trees in the sample plot.

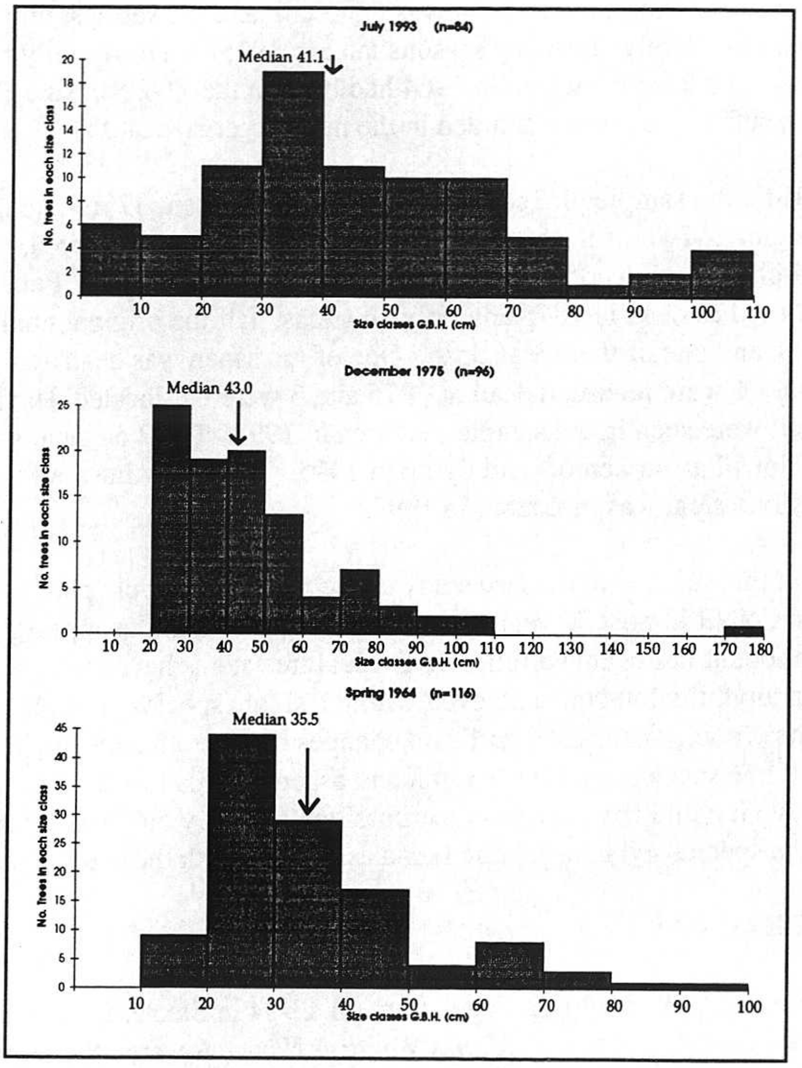


Figure 2 Fraxinus excelsior - class sizes in cmpt 10 in 1964, 1975 & 1993

By December 1975 the gbh range was 21.0-175.0cm, with 26% in the 21-30cm girth class, and a median of 43.0cm for the 96 ash trees measured in the plot.
In July 1993, 6 of the ash measured had a gbh below 10cm with the smallest measuring 2.9cm, and the largest 108.1cm. The 2 largest ash trees measured in 1975 had been lost from the plot during the intervening years. By 1993 most ash trees were in the 31-40cm girth class and accounted for 22.6%, with an even

distribution in the one size category below this and the 3 above, ie 72.3% of the 84 ash had a girth of between 20 and 70cm and a median gbh of 41.4cm. However, if the measurements for the 6 trees with girths of less than 10cm are omitted, as no trees in this size class were measured in 1964 or 1975, the median gbh for the remaining 78 ash trees is 42.7cm. This is remarkably close to that calculated for the sample plot in 1975.

DISCUSSION

It seems likely that when the trees in the sample plot were selected in 1964 only those stems with a gbh of over 10cm were banded to be measured. Steele (1973) does not make this clear but does state that any stems below 3m in height were classed as saplings. The shortest ash measured in 1964 was 6.5m tall, and the shortest tree measured was an Aspen 5.0m tall. Twelve growing seasons later in 1975 Dr Horrill only measured the banded trees. The 9 stems, which in 1964 had been in the 11-20cm size class, had increased their girth sufficiently to be included in the next larger size class.

In 1964 the sample plot contained 14 birch, 16 aspen, 32 field maple, 2 willow and 4 hawthorn. Two of the birch were dead, or at least not measured, in 1975 and by 1993 only 2 birch with girths of 74.2 and 86.2cm remained in the plot. Four of the field maple were recorded as dead in 1975 and only 16 stems, half the original number, were measured in 1993, and one of these was dead. One of the aspen was dead and fallen by 1966. A further 6 were recorded dead in 1975 and 3 were not located, leaving 6 still alive. No aspen were seen in the sample plot area in 1993. The 2 original willows were recorded by Dr Horrill as broken off and dying in 1975. The 4 hawthorn were still alive in 1975 but only one stem was measured in 1993.

From this somewhat cursory study of the trees in a sample plot, established in Monks Wood NNR almost 30 years ago, it would appear that the appearance of the oak-ash component has changed little. Individual tree stems have increased in girth but this has been anything but constant, even within a single species growing in a relatively small area of the wood. The most significant changes observed have been in the death of the short-lived tree species, especially birch and aspen. If this loss is common to other parts of the reserve it could have serious repercussions, not only on the structure of the wood, but also on the specialised invertebrate fauna associated with these two species.

REFERENCE

Steele, R.C. 1973. Flora: Vegetation, pp 43-54 in Steele, R.C. & Welch, R.C. (Editors), *Monks Wood: A Nature Reserve Record,* Huntingdon, The Nature Conservancy/Natural Environment Research Council.

MANAGED CHANGE

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INTRODUCTION

Shortly after Monks Wood was purchased in 1953 and 1954 for establishment as a National Nature Reserve, Sale and Archibald described the wood as consisting mostly of dense stands of even-aged mixed coppice in the southern and western sections, and variable ash *Fraxinus excelsior* coppice in the northern and eastern, that dated from the 1920 felling. The structure of the understorey was variable but there were extensive areas with dense tangles of privet *Ligustrum vulgare*, blackthorn *Prunus spinosa* and hawthorn *Crataegus monogyna*. In the ground layer the dominant species were bluebell *Hyacinthoides non-scripta*, dog's mercury *Mercurialis perennis* and bramble *Rubus* spp. East and West Fields were being slowly recolonised by herbaceous species following the agricultural operations of 1943-51 (Sale and Archibald 1957). Many of the rides were overgrown and impassable (Elias 1973).

The first management plan was written in 1958 and states that for parts of the wood natural change over time was the objective, but over the majority of the reserve the objective was to undertake positive management towards the development of high forest woodland with its characteristic species composition (Duffey 1958).

The purpose of this presentation is to briefly outline those management operations within the reserve that have, or perhaps have not, contributed to achieving that positive management objective.

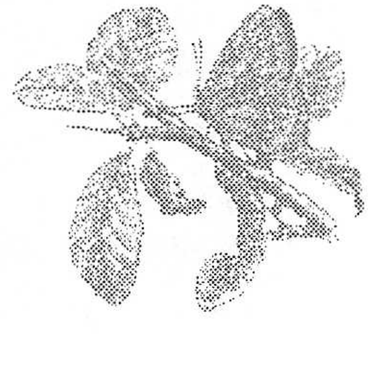
MANAGED CHANGE

High Forest Management

Sale and Archibald (1957) produced a detailed ten year working plan covering 40ha of the reserve and this was incorporated into the 1958 management plan. The main operation was to be a programme of thinning by singling of about 4ha per annum. I have not, incidentally, seen any documentation which states what subsequent management would take place.

A search of the Event Records for Monks Wood, however, shows that the only management undertaken within the high forest areas in the past 40 years was the thinning of approximately 1ha of compartment 24. Substantial change in the structure of high forest areas has taken place none-the-less, but the change has been by natural means not by active management (personal observations, and see Peterken, Chapter 1 this volume~~)~~.

1994



Coppice-with-Standards Management

Coppicing was re-established in 1954. A total area of five ha on a 12 year rotation was proposed in 1957, but both the area (now 12.71ha) and the rotation (now 10 years) were subsequently changed. There has been almost continuous annual coppicing in the wood from the winter of 1961-62 (see Table 1 and map on page vi).

Table 1 Cutting sequence for the coppice plots in Monks Wood since its establishment as an NNR in 1953

Compartment	Area(ha)	
2f	0.61	66/67 87/88
2g	0.5	64/65 90/91
8b	0.81	61/62 76/77 89/90
12d	0.5	61/62 78/79 88/89
13a	0.24	61/62 85/86
19a	0.32	76/77 92/93
23a	0.8	1954 61/62 70/71 84/85
23b	0.97	63/64 71/72 85/86
23c	0.9	65/66 74/75 87/88
23d	0.8	69/70 82/83 92/93
23e	1	69/70 83/84
23f	0.7	64/65 73/74 86/87
23g	0.9	66/67 75/76 88/89
24b	0.81	63/64 71/72 85/86
27c	0.5	68/69 91/92
27e	0.9	? 84/85
27d/30c	1.45	65/66 88/87

During the first 20 years or so, considerable attempts were made to increase the stock of hazel *Corylus avellana* by planting out transplants and by layering of shoots, particularly during the late 1960s (by Dick Steele and Monks Wood Woodland Section) but these suffered severe damage from rabbits and hares. Acorn and oak *Quercus robur* transplants were similarly widely used in the coppice and other compartments but, as a survey by Jeremy Woodward (Woodward 1981) of the oak plantings revealed, most seem to have died. Hazel is now comparatively scarce in most coppice compartments. Since 1985 each year's coppice regrowth has needed protection from muntjac deer *Muntiacus reevesi* browsing, by brash over the stools in the first three years but by electric fencing from 1988.

There has been no long-term monitoring of the coppice management to judge the success or otherwise of it. Anecdotal evidence from the late 1950s early 1960s suggests that the ground flora is less rich now than it used to be and certainly, when compared with some of the better Suffolk coppice woodlands, it

has not been particularly rich in the 15 years that I have been involved with the management of the reserve. In the last 10 years this has probably been more noticeable. Flowering early-purple orchid *Orchis mascula* and Greater-butterfly orchid *Plantanthera chlorantha,* for example, have become the exception not the rule, as has abundant flowering of primroses *Primula vulgaris* and even violets *Viola* spp. On the other hand the open, sunny conditions of the freshly cut coppice plots suit a range of insects, and later in the cycle the plots provide the right structure for a small population of nightingales *Luscinia megarhynchos.*

Pond and Stream Management

A relatively minor management category, but over the years several ponds have been cleaned out to prevent them silting up and bankside vegetation has been cut back. Of more significance as regards scale was the dredging of lower pond in 1961, the strengthening of its dam and the installation of a concrete sluice. The dam was leaking again by the mid 1980s and in 1991 piling was driven into the dam either side of the sluice to cure that leak. There now appears to be another leak elsewhere in the dam.

The Ewingswode stream was dammed in compartment 7 (in 1964) to create a seasonally inundated and marshy area but the dam has not been maintained and is no longer effective.

The colonisation by water violet *Hottonia palustris* of Broad Ride Pond in 1972 was thought to have resulted from accidental introduction through using the tractor from Woodwalton Fen (where the species is common) to clean out the pond in September 1970.

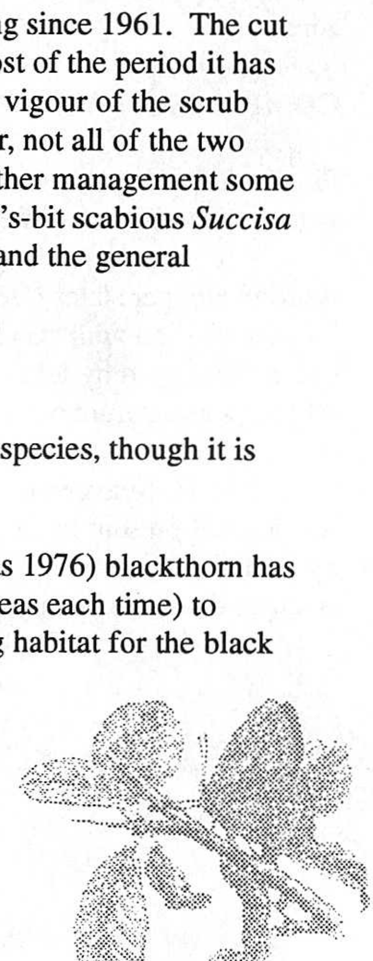
Field and Glade Management

East Field, West Field and the glades have been managed by mowing since 1961. The cut material seems to have been left *in situ* in the early years but for most of the period it has been cut and gather management on an almost annual basis. As the vigour of the scrub regrowth in the fields has declined during the last 10 years, however, not all of the two fields have been cut in each year. Coincidental with this cut and gather management some species -eg pale sedge *Carex pallescens,* Oval sedge *C. ovalis,* devil's-bit scabious *Succisa pratensis* -have become widely distributed and/or locally abundant and the general richness of the floristics has increased (personal observation).

Species management

There has been quite a considerable input into management for two species, though it is their habitats that have been managed not the species themselves.

Following the prescriptions in the report of Jeremy Thomas (Thomas 1976) blackthorn has been cut in compartment 16 on at least seven occasions (different areas each time) to improve age structure with the objective of providing good breeding habitat for the black hairstreak *Strymonidia pruni.* It is not known if or how this has affected the population of that rare butterfly, however.



The other species is the rare plant crested cow-wheat *Melampyrum cristatum*, the grassland/wood edge habitat of which has, since 1972, been mown tightly and raked over on several occasions and scrub has been cut back occasionally. After the cutting back of scrub in particular, the number of cow-wheat plants has increased - from 87 in 1974 to 454 in 1975, and from 12 in 1978 to 400 in 1979 for example.

Reintroductions were attempted for two butterfly species in the 1980s, namely wood white *Leptidea sinapis* and pearl-bordered fritillary *Boloria euphrosyne*, but both failed.

Ride Management

Management of the 18.5km ride system within the reserve has been by far the greatest activity.(See illustrations on pages 18, 28 and 44)

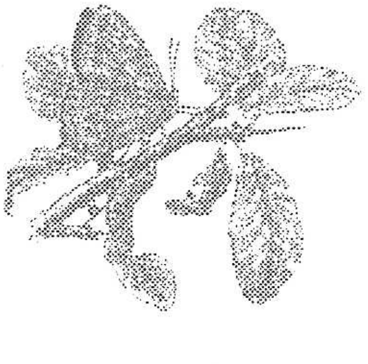
The Event Records suggest that up until 1960 all rides, apart from Main Ride, Stocking Close Ride and Hotel Ride were densely overgrown and virtually impassable, and this is confirmed by photographs taken at the time by John Thompson and others. During 1961-64 most of the others had been cut back to their original width but by todays standards the rides were still rather narrow. By 1973 it had been decided that some of the rides should be substantially widened and over the five years 1973-78, Hotel Ride, Stocking Close ride, Barrow Ride and most of Main Ride were widened to a width of between 15 and 20 metres.

A four year rotational mowing of ride side shrubs was stipulated in the 1964 management plan but the first recorded rotational mowing was in 1971. It continues today, though on a two or four year rotation for the herb zone and a seven to ten year rotation for the shrub zone.

COMPARISON WITH PREVIOUS HISTORY

Finally, how does this management activity and the changes brought about by it compare with the woods previous history. I think 'fundamentally different' is the right description.

As Max Hooper states (Hooper 1973) the wood was actively coppiced up until 1914 on a 20 year rotation with standards also being harvested. That centuries old system was more-or-less destroyed by felling after the First World War by Canadian lumbermen. Over the 40 year's as a nature reserve, 12.71 ha of the subsequent regrowth has been returned to coppice-with-standards which, together with the widened rides and the fields that were created by H. Neaverson in 1943, provide a link back to the past for those light demanding species still present in the wood. The rest of the wood, however, has been left to develop by natural processes into high forest. Little, if anything, can be quantified as to the changes that have been brought about by the development of high forest but there are plenty of winners as well as losers in my view, and perhaps as time continues to create a more diverse woodland structure, as it has over the last 80 years, there will be more winners than losers.



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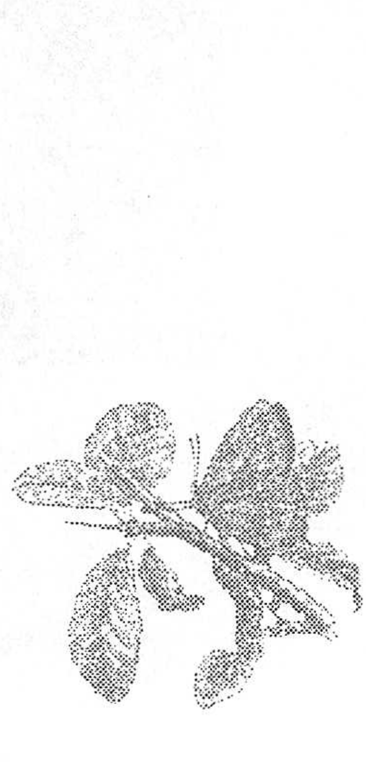
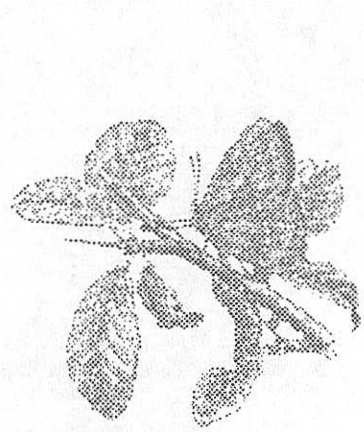


1972

1992

Main Ride looking south from junction with Quarter Ride

Chapter 2
How has wildlife changed?



CHANGES IN VEGETATION AND FLORA
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INTRODUCTION

I have known Monks Wood for just over 30 years and what I have to say will be based on casual observations made in the reserve during walks at lunchtime and longer visits to look for particular species or on visits with the local natural history society.

I will also draw upon data collected by wardens and other staff regarding rare or uncommon species. I would particularly like to pay tribute to Mr Marriott, the first warden of the reserve and to his successors, David Elias, Jeremy Woodward and David Massen; to John Thompson the first warden naturalist and especially to Maurice Massey who has kept observations going on uncommon and rare species and who has made them available to me.

I will try not to trespass on ground which will be covered by other speakers but there may be small areas of overlap. Unless Keith Kirby tells us to the contrary, it is a sad fact that there has been little long-term monitoring of vegetation in the wood, although there have been numerous starts made in the past : there is no botanical equivalent of the Butterfly Monitoring Scheme about which we shall be hearing shortly. (Pollard & Yates, 1994).

While management activities have been accurately recorded on the event record system for over two decades, there have been few attempts to monitor the effects of management on the biota. In one sense this is why we are holding today's meeting.

PROBLEMS WITH THE DATA

Any attempt to compare the number of plant species present in the wood in the past with those present now is fraught with difficulties. These include:

1. Were records included in the Monks Wood book confined to those from the wood itself? Were boundaries clearly defined? Some of the old plant records accepted for the book were probably not actually from within the wood. This applies especially to grassland species. For example, kidney vetch *Anthyllis vulneraria* was recorded from Saul's Lane and Bevill's Lane in 1962 before those tracks were made up and it is doubtful if this species actually ever occurred in the wood. It is likely that some of J G Dony's records of species such as slender trefoil *Trifolium micranthum*, many-seeded goosefoot *Chenopodium polyspermum*, soft-brome *Bromus mollis* and the hybrid *B. x pseudothominii* were from the fields situated to the south of the wood.

