Report Number
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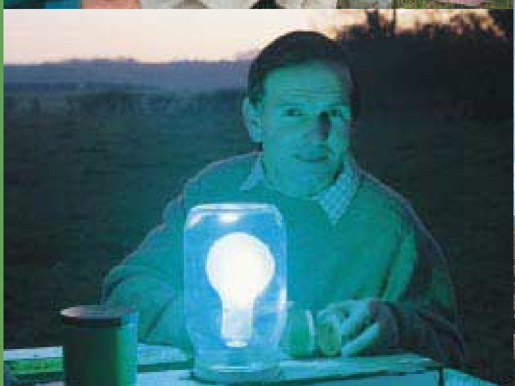
English Nature Research Reports

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A comparison of the structure and composition of The Warburg Nature Reserve in southern England in 1973 and 1992

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Acknowledgements

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Summary

1. The structure and composition of the Warburg Reserve (south Oxfordshire) in 1973 and 1992 are compared using data from 96 permanent 10x10 m plots systematically distributed across the woods, with one plot every hectare.

2. Data were collected on the cover of canopy, shrub and field layers, largest tree in plot, mean basal area of trees in the vicinity and a list of vascular plants present.

3. The woods are a mixture of beech *Fagus sylvatica*, ash *Fraxinus excelsior,* sycamore *Acer pseudoplatanus* and hazel *Corylus avellana* with lesser amounts of other species including some conifers. The main ground flora species are *Mercurialis perennis, Rubus fruticosus, Viola riviniana, Brachypodium sylvaticum, Chamerion angustifolium*, and *Rosa* spp.

4. Over the 19 year period there was little change in the overall structure of the wood: the mean canopy cover stayed the same, with a small decline in the shrub layer and increase in field layer (both *c*10%). However a quarter of the individual plots showed either increases or decreases in canopy cover of at least 40%.

5. The overall composition of the tree layer changed little over this period and about a third of the wood showed no apparent change in canopy structure. There was a reduction in the cover and frequency of introduced conifers (being actively removed). Other plots became more open because of natural blowdowns, while some became more shaded as stands that were young and open in 1973 grew up.

6. The ground flora results at the whole wood level similarly showed little change in terms of the number of species recorded, the mean number of species per plot, or the balance between ancient woodland indicators and other species. At the plot level high turnover of species was noted with the mean Sorensen Similarity Index being only 53%. Plots where the canopy had become more open tended to gain species, those where the canopy closed over tended to lose them.

7. Species that were more frequently recorded in 1973 included *Chamerion angustifolium, Fragaria vesca, Epilobium montanum*, whereas those more often recorded in 1992 included *Clematis vitalba, Potentilla sterilis, Cirsium vulgare, Bromopsis ramosus*. The relative loss of *Chamerion* and *Epilobium* may reflect lower levels of disturbance in the woods since 1973, but otherwise no consistent pattern could be found in the species differentially recorded.

8. Analysis of the ground flora using Ellenberg Scores for light and nitrogen, and using plant strategy characteristics showed little difference between the two years.

9. DECORANA analysis suggested some differences between years in the plot distributions on the axes according to their ground flora composition, but this was less than the spread according to the within site variations (reflecting differences in openness and nutrient status).

10. The data are used to explore the consequences of different levels of sampling, including comparisons between subjective estimates of plant cover and more objective rooted-frequency estimates from sub-plots within each 10x10 m plot. There is an inevitable loss of detail from reduced sampling although many of the broad trends in species richness can still be detected. The subjective cover values correlated well with the rooted-frequency data.

11. We conclude that the woods overall have changed little in structure and composition, but this masks considerable dynamism at the plot level in both tree, shrub and ground flora levels.

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1. Introduction

During much of the twentieth century there were considerable changes in the English countryside, including the conversion of unimproved grassland and native broadleaved woodland to coniferous plantations (NCC 1984; Peterken & Allison 1989; Spencer & Kirby 1992). Nature conservation bodies responded, *inter alia*, by acquiring sites as reserves to protect them from such changes.

However, while the effects of unsympathetic management can be avoided, reserves may still be subject to change through natural ecological processes. There is for example the succession of grassland to scrub and woodland under reduced grazing pressure; the loss of open glades in woods as traditional management such as coppicing has been abandoned (Peterken 1981); tree death from the exceptional droughts such as in 1976; loss of canopy cover through blowdowns in the severe storms of 1987 and 1990 (Kirby & Buckley 1994; Peterken 1996); alterations in the composition and structure of many woods through the impact of increasing deer numbers (Crampton *et al* 1998; Kirby & Thomas 