2. In the absence of herbarium specimens it is impossible to check inaccurate identifications.. For example, the record of marsh pea *Lathyrus palustris* by J F Archibald (1954-56) is unlikely to be correct, as this is a species of wet fens and does not normally occur in woods.

3. Species with long-lived seed banks which require special conditions for establishment may not be seen for many years yet reappear spasmodically. For example, water-purslane *Peplis portula* (present at only 2 sites in the county; Brampton Wood and Monks Wood) was last recorded in Monks Wood in 1960 by Dr SM Walters in Neaversons Ride and in a glade in compartment 2 but was refound at both sites this year by Jane Croft. A special search for the species this year in Brampton Wood has resulted in it being found at about 6 sites with a total population of more than 300 plants.

4. The increase in number of species in 'difficult' groups which occurs when specialists visit a site. Encouraged by A L Primavesi, C D Preston and J Croft looked carefully at *Rosa species* and hybrids and added about 11 taxa to the list for Monks Wood and its environs.

MAJOR CHANGES WHICH HAVE OCCURRED

1. A dramatic decrease in the flowering of pre vernal and vernal species has occurred. The sheets of primrose *Primula vulgaris*, large stands of bluebells *Hyacinthoides non-scripta* and the abundance of wood anemone *Anemone nemerosa* which were specially noticeable in the two years following coppicing have ceased to be a feature of the wood. Violets (*Viola riviniana* and *V. reichenbachiana*) have also decreased.

2. Rides have become much more grassy in the past 10 years and less floriferous in early and mid summer. The increase in wood small-reed *Calamagrostis epigejos*, a rhizomatous perennial, has been most marked. Other grasses, such as wood false-brome *Brachypodium sylvaticum* have also increased considerably, particularly where rides have been shaded by over-hanging vegetation. A study of the ride flora, carried out by Juliet Payne in 1993, has quantified the spread of coarse grasses on rides in the period 1977 to 1993.

3. There has been a significant increase in the amount of bramble in coppiced plots and it appears to persist even when the canopy closes.

4. *C. epigejos* and tufted hair-grass *Deschampsia cespitosa* have increased in West and East Fields and especially in West Field, resulting in the build up of a smothering litter. East Field has also been invaded by scrub which is partially controlled by swiping.

5. Pale sedge *Carex pallescens* has increased considerably in East Field and the oval sedge *C. ovalis*, a rarity in the county, continues to be plentiful in these ex-arable fields.

DETAILED CHANGES

Of the 378 plant species listed in the Monks Wood Book, about 70 have not been recorded since 1980 (see Table 1), while 38 new species have been added to the post 1973 list (see Table 2). On the face of it this is a net loss of 32 species but great caution is needed in interpreting this kind of data, for the reasons I have outlined previously. Many of the species listed as absent are arable weeds and are to be found in the fields around Monks Wood and we cannot be sure if they were actually ever recorded in the wood. Even now, they are likely to turn up on disturbed soil and to disappear the same year and not be seen again for years. Others have been seen but the information not transmitted to NCC/EN, eg American willowherb *Epilobium adenocaulon,* sharp-leaved fluellen *Kikxia elatine*, and the round-leaved fluellen *K. spuria*.

Table 1 Vascular plant species listed in *Monks Wood: A Nature Reserve Record* that have not been recorded since 1980.

Pyrus communis
Rubus apiculatus
R. conjungens
R. discerptus
R. rufescens
R. tuberculatus
R. ulmifolius
R. vestitus
R. watsoni
Salix alba

Agropyron caninum
Agrostis canina
Alopecurus myosuroides
A. pratensis
Avena fatua
Bromus commutatus
B. mollis
B. racemosus
Catapodium rigidum
Hordeum secalinum
Phleum bertolonii
Zerna erecta
Carex pilulifera

Anacamptis pyramidalis
Anthyllis vulneraria
Arctium lappa
A. minus spp nemerosum
Artermisia vulgaris

Atriplex patula
Campanula trachelium
Cerastium semidecandrum
Chaerophyllum temulentum
Chenopodium polyspernum
Chrysanthemum parthenium
Cichorium intybus
Cirsium acaulon
Colchicum autumnale
Cynoglossum officinale
Digitalis purpurea
Epilobium adenocaulon
E. obscurum
E. palustre
Epipactis helleborine
Erigeron acer
Euphorbia amygdaloides
E. exigua
E. lathyrus
Galeopsis speciosa
Geranium pyrenaicum
Kickxia elatine
K. spuria
Lathyrus palustris
Leontodon taraxacoides
Melilotus alba
M. officinalis
Ononis spinosa
Onopordum acanthium
Ornithogalum umbellatum

Peplis portula
Pimpinella major
Potentilla anglica
Ranunculus arvensis
Rumex palustris
Sagina apetala
Sanicula europaea
Schoenoplectus lacustris
Silaum silaus
Dilene dioica
S. noctiflora
Sison amomum
Sisymbrium officinale
Spiraea salicifolia
Thlaspi arvense
Torilis arvensis
Tragopogon pratensis
Trifolium fragiferum
Urtica urens
V. persica

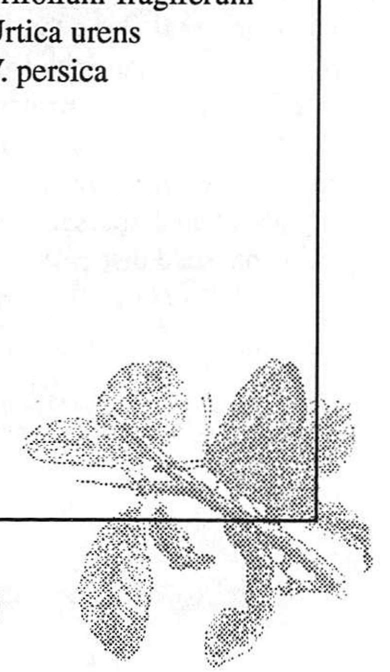


Table 2. Vascular plant species added to reserve's list post 1973

Acer pseudoplatanus	Athyrium filix-femina	Orchis morio
Aesculus hippocastanum	Dactylorhiza incarnata	Plantago media
Ribes nigrum	Epilobium roseum	Raphanus raphanistrum
Rosa caesia ssp glauca	G. uliginosum	Reseda lutea
R. obtusifolia	Hesperis matronalis	Rumex acetosa
R. stylosa	Hypercium pulchrum	R. hydrolapathum
	Lamium prupureum	Sanguisorba officinalis
Agrostis gigantea	Lemna minor	Scrophularia auriculata
Alopecurus geniculatus	L. trisulca	Scutelaria galericulata
Avenula pubescens	Leucanthemum vulgare	Veronica polita
Elymus repens		V. scutellata
Glyceria fluitans		Vicia hirsuta
Hordeum murinum		Viola canina
Phalaris arundinacea		V. tricolor
Carex divulsa		

Of the newcomers, some may have been introduced accidentally, eg it is likely that green-winged orchid *Orchis morio* originated from hay brought from Bratoft meadows, Lincs by Derek Wells and some of the aquatic species may have come into the reserve on tools or machinery used by the estate workers. Others, such as floating sweet-grass *Glyceria fluitans* and grey sedge *Carex divulsa* are likely to have always been there but were overlooked. The message is that the flora of woods is dynamic, with a central core of species which are generally frequent or abundant around which changes in the quantities and quality of other species occurs. Why these changes occur will be addressed later.

Crested Cow-wheat *Melampyrum cristatum*

First recorded in 1845 by F Townsend. There are fine specimens in the British Museum collected from Monks Wood by J T Boswell-Syme in 1846. It is a rare species confined to about 20 sites in eastern England. It occurs at the edges of ancient woods, mostly on calcareous soils. At Monks Wood it occurs on the roadside outside (the ancient woodland boundary) and along the southern edge of the wood, in a narrow band at one point. The plant is an annual, with haustorial connections to grasses. Its seeds are heavy (38.6mg) and Dave Horrill estimated that each plant produces 80-300 seeds per plant. The seeds fall around the mother plant and although they possess a fleshy caruncle and dispersal by ants has been reported, the fact that plants are always found in roughly the same area each year suggests that dispersal is very limited. No new sites are ever reported, which confirms the view that seed dispersal is minimal. The plant is thought to have a long-lived seed bank but there is little direct evidence to support this view.

The population has been monitored at Monks Wood by NC/NCC/EN staff since 1968, with the following results:

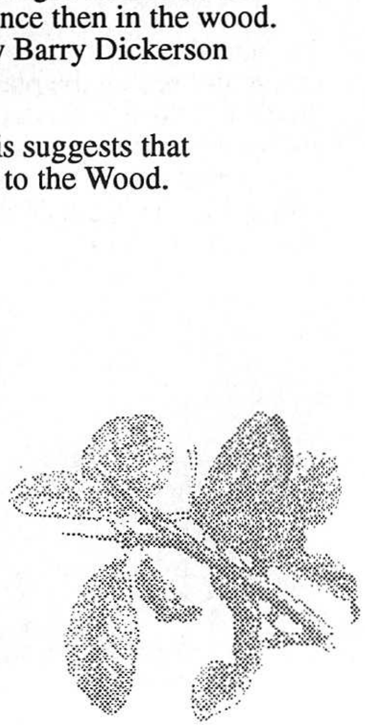
Year	No. Plants
1968	>150
1972	281
1973	122
1974	87
1975	454
1978	12
1979	400
1980	c.4000
1981	Too numerous to count
1982	Not counted but flower spikes noted
1983	Not counted but noted "numbers down"
1984	Declining
1985	Increase
1987	300
1988	50
1989	48
1990	71
1991	66
1992	c.20
1993	11

Disturbance of the ground when a hedge was cut to the ground in 1978-79 resulted in a massive increase in the population, presumably originating from the seed bank. Germination may possibly be stimulated by light. Despite the fact that the hedge has been kept cut back and the ground disturbed by raking, the population appears to have declined considerably since 1985 for reasons which are not at all clear.

Bird's-nest Orchid *Neottia nidus-avis*

A saprophytic orchid usually associated with hazel. Not easy to find because of its brownish colour but a speciality of Mr Marriott who found it in several compartments in the wood from 1961. The number of flowering spikes recorded has ranged from 1 to 12 (1968), the last spike being seen in 1984. It has not been observed since then in the wood. The plant is known from Waresley Wood and was monitored there by Barry Dickerson from 1978 to 1982 but has not been seen there since 1983.

It is not only Monks Wood which appears to be losing species and this suggests that regional factors may be responsible rather than management specific to the Wood.



Purple helleborine *Epipactis purpurata*
A rare, shade tolerant orchid, known from only 3 sites in the county. First found in 1977 (or possibly before, but data not totally clear). The number of spikes has been monitored each year and in the last few years plants have been protected from grazing by deer and rabbits by caging the plants as the leaves appear.

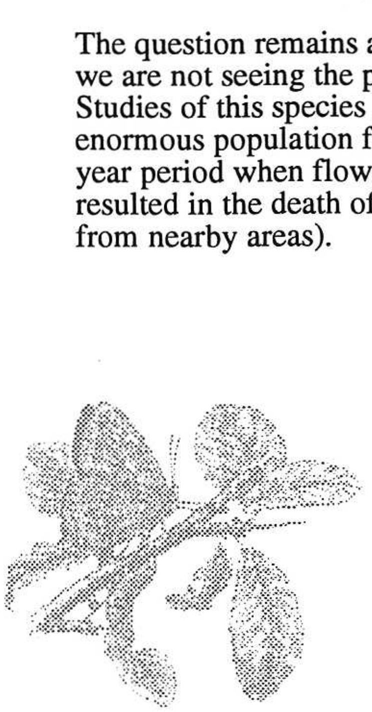
Year	No. spikes
1977	4
1978	15
1979	12
1980	13
1981	18
1982	8
1983	6
1984	9
1985	12
1986	17
1987	14
1988	19
1989	6
1990	4
1991	0
1992	0
1993	4

Droughts in 1990 and 1991 were probably responsible for non-appearance and possible death. Heavy rain from July 1992 and the emergence of four plants in 1993 adds weight to this suggestion (see also next species).

Southern-marsh orchid *Dactylorhiza praetermissa*

A single spike of this orchid was found by Mr Marriott in 1964 growing on the edge of Main Ride adjacent to compartment 16. There was a single spike in 1968, 6 in 1969, seen in 1970 (but how many not recorded) none found in 1972-75. In 1980, 14 spikes were found by M Massey in East Field, 32 in 1981, 50 in 1982, 36 in 1983, 50 in 1984, 70 in 1985 and 43 in 1987. No plants were seen since then until 2 were found in 1993. This again suggests that rainfall may have a marked effect on whether or not leaves and/or flowering spikes are produced. (The number of common spotted orchid *D. fuchsii* also decreased dramatically in East Field from 1987 onwards).

The question remains as to whether inflorescences are grazed by deer and/or rabbits and we are not seeing the plants or whether the plants perished in the 1990-91 drought period. Studies of this species by Leo Vanhecke in Belgium have demonstrated that it shows enormous population flux eg 9000-10000 plants in flower in 1973-74 followed by a three year period when flowering individuals were completely absent. (Severe flooding in 1975 resulted in the death of all orchids in the study area but it was recolonised by seed blown in from nearby areas).



Herb-Paris ***Paris quadrifolia***

A perennial herb, reluctant to flower and difficult to find among stands of dog's mercury *Mercurialis perennis*. Counts started in 1968 but known previously in the wood by Mr Marriott. Mostly under hazel coppice in compartments 17 and 6. Population data:

Year	No. Plants	Year	No. Plants
1968	24	1984	33
1972	94 (8 in flower)	1985	21
1973	117	1986	30+
1974	27	1987	27
1975	60 (3 in flower)	1988	0
1979	5	1989	0
1980	5	1990	0
1981	15 (3)	1991	0
1982	15	1992	0
		1993	0

The drop in numbers does not coincide with any weather pattern and it may be that its decline is associated with increase in deer numbers.

Small Teasel ***Dipsacus pilosus***

A biennial herb which often appears in quantity when disturbance takes place, presumably originating from the soil seed bank. It appeared around the pond following excavation and along woodland edges. Population data:

Year	No. Plants
1972	270
1973	133
1974	788
1975	2309
1978	203
1980	78+
1981	Little change from last year
1982	Little change
1983	Not so abundant as last year
1990	A few plants
1992	A few plants

Numbers fluctuate greatly and population benefits from disturbance. Not known if eaten by deer.

Ferns

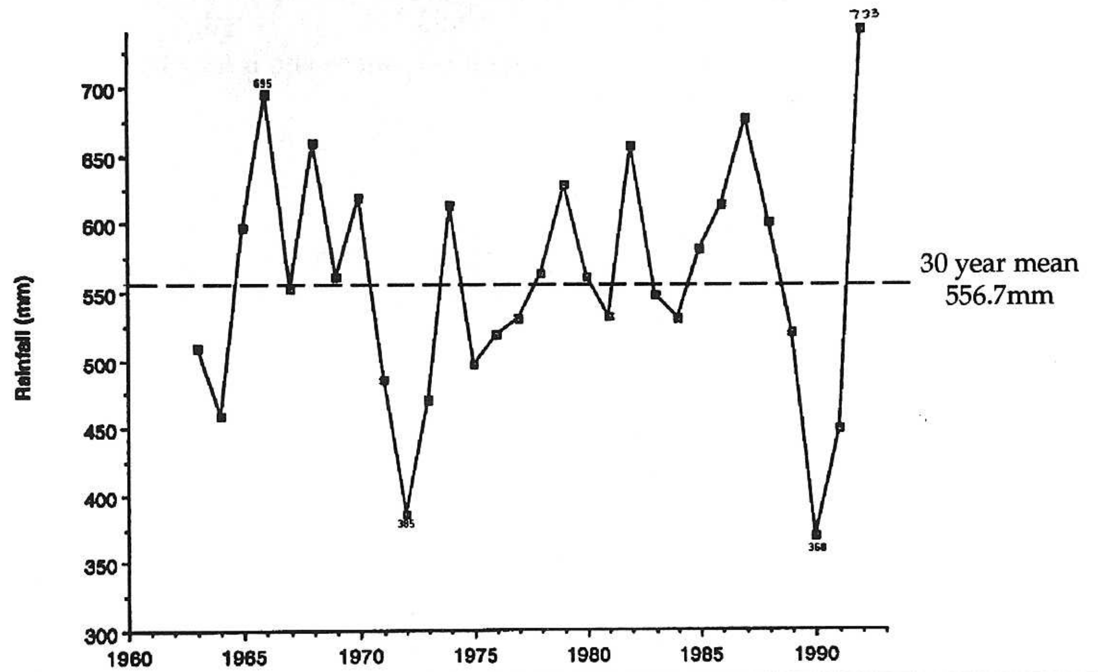
Generally seem to have declined, whereas in other woods around here, eg Lady's Wood, they have increased.

CAUSES OF CHANGE

Climate

Meteorological data has been kept at Monks Wood since the Experimental Station was set up in 1962. During the 30 year period from 1962 to 1992, there have been considerable differences in climate between years, but without further detailed work it is unsafe to ascribe changes in floristics to any one particular climatic parameter. Observation suggests that differences in both the mean annual rainfall (Figure 1) and the distribution of rainfall throughout the year has an effect on the performance of particular species. Orchids seem particularly vulnerable to drought and will only flower profusely in years following good rainfall.

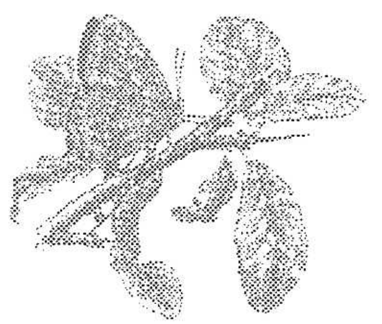
Figure 1 **Total Annual Rainfall (mm) Monks Wood 1963-92**



Mean annual rainfall has varied from only 368mm in 1990 to 733mm in 1992. 1971 to 1973 were years in which rainfall was well below the 30 year mean (556mm) but this was followed by a succession of wet years, particularly in the period 1984 to 1987 when soils were waterlogged for most of the winter period. This was followed by a period (1989 to 1991) when soils were dry for much of the year and no standing water was to be seen in the fields. The long-term effects of such variations in rainfall on vegetation and species is not known.

Grazing

Probably the most important change in the wood over the past 15 years has been the increase in the numbers of muntjac deer. These severely cut back regenerating coppice. They also eat primroses, dog's mercury, bluebells and a host of other species, although what they eat is only just being studied in any detail by Dr A S Cooke (1994). Whether justly or not, muntjac are usually blamed for the decline in attractiveness of the flora which has occurred over the past 15 years or more.



Increase in NOx and other nutrients?

There is considerable evidence that the deposition of nitrogen from the atmosphere has increased over large areas of Europe during the last decade. In parts of the Netherlands values of up to 60kg N $ha^{-1}yr^{-1}$ have been reported. Tor-grass *Brachypodium pinnatum*, a rhizomatous perennial has increased considerably in Dutch chalk grasslands and it has been suggested that the increased deposition of atmospheric nitrogen is responsible.

Monks Wood lies in a region which is currently receiving between 7 and 14kg N $ha^{-1}yr^{-1}$ from atmospheric sources, although its proximity to the A1 road could conceivably result in it receiving much higher levels of nitrogen deposition. Whether this is benefitting *Calamagrostis epigejos* and other coarse grasses is unknown, but it is speculated that this may well be happening. Research into the levels of nutrients reaching sites such as Monks Wood is in my view an imperative.

Change in management, particularly of rides.

Rides in woodlands often support a substantial proportion of the total flora of the wood. They are often rich in grassland species and frequently, because of their age, contain species which are now scarce in the wider countryside. Massey (1994) suggests that prior to 1960 all rides apart from Main Ride, Stocking Close Ride and Hotel Ride were densely overgrown and virtually impassable. The Monks Wood book gives the following details of ride management:

(1) central part of each path cut once, twice or three times each year with an autoscythe;

(2) smaller rides are further cut across their full width each autumn with a tractor and rotary cutter;

(3) larger rides were cut in rotation, Main Ride, Hotel Ride and Stocking Close ride, Westhouse Ride and Leeds Ride being cut on a 8 year cycle;

(4) Barrow Ride was cut on a 6 year rotation.

This kind of management (basically infrequent cutting) is in my view likely to lead to domination by grasses and taller species, with severe invasion from certain shrubs, especially those which spread by vegetative means. This type of management must contrast with earlier management when rides were either cut annually for hay or would have been grazed by horses used in timber extraction. Another factor which would have been likely to have prevented dominance by grasses would have been annual disturbance by carts and draught animals employed in harvesting woodland products.

In summary, it is clear that many factors have influenced the present composition of the wood, some historical, some to do with present and recent management practices. It is unlikely that any one factor is paramount and explanations should be sought through a multivariate approach, underpinned by careful monitoring and recording.

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Pollard & Yates, 1994, Butterflies in Monks Wood 1953-93.

Massey M.E. 1994, Managed Change

All of above in
Massey & Welch (eds) Monks Wood National Nature Reserve: The Experience of 40 Years 1953-93. English Nature, Peterborough

1972

1992

Barrow Ride looking west from intersection with Main Ride

BUTTERFLIES IN MONKS WOOD 1953-93

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INTRODUCTION

This account is divided into two parts, each covering a period equal in length but very different in the nature of the information on butterflies. The first period was from the declaration of the reserve in 1953 until 1972, for which no quantitative information on the butterflies is available; the second is from 1973 to the present, when the butterflies of Monks Wood have been monitored as part of the Butterfly Monitoring Scheme (Pollard, 1982; Pollard and Yates, 1993).

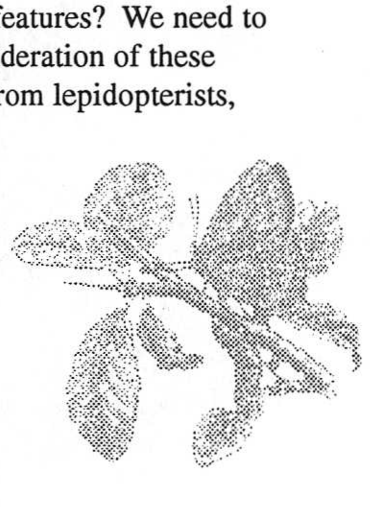
THE LOSS OF BUTTERFLY SPECIES FROM MONKS WOOD 1953 TO 1972

The pattern of change

Monks Wood has featured in several accounts of the conservation of British butterflies as a spectacular example of loss of species from nature reserves (eg Thomas, 1984; Emmet and Heath, 1989; Warren, 1992). In the most recent account by Warren, 35 species are considered to have been resident in 1953 when the reserve was declared; of these 35 species, 12 are listed as having since become extinct. Warren's list is discussed here for convenience, simply because it is the most recent. No criticism of any of these authors is intended, as they used the best available sources. However, two questions arise from the statistics of losses from Monks Wood; first, do they provide a fair summary of events; secondly, why did any loss of species occur.

The bald statistics, 12 extinctions amongst 35 species resident in 1953 can be made to seem much worse if we consider that 19 of the "original" 35 species are widespread butterflies of the agricultural countryside. All of these common species are still present. Examples include the green-veined white *Pieris napi*, small tortoiseshell *Aglais urticae*, and orange tip *Anthocaris cardamines* which occur in all but the most barren (in wildlife terms) areas of farmland; other of these widespread species, such as the small copper *Lycaena phlaeus* and common blue *Polyommatus icarus*, are less ubiquitous, but still occur in green-lanes, abandoned railway-tracks and other surviving fragments of rough grassland in the Cambridgeshire countryside. Thus of the other 16 Monks Wood species, which are the rare or locally distributed butterflies, no fewer than 12 (75%) have been reported as extinct in Monks Wood.

Having presented the situation at its worst, are there any redeeming features? We need to look in more detail at the 12 species reported as extinct. Our reconsideration of these species is based on a study of records, mainly in the form of letters from lepidopterists, held by English Nature in the Monks Wood files. These letters were the result of the foresight of D O Elias, a former warden of Monks Wood, who in the mid 1970s wrote to many collectors known to have visited Monks Wood earlier in this century. Also of particular value is an unpublished report by H A Leeds to the



Nature Conservancy at the time that the reserve was declared in 1953 (referred to here as Leeds, 1953).

His report covers the period 1890-1951. A more general account is given by Leeds (1945). There may be other relevant material in reserve files which have not been consulted; this review cannot therefore be regarded as complete.

Interpretation of the records is not straightforward. For example, in some cases, there may be a record of an individual of a species following several years without records. There are several possible explanations for such records; they may be misidentifications, releases, or non-breeding individuals straying from populations elsewhere. It is also possible that such a sighting was from a small breeding population, but in general, depending on the species, we have not taken such a record to be evidence of a resident population in the wood. There is of course a large subjective element in such judgements.

Notes on the 12 "extinct" species

Species 1.

The white-letter hairstreak *Strymonidia w-album*, may be excluded from the list of extinctions, as it was still present very recently (Welch, 1989). EP is the source of the erroneous assumption that the species had gone from the wood. It was not recorded on the monitoring route for 11 years (1980-1990), but survived on the east edge of the wood.

Species 2.

The chequered skipper *Carterocephalus palaemon* seems to have been present only for a very short period in this century. It was not listed by Leeds (1953) but was recorded in the late 1950s and 1960s, with a (possible) last sighting in 1971. Thus this species does not seem to have been present when the reserve was declared and cannot reasonably be considered to have been lost since the declaration of the reserve. It has since become extinct in England, although it survives in Scotland.

Species 3.

Leeds (1953) considered that the dark green fritillary *Argynnis aglaja* was already extinct by 1951. He thought that its extinction was caused by the ploughing of unimproved grassland adjoining the wood during the 1939-45 war. There are no clear statements on file that it was present after the declaration of the reserve.

Species 4.

The Duke of Burgundy *Hamaeris lucina* was also to be found in the fields around Monks Wood and, like the dark green fritillary, seems to have become extinct during the war (Leeds, 1953). The extinction date of 1957, quoted by Thomas (1984) and Warren (1992) stem from an isolated record, which is perhaps open to doubt, of several individuals in that year. It has been, at best, very rare in the wood during this century.

Species 5.

The records also suggest that high brown fritillary *Argynnis adippe* was generally rare in the wood during this century. For example, G E Hyde, who collected frequently in Monks Wood during the 1930s wrote "never did see this species in Monks Wood". However, it was certainly present from time to time and seems to have increased in abundance in the early 1940s. Leeds considered that it became extinct in 1947; however, there are two records for 1960 and Heath (in Steele and Welch, 1973) gives 1962 as the last year. Its status by 1953 seems open to some doubt and we suggest that it should not have been considered to be a resident species in 1953.

Species 6.

The brown hairstreak *Thecla betulae*, a butterfly of blackthorn scrub and hedgerows, was widespread in the wood in the early years of this century, but declined during the late 1950s and became extinct during the 1960s. This species is very easy to overlook and a single record near Woodwalton Fen in 1991 (N. Greatorex-Davis, personal communication) suggests that it survives in the general area.

Species 7&8

Two fritillaries, the pearl-bordered *Boloria euphrosyne* and silver-washed *Argynnis paphia*, were recorded as common in the wood during the first part of this century. Both declined to extinction during the 1960s. There were a few sightings of silver-washed fritillaries in the 1980s, but there is no indication of a breeding population. It seems possible that these were released individuals, but we have no basis for this suggestion.

Species 9,10,11&12

A group of four species, the dingy skipper *Erynnis tages*, green hairstreak *Callophyrs rubi*, brown argus *Aricia agestis*, and marbled white *Melanorgia galathea*, were mainly associated with the fields and smaller clearings within and around the wood. All of these species seem to have become extinct during the 1960s or 1970s. The marbled white just survived into the period of monitoring (1973-93), with no record on the monitored transect after 1973. Very recently there have been records of single individuals in Bevills Wood (1991) and sightings in Monks Wood (Dickerson, 1992; J A Thompson, personal communication); thus recent colonisation is a possibility. It is reasonable to assume that the war-time ploughing of grassland around the reserve was damaging to these four species.

The survivors of the 16 rare and localised species are the purple *Quercusia quercus*, white-letter *Strymonidia w-album* and black hairstreak *Strymonidia pruni*, grizzled skipper *Pyrgus malvae* (although its survival is in some doubt, as discussed later) and the white admiral *Ladoga camilla*. Of these, the black hairstreak may have become extinct following the fellings after the First World War; certainly it was reintroduced in the 1920s (Thomas, in Steele and Welch, 1973), but its earlier

extinction cannot be certain. The white admiral colonised the wood in the early 1940s during a period of general range expansion (Pollard, 1979).

Several other butterfly species have been recorded in the wood over the last 150 years, but apart from the purple emperor *Apatura iris*, their status as resident species is uncertain. The purple emperor, a butterfly of high forest, disappeared during fellings immediately following the First World War (Leeds 1953).

This brief review suggests that the decline of Monks Wood butterflies since 1953 is severe, but not quite as severe as has been suggested elsewhere. A total of seven extinctions since the declaration of the reserve seems to be a more accurate approximation than the 12 species often quoted.

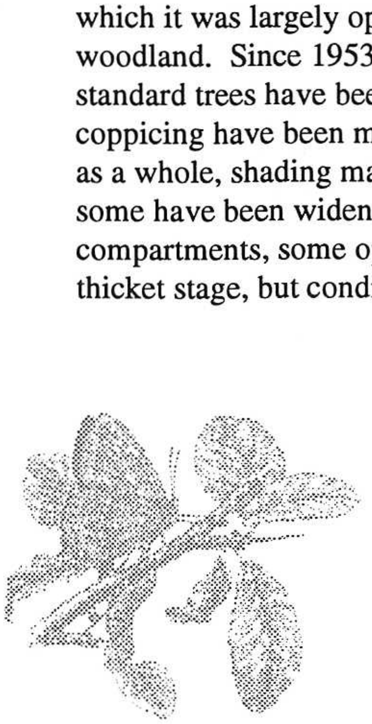
Causes of the changes

To understand the periods of abundance and scarcity, and also the extinctions of butterflies within Monks Wood, we suggest that two main factors need to be considered; these factors are changes in the structure of the wood and changes in weather. In addition, there may have been a major impact of loss of unimproved grassland, by ploughing during the 1939-45 war, and improvement of other grassland in the general area of the wood.

Changes in the structure of Monks Wood

The dominant management event in the history of Monks Wood during this century was the felling of much of the timber following the 1914-18 war. Prior to this, the wood had been coppiced regularly (Hooper in Steele and Welch, 1973). These fellings were drastic; "more than half its area was a desert of grey ashes" (Leeds, 1945). Subsequently the trees were allowed to regrow with little or no management until the reserve was declared in 1953. Perhaps the only radical management in the intervening period was the clearance of trees and scrub to create East and West Fields, in an unsuccessful attempt at arable cultivation in the second World War.

Since 1920 therefore, in broad terms, Monks Wood has changed from an initial period in which it was largely open vegetation, through the gradual development of scrub to thicket woodland. Since 1953, coppicing has resumed in some 10% of the wood, but numerous standard trees have been left unfelled in the coppiced compartments and conditions after coppicing have been much more shady than in commercial management. Over the wood as a whole, shading may be assumed to have gradually increased in rides (except when some have been widened) and clearings as the trees have grown. Within the compartments, some opening of the canopy may have occurred as the trees have passed the thicket stage, but conditions remain shady.



Nearly all of the butterflies which have been lost from Monks Wood in the last 40 years are those normally associated (in woodland) either with permanent clearings or with newly felled areas. In the former category are the dingy skipper, green hairstreak, brown argus and marbled white, and in the latter the two woodland fritillaries; all of these species were lost in this period. It is certain that conditions for both of these groups of species were very good in the years following the post First World War felling of the wood but gradually deteriorated and, by the time the wood was declared as a nature reserve it is likely that conditions were already only marginally suitable for them. The seventh extinction, that of the brown hairstreak is less easy to explain. It requires blackthorn in rather more open situations than does the black hairstreak, and in particular makes use of hedgerows adjoining and radiating from woodland. It is possible that hedge removal in the Monks Wood area, together with the increased shade of clearings within the wood, were inimicable to it.

The same general pattern of increase and subsequent decline of butterflies in woodlands has been repeated more recently when ancient deciduous woods have been felled and replanted with conifers, as at Bernwood in Oxfordshire (Peachey, 1981) and at Picket Wood in Wiltshire (Pollard and Yates, 1993). In these and other similar woods many of the butterfly species formerly found in Monks Wood flourished while the planted conifers were small but declined as the trees grew and shaded the ground vegetation.

Thus the loss of butterfly species from Monks Wood since 1953 is consistent with the known vegetational changes in the wood. We cannot be sure that this is the whole story (and will consider a possible role of weather in the declines), but there is little doubt that losses were inevitable in the absence of radical woodland management.

Weather

There is little doubt that the abundance of butterflies is greatly influenced by weather (Pollard, 1988; Pollard and Yates, 1993). In particular many species benefit from warm summer weather. During this century summer temperatures have varied considerably, with warm summers predominating during the 1930s and early 1940s and with a cooler period in the 1950s and 1960s (eg Manley, 1974). It is likely that some butterfly species flourished during the warm period and indeed the spread of the white admiral may have been, in part, a result of this warmth (Pollard, 1979).

Thus the two decades prior to 1950 were, in terms of weather, particularly favourable for butterflies and the warm summers may have enabled some species to survive while shade conditions were deteriorating. The coincidence of deterioration in weather during the 1950s with further increasing shade in the wood may then have hastened the declines of many butterflies in Monks Wood.

THE PERIOD OF MONITORING FROM 1973 TO 1993

In this second period of twenty years, regular counts of butterflies have been made around a fixed transect route along rides and through East Field (Figure 1) (Pollard, 1982; Pollard and Yates in collaboration with D D Massen, 1993). It is emphasised that the results are for a particular route and may not be fully representative of the wood. In this account, a summary of the main findings are given for the route as a whole, for two managed rides and for East Field.

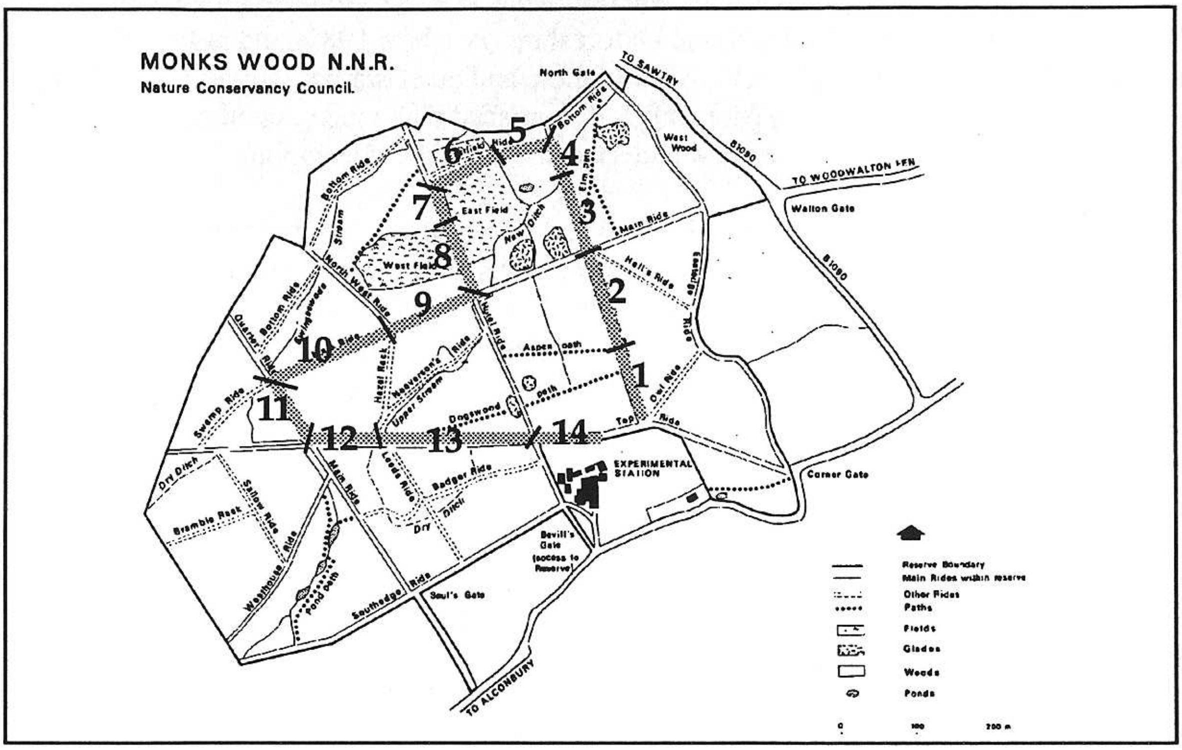


Figure 1 Route used for monitoring since 1973

The fate of the six rare butterflies which survived in the wood to the start of monitoring in 1973 is of particular interest (Table 1). One species, the marbled white, seems to have become extinct almost as monitoring began. The last sighting on monitoring counts was in East Field in 1973.

The rarer butterflies

The grizzled skipper flourished for a short period in the early 1980s following a period of ride management. Between 1972 and 1978 the rides along about half of the transect route were opened up by coppicing 5m belts of adjoining woodland either side. We cannot be sure that the brief period of abundance of the grizzled skipper was the direct result of this management, but believe that this was the case. In this period it was recorded frequently in managed rides. Since 1982 it has been recorded in only one year (1990) on monitoring counts, and its current status is uncertain.

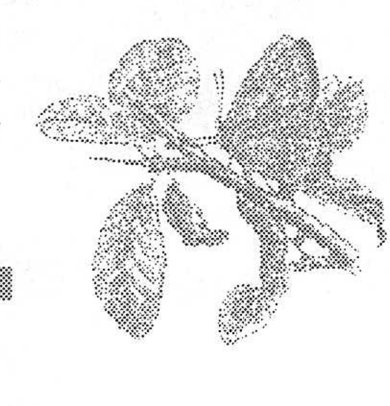
Table 1. Indexes of abundance of the six localised butterflies (populations more or less restricted to the wood) from 1973-92. The index is equivalent to the total number of butterflies seen on the assumption of one count in each of the 26 recording weeks from April to September. The transect method is not ideal for the hairstreaks, which fly relatively little and then usually at canopy height.

	73	4	5	6	7	8	9	80	1	2	3	4	5	6	7	8	9	90	1	2
grizzled skipper	1	1	2	4	1	2	4	44	10	2	0	0	0	0	0	0	0	2	0	0
black hairstreak	1	1	0	3	1	1	3	2	0	0	0	1	0	1	0	2	1	0	0	1
white-letter hairstreak	1	1	1	2	1	1	8	0	0	0	0	0	0	0	0	0	0	0	1	0
purple hairstreak	2	1	1	2	1	1	1	1	1	1	2	4	1	1	3	1	1	0	4	3
white admiral	6	1	2	11	2	1	3	0	0	0	1	1	1	4	4	2	2	0	0	1
marbled white	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

The white admiral was the subject of a five-year population study in Monks Wood (Pollard, 1979). A main aim of the study was to attempt to explain the expansion of range of this species in the 1930s, but information was also acquired on its distribution in the wood and on its main habitat requirements. It was concluded that the species should continue to flourish in the wood. Contrary to this expectation numbers have generally been low in recent years. The reason for this is not clear; it is possible that its food-plant honeysuckle is less abundant than formerly although there is no information available.

The monitoring method is not strictly appropriate for the hairstreak butterflies which tend to fly in the tree canopy. However, some limited information is available. The white-letter hairstreak was recorded regularly, but in very low numbers until 1979. In that year, most of the elms (its only food-plant) on the route were dying rapidly from Dutch-elm disease; curiously, as many more of the butterflies were seen in that year than in the six previous years together. It seems possible that the adults were dispersing from the dying trees to search for new ones. Since 1979 it has been seen in only one year on the transect route and, although it occurs elsewhere in the wood (Welch, 1989), its survival depends on that of elms.

The remaining two of the rarer species present at the start of monitoring seem to have maintained their status. Both are also canopy-flying hairstreaks and the data are scanty, but there is little evidence of decline in these results. The black hairstreak is especially catered for by the maintenance of a succession of clearings for its food-plant, blackthorn. However, this is a particularly sedentary butterfly and the managed areas are too far from the transect route for the effects of this management to be monitored. The second of these species, the purple hairstreak feeds on oak and there is no



reason, as regards its habitat, to expect anything other than its continued presence. In parts of the country the purple hairstreak is a widespread butterfly, using hedgerow oaks and also isolated trees. It is just possible therefore that Monks Wood itself is not essential for the survival of the species in the area.

In addition to the rarer species which were present in the wood in 1973, one further species, the wood white *Leptidea sinapis*, was introduced in 1984 when one of its food-plants, meadow vetchling *Lathyrus pratensis*, was particularly abundant. Initially the wood white increased in numbers, but soon declined and was not recorded after 1988. A subjective view is that the food-plant also declined over this period.

The common and widespread butterflies

A general feature of the changes in abundance of the commoner butterflies of Monks Wood has been the way in which their fluctuations have closely followed the collated index values based on all sites (Pollard, 1991). A few of the butterflies associated with shady situations, such as the green-veined white and ringlet *Aphantopus hyperantus*, have done rather better and an open ground species, the small heath *Coenonympha pamphilus*, rather worse than the all-sites trends; these changes may be a result of a further general increase in shade. However, in general it is the similarity to the national data that is most marked.

Local departures from wider trends have been used to indicate an influence of changes in the local biotope on the butterflies of an individual site (Pollard and Yates, 1993). Thus, the Monks Wood results suggest that there has been rather little change in the wood over the last two decades as far as the butterflies are concerned. This seems surprising, given the drastic opening-up of rides, by clearance of adjoining woodland, in the 1970s. We can look in more detail at an individual species to see what has happened.

The small heath is a butterfly of open situations and in some respect its requirements are similar to those of the butterflies of permanent woodland clearings which have been lost from the wood. The food-plants of the small heath are grasses. It has declined in the wood relative to wider trends since 1973 and the monitoring data makes it possible to examine the changing distribution of this butterfly since then (Table 2).

Throughout the period, the highest counts were recorded in East Field, although numbers there have declined markedly. In the rides, there has been a clear response to ride-widening (Table 2). For example Section 13 of the transect route (part of Barrow Ride) is on a north-facing slope. At the start of recording, it was particularly shady with rather few butterflies and no small heaths except in the extreme heat of the summer of 1976 when many butterflies sought shade away from their breeding areas. In winter 1977-8, a 5m strip of woodland on each side of Barrow Ride was cleared. Butterflies responded quickly. Most increased in abundance relative to wider trends, and the small heath seems to have established a population for a few years. (A few species, such as the ringlet, which requires rather shady condition, at first declined and increased some years later). After a few years the benefits for the small heath were lost and the species again disappeared. Thus

Table 2. Distribution of counts of the small heath *Coenonympha pamphilus* around the transect route 1973-92.

Years of management of widened rides shown by *. Section 6 is through east field. In some years, several counts were made in each recording week, leading to some very low section indexes: all indexes <1 have been rounded up to 1.

Years	1 *	2 *	3	4	5	6	7	8	9	10	11	12	13	14
1973					1	50	3	4	1	1				
1974						50		2		1				
1975					* 1	39	1	1						
1976	1	1			6	53	3	8	* 1	2	* 1	1	1	1
1977					1	17		1	1				1	
1978	2	1			2	17	3	3	4	1	1		* 3	
1979	3				1	21	3	8	9	1	2		1	
1980	1	2		1	4	40	1	16	12	3	6	2	5	
1981	1				1	13	1	4	3		1		2	
1982					1	8		4	4		3		1	
1983						2			1					
1984	1	1			1	8	1	2	1		2		3	
1985	1					8		1	1		1		1	
1986	1	1				20	1	1	1		2	1	2	
1987	1	1				16			2				1	
1988						5								
1989		1				13		1	1	1	2			
1990						13	1	1	4	1	3			
1991		1				10					4			
1992		1			1	9			1		2			

management of this ride was beneficial, but transient. Fuller results for this ride are presented by Pollard and Yates (1993), and the same general pattern was also evident in other managed rides following the fellings after the First World War and may also have been favoured by the warmth of the summers in the 1930s and

1940s. Some species may have disappeared and others become more restricted because of the loss of unimproved grassland around the wood. However, it is certain that conditions in the wood deteriorated as the trees closed over and that the survival of several species was in doubt by the time the reserve was declared. In the absence of further radical management the subsequent losses were probably inevitable.

It can be argued that corrective management, that is the rotational clearance of substantial areas of trees, is too expensive or too inimical to other wildlife in the wood to be considered. Such broader arguments are beyond the scope of this paper. The results from the limited amount of coppice management have been disappointing, perhaps partly because too many standards were left and also, of course, because the species of butterfly which might have benefitted have already been lost.

An alternative approach, management of strips of woodland at the edges of rides, is possible. As far as we are aware, there has been a clear demonstration that such limited management can maintain species of early woodland succession, such as the fritillaries, over a long period. In Monks Wood, ride-widening was begun and showed promise, but lapsed for too long a period of years.

Most of the butterflies which have disappeared from Monks Wood have also disappeared from, or become much rarer in, large areas of eastern England. The causes of the losses in Monks Wood, increased shading within woodland and loss of unimproved grassland, are also most certainly the main causes of these wider changes. Because of these losses, a further factor at an individual site is that, as its butterflies became more isolated from other populations, so the chances of recolonisation were reduced and permanent extinction more likely. It is possible, for example, that the high brown fritillary was an intermittent resident of the wood, but any further natural colonisation (should conditions again become suitable) is highly unlikely.

In spite of the loss of many of its butterflies, studies in Monks Wood have contributed to an understanding of their requirements and so their conservation. We mentioned briefly the population studies on the black hairstreak (Thomas, 1974) and the white admiral (Pollard, 1979). In addition, there has been a long-term study of the orange tip (Dempster, 1991) and short studies on egg-laying by the brimstone (Bibby, 1983) and flower-feeding by the meadow brown (Pollard, 1981). Finally, the National Butterfly Monitoring Scheme itself began in Monks Wood (Pollard et. al. 1975), following up pilot studies along the south-edge of the wood (Moore, 1975). Thus, while conservation of butterflies within the wood has had limited success, these studies may have made a contribution to their conservation more widely.

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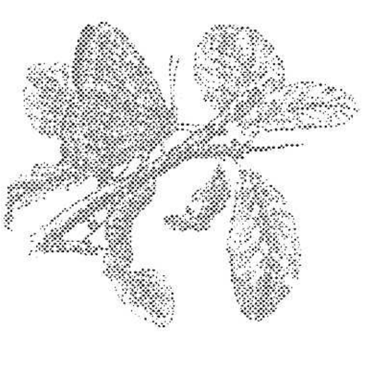

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MACRO-MOTHS IN A MONKS WOOD LIGHT TRAP, 1974-1991

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The Rothamsted light trap (Ewingswode, No.277) has been operating in the same location in compartment 22 of Monks Wood National Nature Reserve since 1974, although complete lists of the species trapped are currently available for the years up to and including 1991. Over this period 401 species of nocturnal macro-moth have been recorded, of which 121 (30.2%) have been trapped in all 18 years, while almost precisely half of the species have been caught during at least 14 of the years, ie not recorded in 2-4 years.

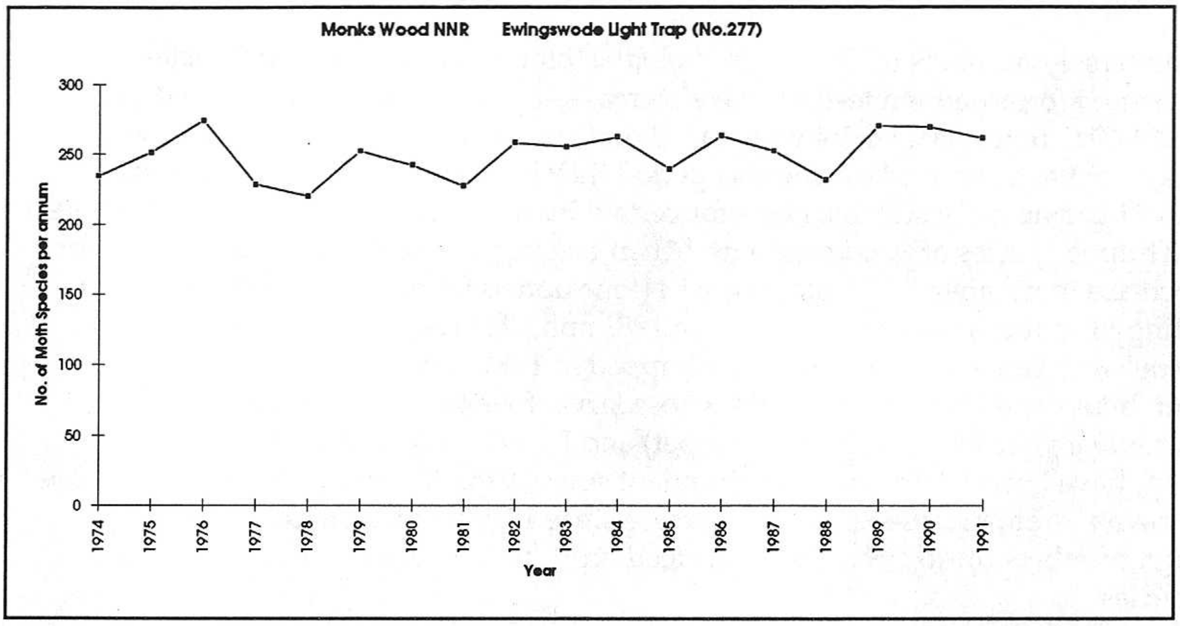
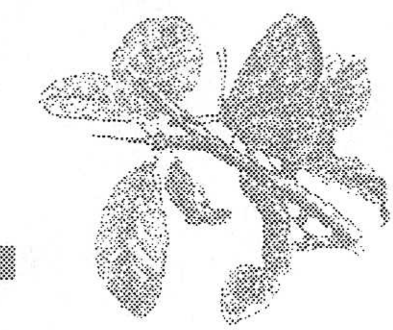


Figure 1 Numbers of moth species caught in Monks Wood light trap, 1974-1991

As is to be expected in any long-term monitoring of insect populations, the number of species trapped each year can show wide fluctuations in successive years. Numbers of species increased from 1974 to a peak of 274 in 1976, crashing to an all-time low of 220 species in 1978. Since then numbers have shown a tendency to rise to the start of the current decade (Figure 1). Over this 18 year period the number of moths trapped annually has fluctuated between approximately 12 and 30 thousand.

Forty-seven species of moth were trapped only during the first half of the 18 year period under review, ie during the years 1974-83. These were represented by a total of 104 specimens with 29 of the species represented by single individuals. Thirty-two species appeared in the trap for the first time during the second period from 1984-91, represented by 204 individuals, of which 14 were single specimens. Little significance should be attributed to those species occurring in ones and twos in scattered years as it is extremely doubtful whether any of those species not trapped since the 1970s have been truly "lost" from the moth fauna of Monks Wood.



Most moth species rarely maintain a constant population size over many years. A species may be abundant for a few seasons and then be less frequent for several years before perhaps peaking again. Some species which appear to have been more abundant during the earlier, or later, years during which this light trap has been operating, may be just reflecting long-term oscillations and not a decline or increase as the data would appear to indicate. Numbers of *Ennomos fuscantaria* (dusky thorn), whose larvae feed on *Fraxinus*, appear to have more than halved in the second half of the trapping years, but this may simply be a reflection of a much larger peak in numbers in 1975/76 compared with the later peak in 1983/84. There is certainly no evidence for an equivalent decline in the numbers of ash trees in the reserve.

Conversely numbers of *Comimaena bajularia* (blotched emerald) and *Ectropis extersaria* (brindled white-spot) have increased by 9-10 times during the latter half (1984-91). Both have larvae which feed on *Quercus* and although oak numbers may not have changed during this period they have increased in size and may have become more suitable hosts for certain insect species. It is interesting to note that three species of Arctiidae, with lichen-feeding larvae, have exhibited a recent increase in numbers. *Cybosia mesonella* (four-dotted footman) and *Eilema griseola* (dingy footman) have increased since 1981 and 1983 respectively, while *Lithosia complana* (scarce footman) was first trapped in 1984 and has occurred in very low numbers since 1989. Two species whose larval foodplant is *Clematis vitalba, Melanthia procellata* (pretty chalk carpet) and *Eupethecia haworthiata* (haworth's pug) have been relatively more abundant since 1984. *E. vulgata* (common pug) has shown a dramatic, unexplained, increase since 1979 and has maintained fairly high numbers up to 1991. Its larvae feed on *Salix, Crataegus* and various herb species.

Most people visiting Monks Wood for the first time after many years will have been aware of the invasion of coarse grasses onto the rides at the expense of the flowering herbaceous species. This is reflected, to some extent, by an increase in some moth species with grass-feeding larvae, *Lithacodia pygarga* (marbled white-spot) and *Rivula sericealis* (straw dot) have both shown a marked increase in the last 10 years. Only 30 specimens of *Philudoria potatoria* (the drinker) were trapped in the first 6 years but it has since shown a steady increase with a maximum in 1989. *Apamaea scolopacina* (slender brindle), a species more associated with woodland grasses, first appeared in 1985. *Eulithis pyraliata* (barred straw) on *Galium* species, and *Scolopteryx chenopodiata* (shaded broad-bar) whose larva feeds on vetches and clovers, have both been more abundant since 1984. Perhaps surprisingly *Tyria jaccobaea* (the cinnabar), with *Senecio*-feeding larvae, did not appear in the trap until 1984 and has increased steadily in numbers since 1986. These may reflect changes occurring in the vegetation of the field plots to the south and east of this corner of Monks Wood rather than those within the reserve. Certainly the growth of conifers in Bevill's Wood, south of Monks Wood, has resulted in the appearance of small numbers of conifer-feeding species in the light trap. *Hylaea fasciaria* (barrel red) and *Semiothisa*

liturata (sharp-angled peacock) were both most numerous in the mid to late 1980s while *Eupithecia indigata* (ochreous pug), whose larva feeds on *Pinus sylvestris*, was only trapped in 1980.

Considering the significant changes observed in the herbaceous vegetation over the period during which this light trap has been continuously operating, it is surprising that the species of moths caught have remained relatively constant. Pollard & Yates (1994) noted a similar lack of change in the butterfly fauna in Monks Wood over the last two decades. Had this trap been sited at a ride junction, or in a clearing or coppiced area, the resulting catch would doubtless have differed markedly from that of a trap in closed canopy woodland. Whether the moth fauna of these more open areas of this reserve has changed significantly during the same period must remain a matter for conjecture. However, caution is always necessary when attempting to interpret local faunal changes. They may be the result of much wider changes, eg climate, affecting that species regionally or nationally.

The increase observed in numbers of the two grass-feeding species, *Lithacodia pygarga* and *Rivula sericealis*, in Monks Wood may be part of a nation-wide increase noted for both these species during the period 1980-83 in the analysis of data from more than 50 Rothamsted light traps (Woiwood and Dancy, 1987).

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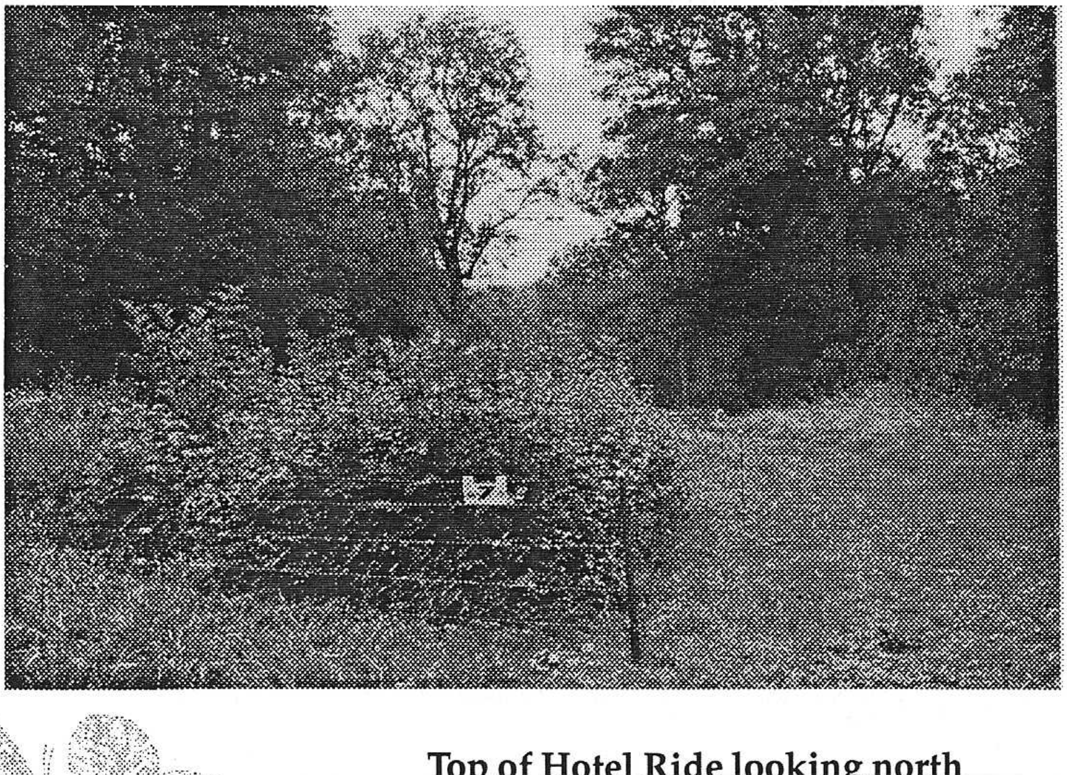

Top of Hotel Ride looking north

COLONISATION BY MUNTJAC DEER *Muntiacus reevesi* AND THEIR IMPACT ON VEGETATION

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ABSTRACT

Small deer, presumably muntjac *Muntiacus reevesi,* were present in Monks Wood in the early 1970s. At the time there was confusion locally with Chinese water deer *Hydropotes inermis*, but these have probably always been less numerous in the wood. The sightings of J Woodward indicated a steady increase from 1977 to 1984 with a substantial rise in 1985. Dusk visits during January to May 1986 to 1993 have shown no overall change; the mean number recorded per hour during these walks is about 20, an exceptionally high number.

The level of browsing damage to coppice regrowth was such during the late 1980s that electric fences were introduced to protect newly-coppiced areas. While these seem to have provided some protection, they clearly have not been totally effective. A study is in progress in 1993/1994 to look at this problem in more detail.

Surveillance walks are undertaken regularly at midday and at dusk to quantify the presence of muntjac and other browsers inside the electric fences and inside plots of known size in other habitat types. Dung counting is used to indicate relative occurrence into woodland compartments.

The success of the fencing is being determined, including by quantifying contemporary damage to recently-cut coppice and by assessing the current structure and species composition of blocks cut over the last ten years in relation to protective management. Grazing damage to primroses *Primula vulgaris*, bluebells *Hyacinthoides non-scripta* and orchids has been studied; in some localities in the wood, losses for bluebells and orchids can exceed 90%.

INTRODUCTION

The Chinese or Reeve's muntjac *Muntiacus reevesi* is a native of China and Taiwan. During the twentieth century it has colonised much of southern Britain after initially escaping from Woburn and later escaping or being deliberately released in other areas (Chapman & Harris 1993). The muntjac is still spreading its range in Britain and concern is increasing over the effect it might be having on other deer species, forestry interests and native flora (Symonds 1985; Legg & Parsons 1990; Ratcliffe 1992; Chapman & Harris 1993; Chapman *et al* 1993; Putman in press). Muntjac are classed as "concentrate selectors" rather than bulk feeders (Hofmann 1985) ie they actively select particularly nutritious food items from their environment.

This paper summarises the situation as it is currently understood in Monks Wood. Work is ongoing to assess the damage to conservation interests. Here I concentrate on browsing damage to scrub regrowth and grazing of certain species of ground flora, as well as dealing with the colonisation of the wood by muntjac.

COLONISATION

Mellanby (1973) was the first to document the probable presence of muntjac in Monks Wood. At the time, there was considerable confusion in this area between muntjac and Chinese water deer *Hydropotes inermis*. My first sighting of Chinese water deer in the Monks Wood area was in 1977 beside the road between Monks Wood and Bevill's Wood. Chinese water deer have probably always been less numerous than muntjac in Monks Wood and that is especially true at the present time (see below). Odd individuals of other deer species have been reported from time to time.

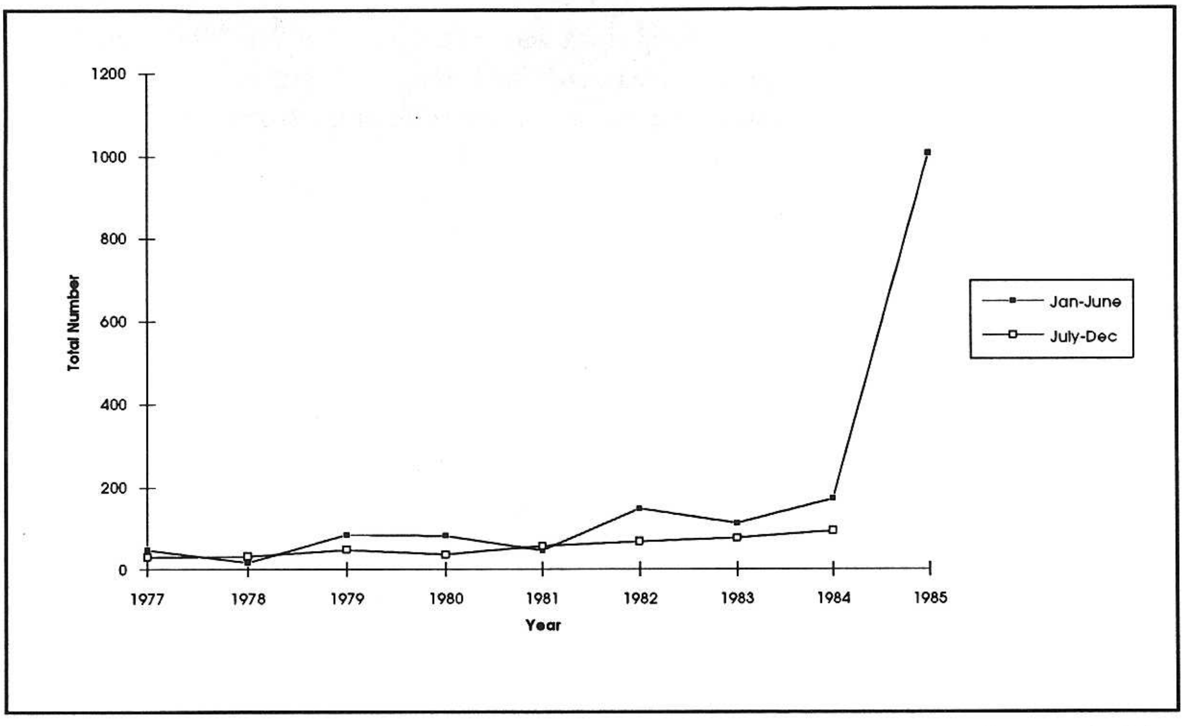


Figure 1 **Numbers of sightings of "small deer" in Monks Wood recorded by J Woodward, January 1977-June 1985**

Information on the build up of muntjac numbers comes principally from the records of "small deer" made by J Woodward, who was warden during the late 1970s and early 1980s, leaving in the second half of 1985 (Figure 1). Because there was such a large rise in his recorded sightings in the first half of 1985, totals have been sub-divided to show numbers for January-June and July-December. Evidently there was a steady increase from 1977 to 1984. This was followed by an increase of more than five fold from early 1984 to the first half of 1985. Such an increase cannot be explained by changes in the warden's habits. Equally, however, muntjac cannot increase their numbers five fold in a year except by substantial immigration, and in 1985 there were no local sources of immigration of such proportions. So while there can be little doubt that a conspicuous increase occurred in 1985, the size of that increase cannot be quantified with confidence.

Following the departure of J Woodward, L Farrell and I decided that the level of the muntjac population should be monitored, especially as damage to new coppice was being reported. In 1986, we began a spring monitoring programme that still continues, with a total of 6-8 dusk visits being made from January to May to record deer numbers seen per hour. Mean numbers of muntjac have not changed significantly since that time (Figure 2), perhaps indicating that the wood has been more or less at its carrying capacity throughout the period 1986-1993. A mean number seen per hour of about 20 represents an unusually large and dense population.

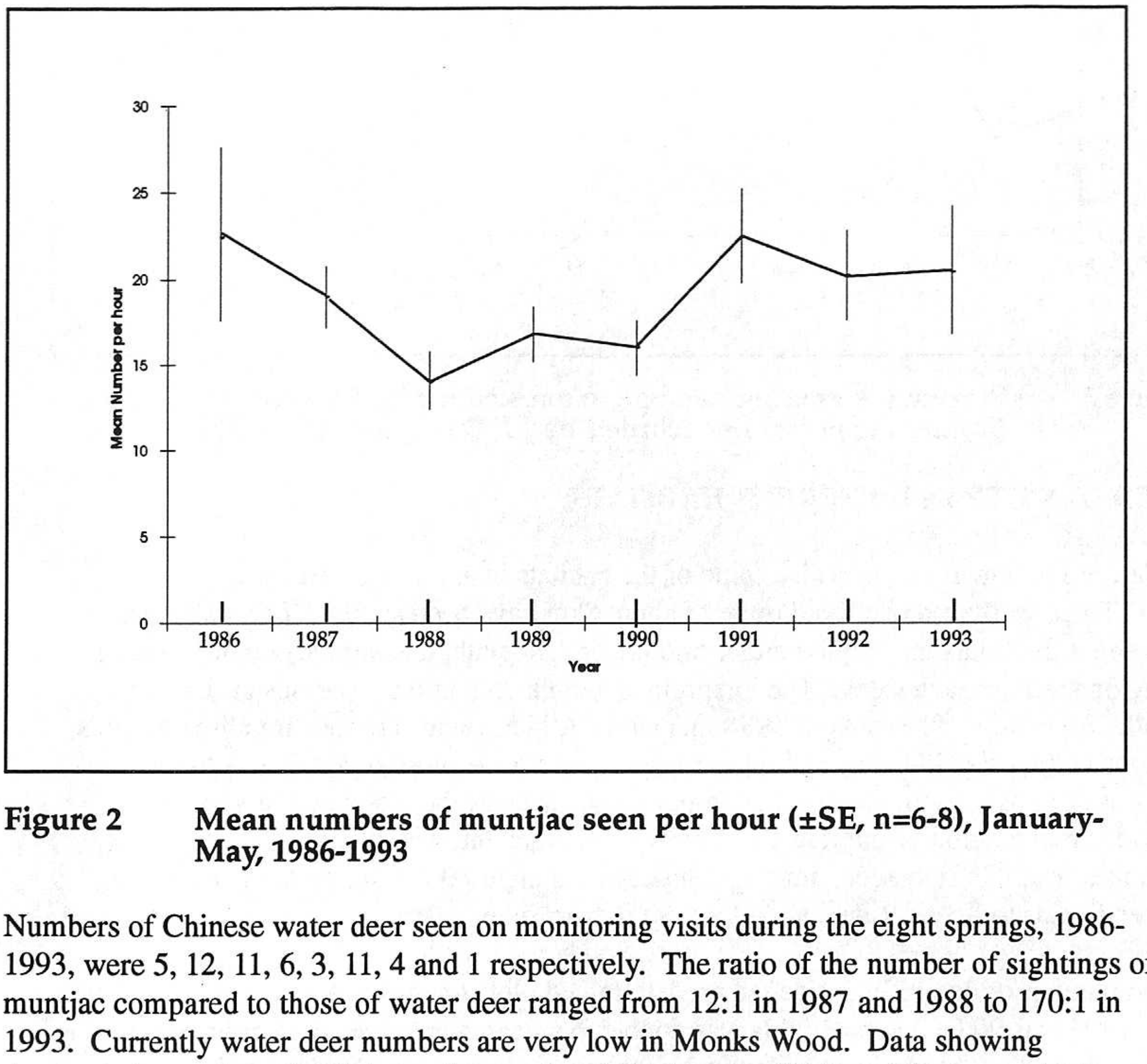


Figure 2 Mean numbers of muntjac seen per hour (±SE, n=6-8), January-May, 1986-1993

Numbers of Chinese water deer seen on monitoring visits during the eight springs, 1986-1993, were 5, 12, 11, 6, 3, 11, 4 and 1 respectively. The ratio of the number of sightings of muntjac compared to those of water deer ranged from 12:1 in 1987 and 1988 to 170:1 in 1993. Currently water deer numbers are very low in Monks Wood. Data showing decreases in number of sightings of water deer in Holme Fen NNR and in the south of Woodwalton Fen NNR associated with increases in muntjac will be reported elsewhere.

Levels of deer abundance in Figures 1 and 2 cannot be directly related to one another. However, a possible indirect measure is provided by the observations of J P Dempster on grazing damage, thought to be caused primarily by deer, on lady's smock *Cardamine pratensis*. The level of damage increased in 1986 and has remained relatively high through to 1993 (Figure 3). There was roughly a three fold increase from 1982-1985 to 1986-1993. So while an increase is indicated, this occurred in 1986, rather than in 1985 when damage to coppice appears to have become obvious.

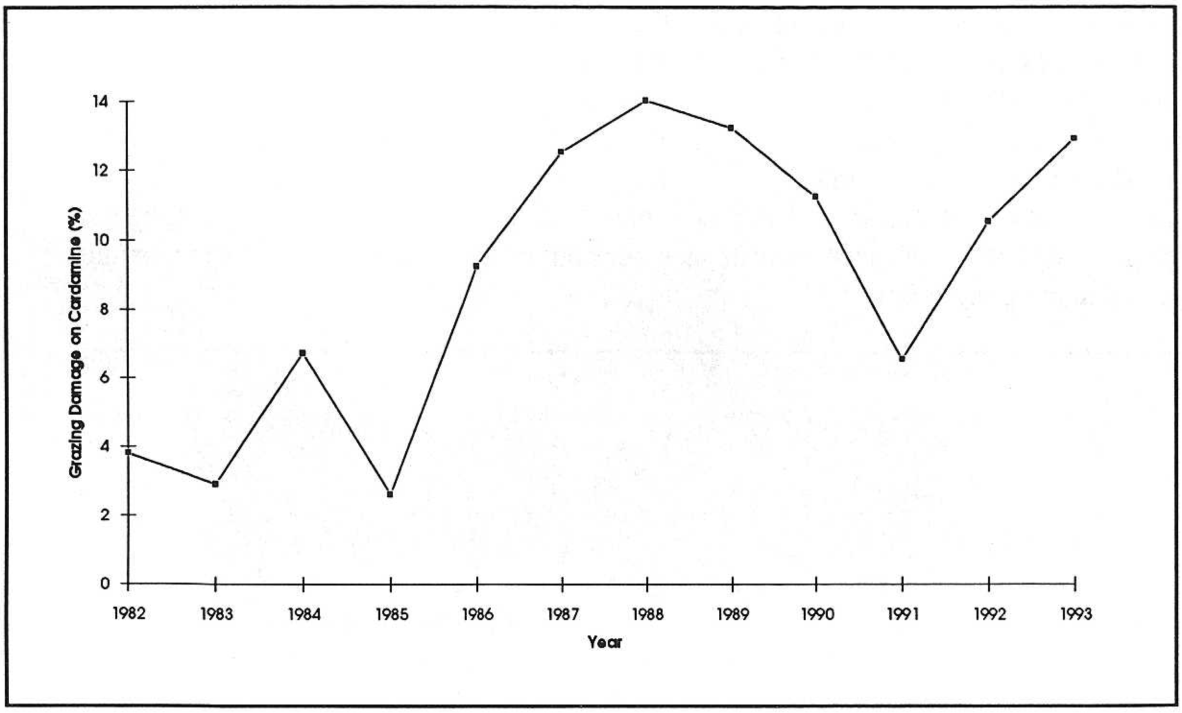


Figure 3 **Percentage grazing damage to marked individuals of lady's smock *Cardamine pratensis* recorded by J P Dempster, 1982-1993**

DEER DENSITY IN DIFFERENT HABITATS

To determine how muntjac utilise some of the habitats in and just outside the wood, surveillance walks along a fixed route of about 8km have been started. The walks which take about 2½ hours encompass either midday or dusk with, on average, a pair of walks being undertaken each week. The intention is to bulk data into six periods each of two months from May 1993 to April 1994 inclusive. All ten electric fences are observed plus plots of known size in a range of other habitats. The route more or less keeps to the rides and it is not possible to see far into compartments, such as the woodland blocks. To provide an indication of the relative activity of muntjac into woodland at different distances from the ride edge, dung is counted along eight 80 x 2 m transects arranged perpendicular to Leeds Ride, and at least 80 m from other rides.

Mean number of deer ±SE inside the predetermined plots on dusk walks during May and June 1993 was 20.0±2.3 (n=8); this was double the mean number seen on midday walks, 10.1±1.4 (n=8). There was a tendency for encounters inside open habitats to increase at dusk (Table 1), with significant increases being recorded for rides, recently-cleared areas and the Station fields. Dung counts (Table 2) indicated higher deer activity overall with increasing distance into the woodland. Taken together, these results are consistent with (many) muntjac spending the middle of the day deep under cover and emerging in the evening on to open habitats.

Table 1 **Number of encounters with muntjac per hectare in plots of different habitat types during May and June 1993 at midday (8 surveillance walks) and dusk (8 walks)**

Habitat type	Plot size (ha)	No. of replicates	Mean encounters/ha ±SE	
			Midday	Dusk
Electric fences	variable	10	0.29±0.22	0.58±0.32
Woodland edge	0.50	20	0.53±0.10	0.44±0.10
Rides	0.25	18	0.61±0.15	1.69±0.22***
Coppice or rideside clearance (unfenced)	0.125	15	0.53±0.22	1.67±0.36*
NNR fields	0.60	4	0.16±0.10	0.42±0.17
Station fields	0.80	6	0.00	0.36±0.07***

* Significantly different from midday, $p<0.05$; *** $p<0.001$

Mean numbers of encounters per unit area inside fences were comparable to many other habitats (Table 1). However, at dusk, significantly fewer deer per hectare were recorded inside fences than in the cleared plots (t_{23}=2.11, $p<0.05$), many of which had been fenced immediately after clearance, but were no longer fenced during May and June 1993. The difference between encounters inside fences and in cleared plots at midday was not statistically significant.

The general distribution of muntjac in Monks Wood is illustrated by the fact that they were recorded on all 18 ride plots during dusk visits in May and June 1993.

Table 2 **Mean number of dung pellet groups (±SE, 8 transects, 2 m wide) indicating relative levels of deer activity at different distances into woodland away from Leeds Ride**

Distance into woodland away from ride (m)	Mean no. of dung pellet groups ±SE*		
	Standing crop on 3.6.93	New dung on 30.6.93/1.7.93	New dung on 29/30.7.93
0-20	2.4±0.7	2.0±0.6	1.6±0.5
20-40	3.0±1.3	3.4±1.2	3.0±0.8
40-60	3.4±0.8	3.5±1.0	2.3±0.6
60-80	4.1±1.0	3.8±0.6	3.5±0.8

* Group arbitrarily defined as an aggregation of at least 5 pellets within 30 cm.

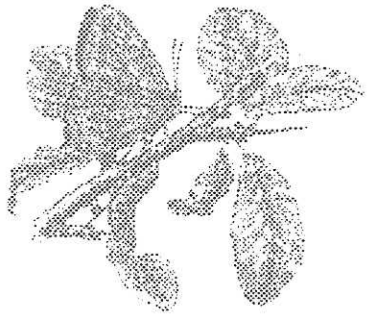
BROWSING DAMAGE TO SCRUB REGROWTH

Management against deer in coppice sub-compartments

Coppice management in Monks Wood has been described by Steele & Schofield (1973) and Massey (1994a). In Table 3 an attempt is made to draw together information for sub-compartments in the main coppice area of the wood representing nine years of the ten year cycle. The type of management used to protect new coppice against browsing is given together with a subjective visual assessment of the long-term success of the coppice operation from the conservation viewpoint provided by M.E Massey and D. D. Massen in June 1993. It is too early to assess the success of the tenth sub-compartment coppiced in 1993.

In 1984, no protection was afforded to sub-compartment 23e, the deer not being perceived as a problem. The operation was judged to be acceptable with good closed canopy but of mainly maiden stems.

In 1985 and 1986, no protection was given to sub-compartments 23a and 24b, and both failed, apparently because of browsing by deer. Contemporary browsing damage was recorded in the mid 1980s, and in both sub-compartments it is now possible to find dead coppice stools with regrowth shoots which still show evidence of earlier browsing damage despite being long dead.



Sub-compartments 23f and 23c were coppiced in 1987 and 1988 respectively and stools were protected by brash with reasonable success. It should be noted that in a number of sub-compartments,

Table 3 Management to protect initial regrowth against deer browsing in a selection of sub-compartments in the main coppice area, compared with a visual assessment of the success of each operation

Sub-compt.	Year last coppiced	Immediate management against deer	Assessment*
23e	1984	None	Acceptable. Good closed canopy, mainly maidens.
23a	1985	None	Failed. Mainly open or blackthorn thicket.
24b	1986	None	Failed. Few stools survive.
23f	1987	Brash	Marginally acceptable. Too many standards.
23c	1988	Brash	Acceptable on balance. Too many standards.
23g	1989	Electric fence	Marginally acceptable. Too many standards.
8b	1990	Electric fence	Acceptable. Good structure and density but would prefer more hazel and less birch.
23b	1991	Electric fence	Failed.
27c	1992	Electric fence	Acceptable but degree of deer damagedisappointing.

* Visual assessment by M. E. Massey and D. D. Massen, June 1993.

too many standards were present in the 1980s and the coppice was sub-optimal during the previous rotation (Massey, 1994b).

Since 1988/1989, electric fencing has been used to protect coppice areas and also areas of rideside clearance (Massey, 1994a). Of the nine fenced sub-compartments in the four compartments covered in Table 3, only one(23b) failed because of deer browsing. The lack of effectiveness of this particular fence has been blamed on a person or persons unknown persistently turning off the electricity supply (D. D. Massen, personal communication).

Damage inside electric fences is assessed and the structure of regrowth in selected coppice blocks is described in the following sections.

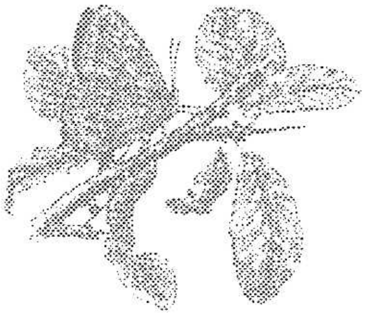
Table 4 Electric fences erected spring 1993: information from mid July 1993 on damage to marked ash trees and of dung counts indicating the presence of (potential) browsers

Location of electric fence	Date of erection	Mean % damage to ash (damage to unfenced control ash)[a]	Deer dung pellet groups in transect plots[b]	
			Replicates	Mean ±SE
Hotel Ride N	February	0 (-)	5	0.0 (Hare 14±9)
Sub-compt 23d	April	86 (71)	7	2.0±0.9
Barrow Ride W	April	0 (87)	4	0.0 (Hare 23±8)
Barrow Ride E1	May	1 (73)	4	0.0
Barrow Ride E2	May	65 (53)	4	0.3± (Rabbit29±18)

[a] Damage calculated as percentage of stems growing from each stool showing evidence of browsing
[b] Plots measuring 20 x 2 m cleared of dung and reassessed 3 weeks later. Number of individual pellets is shown for rabbit and hare where appropriate.

Deer inside fences erected in 1993

Intrusions of deer into electric fences erected during the spring of 1993 was monitored by counting dung and by determining browsing damage on shoots on selected ash *Fraxinus excelsior* stools at intervals of roughly three weeks. By mid July the level of damage to ash was similar inside two fences as on "control" ash outside fences (Table 4). Inside another fence there was detectable, though insignificant, damage from earlier in the summer. Inside the final two fences there was no evidence of either deer or browsing damage; hares *Lepus europaeus* were present inside both fences but had not browsed regrowth on the marked ash trees.



Damage inside fences erected in 1992

In May 1993, fences remained around one coppice block (sub compartment 27c) and four areas of rideside clearance that had been first fenced in the spring of 1992. In order to assess browsing damage, all coppice stools were inspected inside 100 m x 5 m transects down the long axis of the coppice block and the rideside clearance plot that appeared most affected (Hotel Ride south). So as to increase the range of species studied, a 5 m wide transect was also studied in a third fence (Barrow Ride to Leeds Ride junction). In this third fence, the first 25 birch *Betula* sp and elm *Ulmus* sp encountered were assessed as were the first 25 ash for comparison with damage inside the other fences. Of the remaining two fences, there appeared to be no damage inside one (Barrow Ride west) but some damage inside the other (Barrow Ride east).

Browsing damage inside the three fences studied is shown in Figure 4 for species recorded on at least five occasions. For species attaining a mean height of at least one metre, there was an inverse relationship between regrowth height and browsing damage (Spearman Rank Correlation Coefficient R_{11} = 0.84, p<0.01). Species that failed to attain one metre suffered on average at least 70% damage.

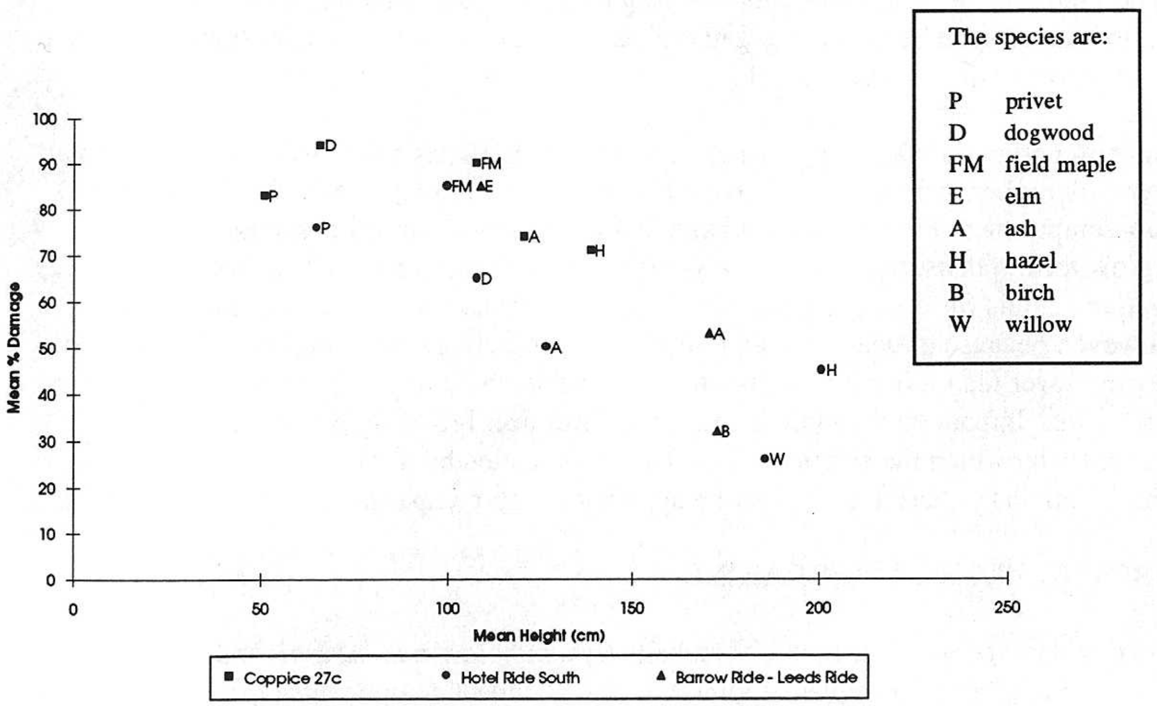


Figure 4 **Relationship between mean percentage of stems with browsing damage and mean height attained by regrowth on each stool for species recorded at least five times inside three areas cleared and fenced in spring 1992.**

Palatability trial

To determine the relative short-term palatability of examples of fast- and slow-growing species a pair of captive muntjac was presented with 50 stems each of field maple *Acer campestre* and birch arranged alternately with half metre spacing on a 10 x 10 grid. The field maple was 45±10 cm in height and the birch 55±10 cm ie all stems were comfortably within the browse height of the deer. After six hours, although there was no significant difference in the frequency of damage to the side shoots, significantly more birch tips were taken ($p<0.05$). So the quicker growing birch suffered a higher frequency of tip damage. The experiment was undertaken in May; it is not known whether such a trial would produce the same result later in the season if, following browsing damage, birch may be better protected by its chemical defences (see Grime, Hodgson & Hunt 1988).

Impact on coppice structure

A start has been made to analyse the structure of coppice regrowth in the various sub-compartments in order to compare it with a hypothetical ideal and so determine the extent of the difference. This exercise also helps to understand the real impact of the deer as opposed to the rather academic measures of damage outlined above. Centrally-oriented 50 x 5 m transects are being used to gather data on species composition, on stool density and on canopy density at different heights.

Sub-compartment 24b, which was last coppiced in 1986 has no stools in the transect with regrowth higher than one metre, so confirming the visual judgement of failure (Table 3). Sub-compartment 8b, on the other hand, has a very dense canopy composed mainly of regrowth from densely-packed, newly-coppiced birch. There are sufficient hazel *Corylus avellana* stools for this species to have made a significant contribution to the canopy. However, because of deer browsing, regrowth on hazel has been poor with 55% of stools having fewer than five stems higher than one metre, including 20% with no growth above one metre. Impact on the birch is minimal. Thus deer browsing is helping to drive the processes by which the coppice is now being dominated by birch rather than hazel. Similar effects on hazel are becoming apparent in sub-compartment 27c coppiced in 1992.

GROUND FLORA AND GRAZING

Grazing damage was assessed for bluebells *Hyacinthoides non-scriptus* and primroses *Primula vulgaris* as examples of important and abundant components of the wood's flora (Steele 1973). Clumps of primroses and 0.25 m^2 quadrats of bluebell-dominated areas were randomly selected early in the season and these marked clumps and fixed quadrats were then monitored through to seed production. The two principal parameters chosen for study were reduction of flowering at peak flowering season and loss of seed capsules. Both species were studied inside the electric fence of sub-compartment 27c and in the nearby unfenced sub-compartments 27d and 30b. However, subsequent counting of the standing dung crop indicated no significant difference in deer activity in the unfenced and fenced sub-compartments. Sightings in the area of deer and lagomorphs on surveillance walks gave 23 muntjac, 2 hares but no rabbits; frequency of encountering dung in 20 x 2 m plots (n=25) was 68%

for muntjac, 20% for hares, 12% for rabbits. Thus the muntjac appeared to be much the most abundant grazer in the vicinity and therefore the likely cause of most of the damage. Rabbits are reported not to eat bluebells (see Grime, Hodgson & Hunt 1988).

Table 5 Grazing damage to bluebells and primroses in 1993 inside and outside an electric fence

	Inside electric fence: sub-compt 27c	Outside electric fence: sub-compts 27d & 30b
Bluebells[a]		
Mean % loss per 0.25 m^2 quadrat at peak flowering (range for quadrats)	54 (32-78)	38* (19-63)
Mean % buds failing to produce any seed (range)	98 (85-100)	88 (62-100)
Primroses[b]		
Mean % loss per clump at peak flowering (range for clumps)	28 (0-63)	46* (32-69)
Mean % buds failing to produce any seed (range)	42 (0-68)	62 (23-77)

[a] Sample size = 10 quadrats, duration of observations = 72 days
[b] Sample size = 15 clumps, duration = 56 days
* Significantly different from loss inside fence, $p<0.05$.

Flowering loss for primroses was significantly higher outside the fence, but the reverse was true for bluebells (Table 5). Although there was further loss of late flowering primroses, losses because of grazing at the seed capsule stage were low. Capsules tended to be overgrown by other vegetation and so protected from vertebrate grazers. Pollinated primrose flowers in which the petals had been grazed but the base of the calex left, could still produce a seed capsule. In contrast, bluebells continued to be grazed even at the capsule stage. Although the difference was non-significant, the bluebell sample outside the fence had better survival on average to the capsule stage than the sample inside the fence. Superficial examination of bluebells generally in the wood revealed considerable variation in grazing damage between localities. The sample outside the fence enjoyed atypically good survival. For instance, in mid June, mean number of inflorescences with seed capsules per 0.25 m^2 quadrat ±SE (n=10) was 3.8±1.0 for the sample outside the fence, 1.3±0.4 for the sample inside the fence, but only 0.7±0.3 for a third sample midway between the other two. The last sample was more typical of the performance of bluebells outside the fence in compartments 27 and 30.

Table 6 **Fate of a sample of 50 common spotted orchids selected in East Field at peak flowering season**

Type of damage	Number with such damage	Number with seeds[a]
Inflorescence eaten	7	0
Part eaten	25	4
Not eaten	18	15

[a] Duration of observations = 56 days

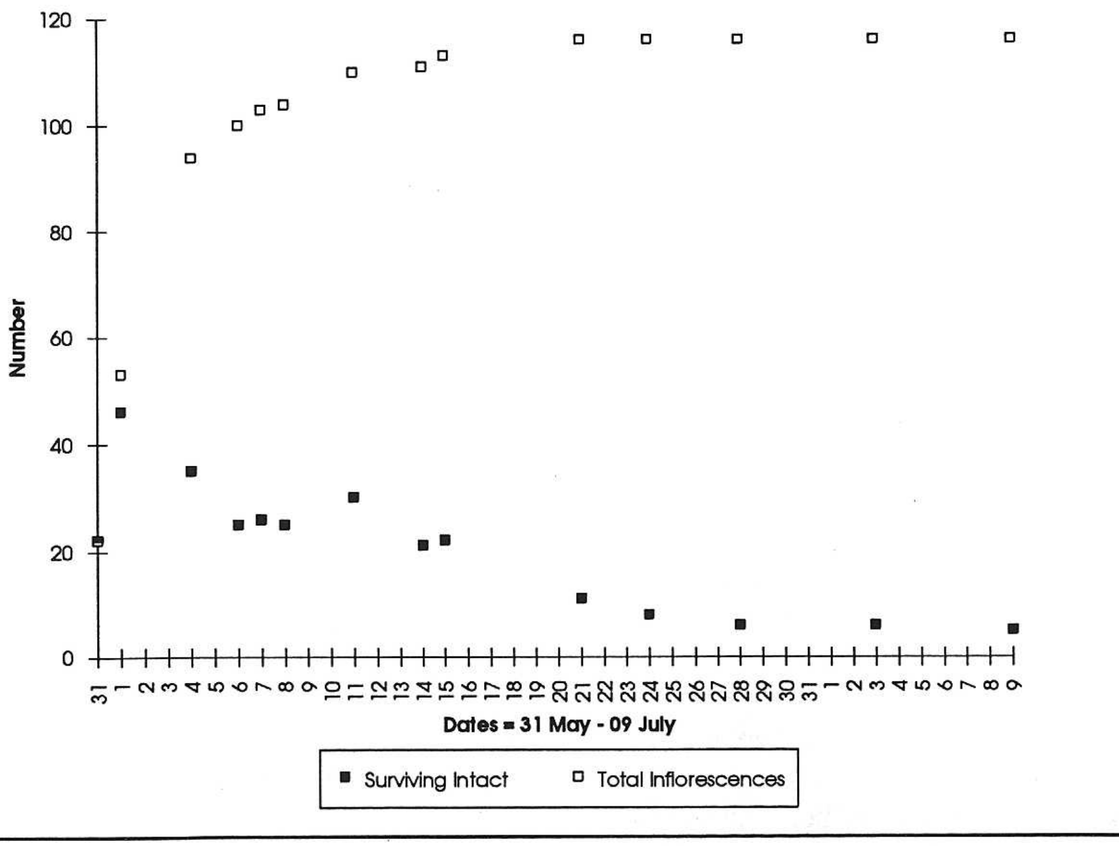


Figure 5 **Survival of common spotted orchids *Dactylorhiza fuchsii*, Main Ride, 1993. The population was observed for 26 more days without any further change**

Grazing damage to common spotted orchids *Dactylorhiza fuchsii* has been studied in unfenced areas in East Field and beside Main Ride. In East Field, 50 intact inflorescences were selected at peak season (9 June) and monitored through to seeding; 15 (30%) survived intact and produced seed (Table 6). On an 80m stretch of Main Ride beside the electric fence of sub-compartment 27c, an attempt was made to find all the common spotted orchids in the tall herb layer on both sides of the ride. Of the 116 found, 5 (4%) survived intact and produced seed (Figure 5). Survival to peak flowering (8 June) and from peak flowering to seed production was 24% and 16% respectively. Median time from an orchid being found to it being recorded as lost was only 4 days. Figure 5 provides a demonstration that casual observation of the apparent survival of flowering orchids can be misleading. The extent to which losses can be at least partially offset by new inflorescences will only be appreciated if individuals are monitored. As an extreme example of this, of 46 intact inflorescences on 1 June, only one survived three days later, but the total counted was 35 because of 34 "new" orchids.

No damage was recorded to the 11 plants of crested cow-wheat *Melampyrum cristatum* found in the usual locality in 1993. A number of other species, notably dog's mercury *Mercurialis perennis*, are heavily grazed throughout the wood. A few others, such as ground ivy *Glechoma hederacea,* do not seem to attract grazers.

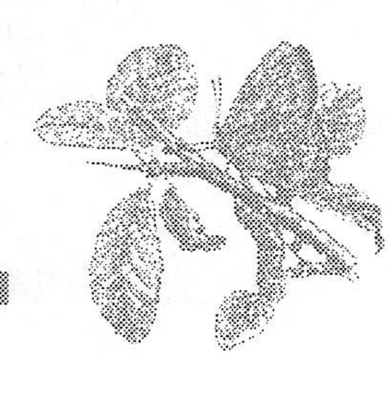
One of the eight dung transects in Leeds Ride (Table 2) consistently had much lower numbers of dung piles. In July 1993 it became apparent that this transect was dominated by ground ivy, whereas in the other transects, ground ivy was either absent or made only a minor contribution to ground cover. At the end of July, 2 dung piles were counted in the transect dominated by ground ivy while the mean ±SE for the other seven transects was 11.6±1.6.

To test further any possible inverse association with ground ivy, its dominance was assessed at the end of July in the 20 woodland plots on the surveillance walk. In 10 plots, ground ivy was the dominant species of ground flora; mean encounters with muntjac in these plots in July (±SE, n=8) was 0.25±0.07 per ha. In the remaining 10 plots where ground ivy was less dominant, mean deer number was 0.75±0.14 per ha. The difference between encounters in these two types of woodland plot was significant ($t_{18}=3.08$, $p<0.01$).

CONCLUSIONS

Results on deer distribution and damage must be regarded as interim. The detailed study started in May 1993 is not due to be finished till April 1994. But even then some aspects may require long-term observation to determine if subtle effects or shifts in community structure are occurring.

The population level of muntjac seems to have been fairly stable since 1986, which suggests that the wood is at its carrying capacity. This simplifies somewhat the management decisions for English Nature. If it is decided that the amount of damage done by the deer is tolerable, then there is no need to do more than maintain the current practice of using electric fences to protect newly-cleared coppice or rideside areas. If, however, the current level of impact is unacceptable, then further management may be deemed necessary. This might take



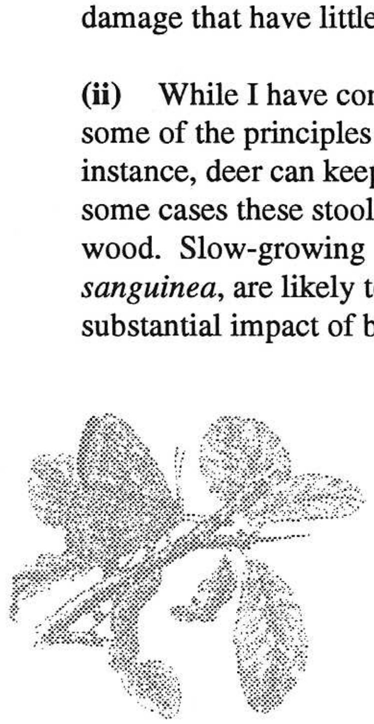
the form of reducing deer numbers by culling. While this is presumably possible, it has a range of drawbacks eg it would need repeating regularly, it has an element of danger for visitors and killing large numbers of deer may not be viewed favourably by the public. Another option might be to safeguard sensitive areas more effectively than at present. This might be done by upgrading the energy level of the pulse through the fence (Pepper *et al* 1992) and/or by protecting stools inside fences with brash. Alternatively, the main coppice compartment (23) could be permanently fenced with a properly-maintained, high, mesh fence, combined with the total elimination of deer from that compartment. A different and more radical option may be to decide that the potential costs of management against deer outweigh the benefit, and so modify the management aims accordingly to make them achievable given the current level of deer damage. For instance, certain blocks might be taken out of the coppice rotation and other, apparently less-vulnerable ones added. Whilst on this subject, the future of failed coppice sub-compartments, such as 23a and 23b, is not clear.

At this stage, a number of different effects appear to be attributable to deer:

(i) Damage undoubtedly occurs on scrub regrowth inside the electric fences. Consequent impacts range from shifts in community composition (eg from hazel-domination to birch-domination) to failure to varying degrees to form a proper canopy of regrowth stems. Fast-growing species such as birch often seem to survive browsing better providing that browsing pressure is relatively moderate. The palatability trial showed birch to be readily eaten, and in sub-compartment 23d, which was coppiced in 1993, severe browsing by deer is currently keeping regrowth on birch at little above ground level.

The criteria for assessing success of any particular coppice operation are based on how well the coppice grows so that those species of animals and plants associated with this traditional form of management are effectively conserved. Thus damage to the timber quality of coppice regrowth, in particular, is more easily tolerated here than elsewhere where commercial considerations are important. In rideside management plots, browsing damage is yet more readily tolerated as it may help to promote an uneven and more interesting shrub layer. It is therefore important not to focus too much on measures of damage that have little relevance for real impact.

(ii) While I have concentrated on events within areas of coppice and rideside clearance, some of the principles emerging are probably applicable to the wood as a whole. For instance, deer can keep some stools below their browse height by persistent attention; in some cases these stools die. Evidence of browse damage by deer is widespread in the wood. Slow-growing species, such as privet *Ligustrum vulgare* and dogwood *Cornus sanguinea*, are likely to be especially susceptible to such a fate. Peterken (1994) reports a substantial impact of browsing on privet in compartment 18 between 1985 and 1992. A study has been started on the impact of deer on seedling regeneration in two coppice areas; results may be more widely applicable.



(iii) Studies undertaken so far on flora indicate that losses at peak flowering can be significant. The spectacle of, for instance, a stand of flowering bluebells is being diminished for the visitor. Perhaps more importantly little bluebell seed is surviving in many parts of the wood, and bluebells are primarily dependent on seed for regeneration (see Grime, Hodgson & Hunt 1988). Community shifts may be occurring but this can only be confirmed by long-term observation. Avoidance of areas dominated by ground ivy is not surprising as this species is known to be toxic to animals (Cooper & Johnson 1984). But if other ground flora, such as dog's mercury, are being heavily grazed, then ground ivy may be spreading at the expense of such species. This conjecture is supported by the casual observations of Station scientists with a long-term knowledge of the wood (T C E Wells, B N K Davis, personal communications).

Not all plants of conservation interest are being affected. Crested cow-wheat on the southern edge of the wood was untouched in 1993. Just outside the wood to the south, grazing losses of bee orchids *Ophrys apifera* in a study plot have been slight (Wells & Cox 1991) and have been mainly blamed on lagomorphs. Lack of impact of deer in this situation is probably due to relatively low numbers on the Station fields in the summer (see Table 1).

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Chapter 3
Research

How has Monks Wood been used for research (1953-92)? - K. Kirby

HOW HAS MONKS WOOD BEEN USED FOR RESEARCH (1953-92)?

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INTRODUCTION

My personal involvement with Monks Wood and its research is very slight. These impressions are therefore those of an outsider and I apologise if I appear to downplay or omit references to some important work which is being or has been done on the site. However that English Nature's woodland ecologist does not have direct regular contact with research on the premier local woodland National Nature Reserve itself indicates the change in the roles that scientific staff in English Nature have compared to those in the Nature Conservancy or even the early years of the Nature Conservancy Council.

Much of the research that has gone on in the wood is listed in the Monks Wood Record; more recent work has been picked up in part in Christa Backmeroff's survey of research on NNRs in 1988 while Maurice Massey produced a selective listing of research projects on the reserve (Table 1) up to 1991 that might form the basis of a monitoring programme. Rather than go through this work in detail I intend to consider what sort of research we might hope would be done on the reserve and see to what extent the studies fit into this framework in practice. The priority given to research in the Nature Conservancy Council and its successors has varied, but a recurring theme was, and still is, that we are not making the most of the research potential of its reserves.

RESERVES AND RESEARCH

The site of the research station was chosen because it was near to four NNRs with "important but neglected potentials for scientific research".

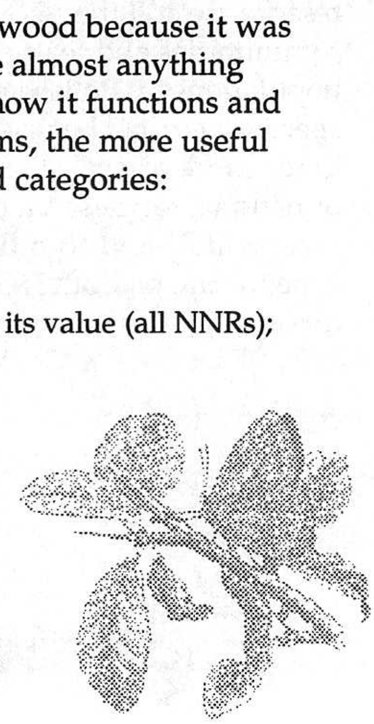
After the Station opened knowledge about the wood expanded rapidly, both through formal surveys and informal observations by staff during their lunch hours; some of the work was specifically directed at issues of concern to the management of Monks Wood, other projects simply used the wood because it was a convenient and relatively safe working environment. While almost anything that is done in the wood may enhance our understanding of how it functions and hence be of at least potential value in nature conservation terms, the more useful work (from our point of view) can be grouped into four broad categories:

-Basic site inventory, identifying what's there (all NNRs);

-Monitoring species/features of interest to check the site maintains its value (all NNRs);

-Research/experimental studies for local or national use (selected reserves, short term usually);

-Contributions to national or regional monitoring/research networks (selected reserves, long term).



BASIC SITE INVENTORY

We ought to be able to tell people what species, communities, features occur on a reserve. Many of the studies in the sixties, whatever else their purpose led to improved knowledge of the species found in the wood which was summarised in the 1973 reserve record. While inevitably incomplete the Monks Wood records still provide a standard because they cover a wider range of groups, they are published (rather than having to trawl through files) and there is some scope for comparison with other Cambridgeshire woods for which there is a similar overall published coverage (Hayley Wood, Bedford Purlieus and most recently Brampton Wood). Basic inventory and survey (like taxonomy) are unglamorous, unfashionable subjects and their value is often under-rated. They provide, however, an essential context for more detailed work on species and communities such as work on the Orange Tip and its food plant (by Dempster) or colonisation by arboreal invertebrates (by Duffey).

We cannot hope to match the level of recording that has gone on in Monks Wood at every site - probably not at every reserve. It would, however, be desirable to put together some basic data for suites of reserves which potential researchers could use to help them identify sites and issues of interest.

Where there is already a solid base of basic inventory information we should aim to keep it up to date and to apply new techniques (such as the National Vegetation Classification for vegetation mapping). Only by having some sites recorded in very great detail can we get an inkling of what is missed by the sample surveys and less time-consuming methods that must be applied elsewhere. I wonder, however, how effective our systems are for ensuring that all records made on the reserve do actually get incorporated into consolidated reserve lists.

MONITORING SPECIES/FEATURES OF INTEREST

How do we ensure that the species/features for which a site is made an SSSI or a reserve are still there? Monks Wood is still a wood, but how have the species, communities and features fared since it became a reserve? Research on butterfly populations by Pollard and others showed that there is no room for complacency - species were lost because we were not able to get the management right at the time. More recently there has been a programme of periodic checking of the local or national rarities that occur on the reserve. This approach needs to be adopted more widely and co-ordinated across sites if we are to be able to justify our expenditure on both SSSIs and reserves. Too often elsewhere the monitoring that does go on is driven as much by individuals interest or habit rather than based on an assessment of the site needs.

Concern about what is happening to particular species or groups in relation to management may lead on to what is potentially one of the most profitable uses of reserves for research - short term experiments or studies aimed at dealing with a specific issue.

RESEARCH/EXPERIMENTAL STUDIES FOR LOCAL/NATIONAL USE

When the reserve was set up there was much concern about the lack of oak regeneration. This is now seen as less of a problem, but the work done to highlight the impact of small mammals on seeds and seedlings has been useful elsewhere. Similarly the work by Thomas on black hairstreaks has provided a basis for site management not just on this site, but in other woods as well. The surveys of the impact of muntjac just starting by Cooke, I expect to have a similar wide application.

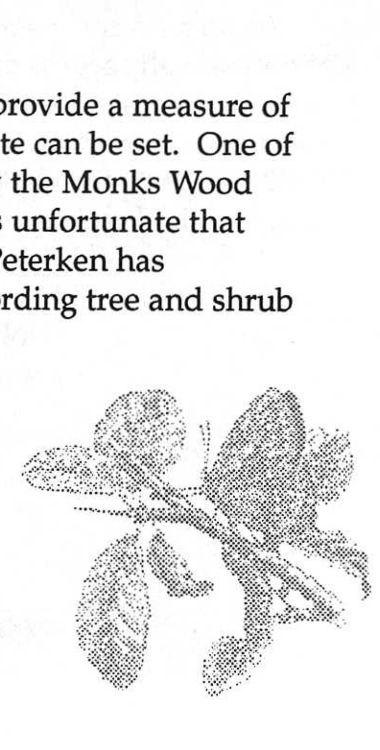
What has been disappointing (but understandable given the way research is organised) is that there has not been more of this type of work. A common question in coppice restoration is dealing with the lop and top left over. Could the relative merits of burning versus stacking, versus leaving it scattered be investigated in a controlled trial? With increasing concern about the impact of recreation on woodland vegetation why not an experimental trampling trial?

Many studies of this nature are relatively short-term (although in woodland work this may mean 5-10 years!). Some short term studies may, however, have the potential to contribute to longer term studies (Table 1). Dick Steele, for example, set out permanent plots in Monks Wood and a number of other reserves; initially to collect data on the population structure of the tree layer, but where they have been relocated, other data on woodland dynamics can be collected. More recently observations of tree dieback in transects will be of potential longer term interest even if it turns out to be a continuing problem.

There is a need for a network of sites where such work goes on and reserves are often potentially the most appropriate places.

NATIONAL AND REGIONAL LONG-TERM STUDIES

There are several long-term national recording schemes that provide a measure of background change against which change on an individual site can be set. One of the best of these is the butterfly recording scheme initiated by the Monks Wood Station. BTO's Common Bird Census is another such and it is unfortunate that Monks Wood is not regularly censussed. Since 1982 George Peterken has encouraged the establishment of permanent transects for recording tree and shrub populations and woodland structure, one of which is in Monks Wood.



CONCLUSIONS

Interest in research on resources goes in phases; I hope we are about to see a renaissance of interest, but I doubt that much in the way of extra resources will be available. We are also at a time when there is an increasing need for more experimental testing/controlled trials of ideas and less reliance on simple correlative observation. There are more and more "experts" out there such that personal opinion unbacked by good data is increasingly likely to be questioned.

In the reserve system and particularly in Monks Wood, because of its past research history, there is a resource that could be used for this purpose.

If EN is not going to provide much money how else can we make progress.

a. Welcome researchers, even if their project (eg the genetics of birch) does not appear to provide immediate conservation benefits. Sites where research is going on tend to 'attract' other workers who may have more relevant projects.

b. Be prepared to accept some damage/destructive sampling. It would not be appropriate to accept major disruption of a reserve in the interests of research, but many experiments may involve an element of damage (or potential damage). We should be prepared to accept some of this - there may even be secondary opportunities to study recovery.

c. Have a clear framework of issues that we would like looked at on a particular reserve, preferably broken down into elements that can be tackled by a PhD student/post doctorate or other short term grant holder.

d. Co-ordinate research strategies across reserves so that if a researcher wishes to look at an issue across a range of sites that can be provided.

e. Develop a prospectus for individual reserves and the suite as a whole which highlights the scope for working in a particular area, what the sites can offer etc.

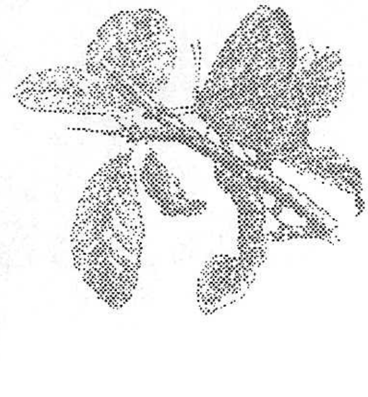
f. Improve our systems for recording research and survey on reserves, so that not only are all records easily available to inform the decisions of site managers, but also new researchers can see what has gone on in the past and can find the results for comparative purposes. Various forms of event and project recording have been started in the past, but all too often they lapse or remain incomplete through lack of collective support for them.

Little (if anything) I have said is new. Others have highlighted the problems and solutions. The challenge for the reorganised EN will be whether this time it can deliver.

Table 1. Research/survey projects undertaken in Monks Wood NNR identified by M E Massey as a possible basis for a monitoring programme

NB WRS = Woodland Research Section of NC

Bluebell/Dog's mercury nutrition studies	1961-65	WRS
Community relations of an Oak	1963	UCL
Growth and nutrition of Ash coppice	1963-64	WRS
Vegetation recording sites	1962-(?)	WRS
Botanical recording along Hotel Ride	1961	J A Thompson
Soil survey of wood, pit positions	1963, 1973	Soil Survey, Cambridge
Ecology of Black Hairstreak butterfly	1969	J A Thomas
Pseudoscorpions in litter samples	1969	W C Block/Leicester University
Survey of weevils, *Hymenoptera, Cynipidae* and *Hemiptera*	1962-(?)	M G Morris
Fixed point photography	1972	Site Manager
Colonisation by arboreal invertebrates especially spiders	1975	E Duffey
Butterfly transect	1977	ITE
Ride vegetation transects	1977-81	Janette Ward *et al*
A study of coppicing	1977	Janette Ward
The effects of vertebrate and invertebrate herbivores on woodland ground flora	1978-80	J K Walker/UEA
The sub cortical fauna of oak	1979-(83)	M G Yates
Aspects of the ecology of the Meadow Brown	1981	E Pollard
White admiral population study	1972-77	E Pollard
Rothampsted moth trap	1974	
Resource limitation in the Orange Tip butterfly	1982	J P Dempster



Invertebrate fauna of native and introduced broadleaved trees	1983-84	R C Welch
Pollen rain in ancient woodlands	1986-87	F Di-Giovanni/ Hull University
Long-term monitoring by transect in unmanaged woodland	1988	G F Peterken, C E Backmeroff
Tree health transect	1991	Site Manager
Crested Cow-wheat *Melampysum cristatum*		Site Manager
Black Hairstreak *Strymonidia pruni*		Site Manager

Chapter 4
Have objectives and management changed?

Changes in management policies - M.E. Massey

CHANGES IN MANAGEMENT POLICIES

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INTRODUCTION

During the 40 years of Monks Wood as a National Nature Reserve, there have been four management documents that have determined objectives, and set policies and prescriptions. The first was a Working Plan in 1957 which was then incorporated into a Management Plan in 1958. This was revised and expanded in 1964 and a second revision was undertaken in 1984.

In this presentation, I will briefly consider whether the objectives have changed over the past 40 years, whether the management practices have changed and whether changes have occurred through reactions to experience within the reserve.

MANAGEMENT OBJECTIVES

In the first management document, the 1957 Working Plan, there are two aims:

- To re-establish self-seeding woodland of indigenous species.
- To maintain such conditions as will provide adequate habitats for a diverse woodland flora and fauna.

In the 1958 Management Plan the aims had become objects of management, the first two of which are:

- To maintain, encourage and develop the conditions necessary to preserve the rich invertebrate fauna associated with the ancient ash-oak woodland of the heavy Huntingdonshire clays.
- To set aside sections of the wood (a) which will be allowed to develop undisturbed and (b) where traditional woodland management of a type which preserves habitats of biological interest will be followed, eg coppicing.

NB There is then (as in all three plans) objectives for scientific study and public access.

In the 1964 revision of the Management Plan the objects of management are:

- To obtain variants of Ash-Oak woodland, both natural and managed, typical of the heavy clays bordering the Fens.
- To preserve as a viable ecological unit sufficient coppice-with-standards woodland, the traditional form of management at Monks Wood.

° To maintain a diversity of habitats, such as fields and rides, and special communities such as aspen, sallow and blackthorn supplementary to the woodland and coppice blocks and thereby to attempt to maintain conditions suitable for the preservation of the variety of fauna and flora associated with Monks Wood.

In the 1984 revision of the Management Plan the ideal management objectives are:

° To protect and where appropriate enhance the features of scientific interest for which the reserve is established, ie those features of National Importance listed in Section 2.2.2, namely mixed ash/oak woodland and its characteristic fauna and flora together with the fungal community and the listed nationally rare plant and animal species.

° To maintain and where appropriate enhance other features of scientific interest, ie those features of Regional and Local importance listed in Section 2.2.2, namely woodland rides together with the listed plant and animal species.

It is, at this distance in time, perhaps surprising that the 1958 plan only mentions the invertebrate fauna and does not include the conservation of the flora and fauna as a whole in the objectives. However, it does include the concept of non, or minimum intervention - a concept which still seems to cause controversy amongst nature conservationists.

To my mind, though, the fundamental intention behind the management objectives have remained constant over the 40 years. What we do now is, in my view, a continuation of what was done in the past, whether the objective is to maintain the *rich invertebrate fauna* or the *variety of flora and fauna*. In other words, the style of the message has changed and this reflects the ongoing debate within NCC/EN on how to write a management plan rather than the actual reality of the message changing.

That is not to say that there have been no changes in management over the past 40 years however. There have, but those changes have not, in my view, resulted from changing objectives but from changes in ideas and methods as to how to attempt to achieve objectives.

MANAGEMENT PRACTICES

What are the more significant of those changes, and why have they been made?

Ride Management

I deal with ride management elsewhere in this volume (Massey 1994) but a point not covered then that is relevant here is that the ride widening between 1973-78 became necessary (Elias 1973) as the original width, given the increase in height of the adjacent trees, was not sufficient to provide the open, sunny conditions required by light-demanding species. If some of the present day recommendations are to be believed, the main rides may not yet be as wide as will eventually be necessary.

There have also been changes in the rotation cycle of the management of ride side vegetation. The first details are given in the 1964 Management Plan which specifies that the centres will be mown at least once annually and bordering shrubs will be cut every four years, with alternate sides being mown every two years. However, there is a reference on file (Elias 1973) that suggests that a six or eight year rotation was adopted at some time prior to 1972. This was changed in autumn 1972 to a four year rotation for what is described as the tall herb zone, the six or eight year rotations resulting in too heavy growth by the time of cutting (Elias 1973).

The situation was reviewed again in 1983 by NCC's East Midlands regional staff because the tall herb zones were being dominated in the third and fourth year by scrub regrowth, which was (a) time consuming to cut, and (b) judged not to be the habitat required. It was decided that from autumn 1983 all tall herb zones cut on a rotation would be cut on a two year rotation.

By 1989 it was generally agreed that the richness of the ride side flora was still declining, but this time through dominance by various grasses and sedges. As with the 1983 review, advice was sought from the Monks Wood Station's butterfly section and from other woodland managers and it was decided from autumn 1989 to revert to a four year rotation on some of the rides. It is hoped that a build up of litter may, through suppression, produce bare ground resulting in a more open sward in the first two years of the rotation which in turn may result in more flowery rides again. If scrub becomes a problem again we now have better equipment to deal with it more easily. In addition to this David Massen has just started small scale trials of a summer hay type cut and several summer cuts regimes to see what sort of flora is produced.

Personally, I am beginning to think that management by mowing of tall herb zones along open, sunny ride sides will not retain the plant community that develops in the first few years following ride creation or widening. We have to accept that over time the plant composition will change as

regards the relative abundances between species. A more stable plant community may evolve at some time in the future, but that may take a number of decades. We have, after all, been mowing the rides at Monks Wood since the early 1960s and they are still changing.

Coppice Management

Another significant change I wish to cover has been in management of the coppice compartments as regards the number of standards. Unfortunately, the Monks Wood book (Steele and Welch 1973) does not mention the historical number of standards per unit area with which to compare modern practice, but in nearby Rockingham Forest it is known that 30 standards per ha has been the practice in the past (Marren 1990).

In the 1957 Working Plan it is proposed that the number of standards should be kept low but the plan does not say how many that is. The 1958 Management Plan does not mention standard numbers but by inference carries forward the Working Plan proposal. In marked contrast, the 1964 Management Plan states that up to 75 trees per ha will be retained as an overstorey and that in addition 25 oak seedlings will be planted to form standards. In the 1973 book it is given as a density of about 75 standards per ha. No reasons are given for the change of policy brought about by increasing the number of standards to those very high levels from 1964 onwards.

The 1984 Management Plan revision questions the wisdom of such a high density and, whilst retaining 75 as the maximum number, adds the qualification that only 35-40 should be more than 50 years of age. In practice over the past decade standards have been heavily thinned, the number remaining being dependent upon the balance of age and size within any given coppice compartment. The eventual aim is to have up to 20 large trees per ha that will be left to die in situ. This follows widely accepted principles and practices for nature conservation management of coppice and, despite the problems with deer (see Cooke,1994) coppice regrowth in Monks Wood has been very substantially improved by removing, in my view, the hitherto overshading affect of too many trees. Unfortunately the ground flora has not responded in such a dramatic fashion, but perhaps that will need several cycles to recover if, that is, there was in the past a greater richness than we have now and there is the potential within the present flora to become more diverse.

High Forest Management

The last change, or rather the lack of it that I want to say a few words about is high forest management. The failure to undertake any significant thinning and singling work over the past 40 years even though all the plans include it as a policy for parts of the reserve is, in effect, a change of that policy. The next revision of the management plan ought, in my view,

accept reality and formally reassign all those woodland compartments from active management to non-intervention.

HAVE OBJECTIVES BEEN ACHIEVED

If I am right in saying that the fundamental management objectives for Monks Wood have not changed over the past 40 years, a question pertinent to this meeting would be, have those objectives been achieved? My answer is that we do not know with any degree of certainty. There probably was sufficient research and recording pre 1972 to answer the question with some degree of objectivity, but I would claim that there has not been since the division by government of the Nature Conservancy in 1972. The same can be said of a large number of NNR's, I suspect, and many of the early ones did not have the same input that Monks Wood received. It is, I think, unrealistic to expect resources to be available for substantial research, survey and monitoring programmes on all, or even the majority, of NNR's however. But resources ought to be available for some and NNRs, such as Monks Wood, with a substantial body of past or current research ought to be selected as a series of sites upon which available resources are concentrated. Spreading the resource thinly over many projects is an easy option, I fear, that produces very little of value for the long-term management of nature reserves.

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Summary of discussion

List of participants

Monks Wood NNR: A Bibliography, 1973-1993 - R.C. Welch


SUMMARY OF DISCUSSION

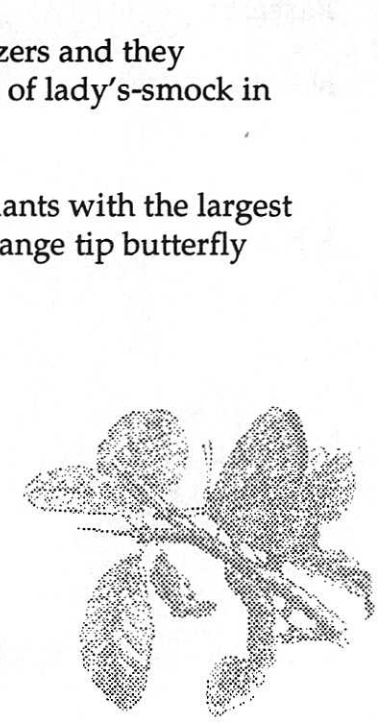
The programme allowed for discussion after each session but for convenience those discussions of key issues have been amalgamated and presented here in summary form.

Change

M Schofield/ M Service	The changes in the reserve have been very significant over the past 40 years - is a lower water table one of the causes? Certainly adjacent land is better drained now than in the recent past.
G Peterken	There has been a marked decline in the diversity of flora.
C Welch	The rides were much narrower and more shaded in the 60s and 70s.
J Thompson	One of the biggest changes since the early 1960s is the increase in grasses, particularly *Calamagrostis*, at the sides of the rides, and the trees, especially ash, are a lot taller.

Muntjac

E Pollard	What are the muntjac doing to honeysuckle, the food plant of the larvae of the white admiral?
A Cooke	I have not studied honeysuckle specifically.
J Croft	Do the muntjac graze on pendulous sedge?
A Cooke	I have not noticed any damage.
C Welch	Muntjac appear to be selective grazers and they devastated experimental plantings of lady's-smock in the rides.
J Dempster	They appear to selectively graze plants with the largest flowers which are also what the orange tip butterfly requires.
B Davis	In Top Ride ground ivy has replaced dog's mercury. Do muntjac avoid the former, and do they avoid any shrub/tree species?



A Cooke	Muntjac do not appear to graze nettles, thistles or ground ivy. Aspen is one shrub species they do not relish, and there is little damage to birch and willow - in part because of their relatively rapid growth. Several coppice blocks have done well because they have a lot of birch in them, although muntjac regularly go under or through a 5 strand electric fence. I have not seen them jump over these fences.
J Dempster	I have seen one clear a 5ft wire netting fence.
E Duffey	Would it be a difficult task to control the muntjac population.
A Cooke	Numbers have not changed in the past few years. EN has to decide whether current impact is unacceptable; if it is, further management or control may be necessary. Should the numbers rise again rapidly we would have to consider a cull. I estimate the population at 150-200 deer. This is very high and must be near the carrying capacity of the wood. 100 would need to be culled annually to reduce numbers. Elimination would not be possible.
D Jefferies	Do numbers decline during a severe winter?
A Cooke	No - the main mortalities are from road accidents.
J Thompson	The deer are certainly a problem. Coppice blocks should be larger and protected with conventional deer fences, and one section of non-intervention should be permanently ring-fenced to protect it from deer.

Research

N Moore	It seems that it is now not considered important at a senior level within EN to record basic information about reserves and there is a lack of continuity.
K Kirby	There is, in fact, a lot of work going on to record information about NNRs, but we do need to establish an archival system for records and there needs to be continuity in recording.

M Service

Universities are always looking for good, secure, research sites. Is anything being done to stimulate universities to use Monks Wood? Would EN encourage such use.

K Kirby

Some site managers and other EN staff promote NNRs for use by research workers. This should be encouraged.

J Plumridge

I agree that more should be done to promote Monks Wood as a research site but due to limited resources at universities there is only so much that can be done.

Open Discussion

B Davis

Monks Wood has a high population of muntjac. What follow up would you like to see to what you [A Cooke] are doing now?

A Cooke

Money is very tight so if we wanted to follow up and develop the project there may not be funds available. But possible future work includes more detailed studies and long-term monitoring of impact in the wood, and also helping managers of other sites identify and remedy impacts from muntjac and other deer species.

J Thompson

We do not seem able to protect our reserves from outside influences. I believe that NNRs should be as large as possible and EN ought to try to extend the area of Monks Wood by acquiring a buffer zone of agricultural land and also Bevill's Wood.

J Plumridge

EN is starting to look at the question of linking up sites of nature conservation importance and making the land in between wildlife friendly.

C Welch

Basically there is no hard recent information as to what has happened in the wood. What is done, where, when and what happened should be recorded in such a way that the site can be relocated, perhaps years later, and changes identified.

J Plumridge

Research and monitoring can be seen as a luxury when resources are tight. The management of NNRs in this area are all project based and

management records exist, in the case of Monks Wood from 1960 onwards. The problem is in accessing that information and as a result a lot of existing information is not used.

G Peterken

We need to discipline ourselves to make records - eg photos - and record when it was and where it was. Think simply for the long-term. The existence of an ecological archival system would mean people would make more effort to record information knowing it will be recorded.

H Arnold

Record the common as well as the rare species in order to provide data against which later records can be compared.

A Cooke

A simple scheme should be set up for long-term accessibility of data, not a vast complex archival system.

In the ensuing general discussion, many examples were quoted of documentation lost when staff moved, left an organisation, or retired. At such times, if no obvious interested recipient can be identified, the data are sometimes thrown away. There was a general view amongst those present, which was voiced with considerable feeling, that there is an urgent need to establish an Ecological archive, not only for National Nature Reserves but for ecological research in general. A possible avenue for this may be within the UK Biodiversity Action Plan.

The meeting recommended, therefore, that English Nature, in collaboration with other statutory and voluntary organisations, and with relevant research organisations, should undertake the establishment of a National Ecological Archiving system, to accommodate and make accessible ecological data (in paper and digital forms) on a permanent basis.

PARTICIPANTS

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Don Jefferies

Keith Kirby

Mike Labern

John Mason

David Massen

Norman Moore

George Peterken

Janette Plumridge

Ernie Pollard

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Chris Shaw

John Thompson

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MONKS WOOD NATIONAL NATURE RESERVE: A BIBLIOGRAPHY, 1973-1993

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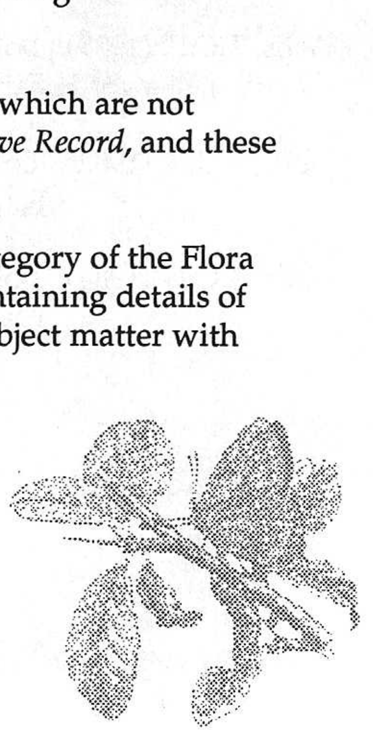
When *Monks Wood : A Nature Reserve Record* (edited by R C Steele and R C Welch) was published by the Nature Conservancy in 1973 the authors of each chapter provided a list of references which were usually fairly comprehensive up to 1972, and often included some papers published in the early months of 1973. In 1988 Christa Backmeroff was employed by the Nature Conservancy Council to produce a record of research on woodland NNRs with particular reference to long-term studies. Dr Keith Kirby later combined Backmeroff's series of Regional Reports into a single bibliography in which he provided details of the author, title, journal, book etc., and year of publication, for each reference. This was published in February 1993 under Backmeroff's name as English Nature Research Report No.41, *A bibliography of research on woodland NNRs.* Of the 511 references contained in this National bibliography, only 63 refer to Monks Wood NNR, and their selection appears a little idiosyncratic in that it includes only 12 post-1973 references, whereas this current review has identified 186 publications which in whole, or in part, refer to the fauna and/or flora of Monks Wood National Nature Reserve. Papers which refer solely to species recorded in the Field Plots belonging to ITE and to other land adjacent to the reserve have not been included. As Backmeroff included a few Nature Conservancy Council Internal Reports, these have been incorporated into this bibliography even though they may not be widely available. On the other hand Dr Pollard and his colleagues at ITE Monks Wood, as part of the National Butterfly Monitoring Scheme, have since 1976 produced an annual *Report to Recorders* which, more often than not, contains a reference to a species recorded from the transect in Monks Wood NNR. However, because these reports have a limited circulation, they have not been included in this bibliography. The Annual Reports for Rothamstead Experimental Station for the years 1975(pub 76) to 1987 (pub 88) included "Annual Summaries of the Rothamsted Insect Survey", initially prepared L.R. Taylor and R.A. French, and latterly by I Woiwood et. al. These contained "annual records of moths of economic or other importance" which included lists of species caught in the Monks Wood (Ewingswold) light trap.

Backmeroff's bibliography does include 8 pre-1973 references which are not quoted in the relevant chapters of *Monks Wood : A Nature Reserve Record*, and these are listed as an Appendix to the following bibliography.

Most of the publications listed are placed within one major category of the Flora or Fauna which may be a class, phylum, order, etc. Papers containing details of more than one group will be listed according to their major subject matter with cross-reference to the others. The few papers covering both ecological issues (eg those by Peterken and Backmeroff) are included with those referring to "Flowering Plants".



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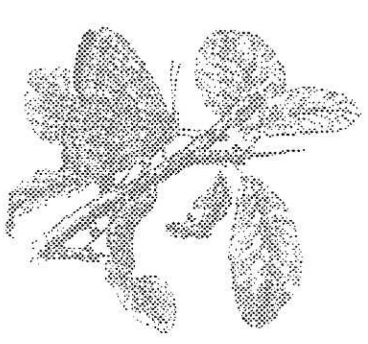

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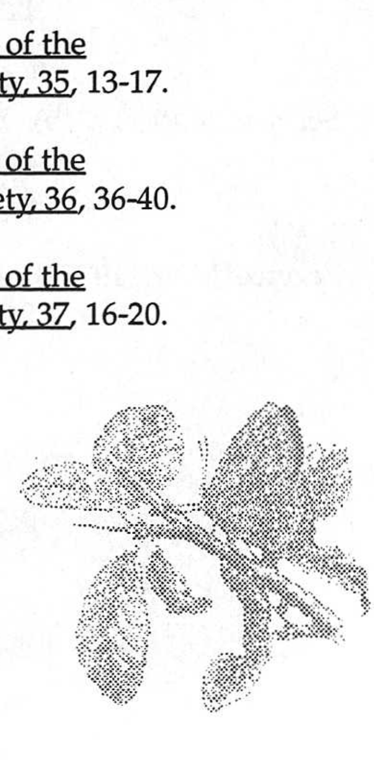

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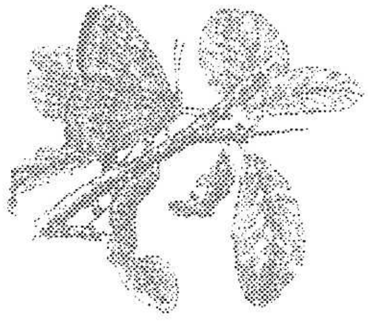

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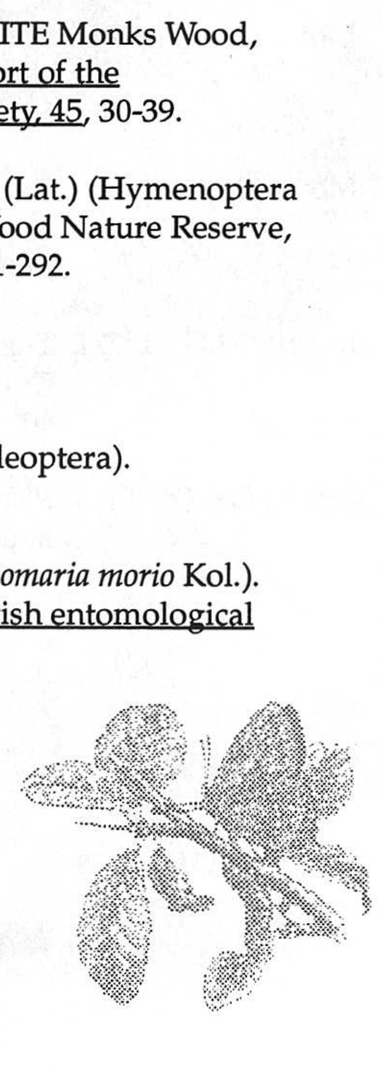

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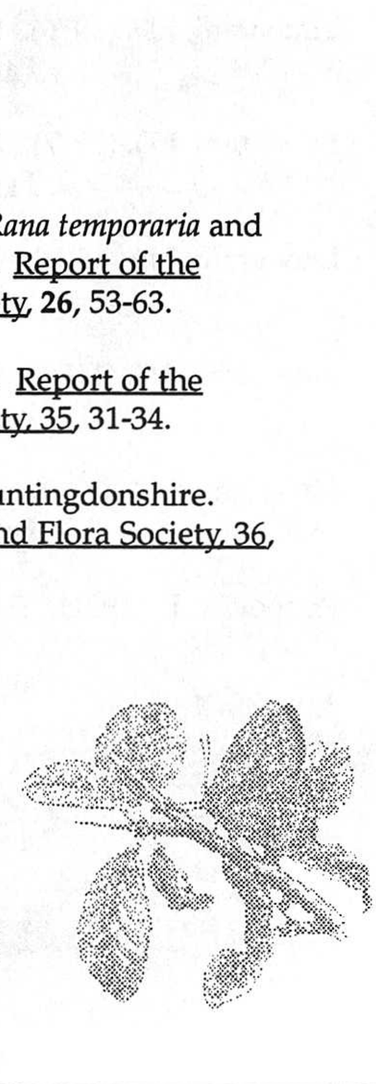

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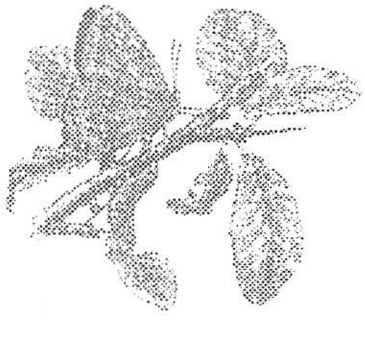

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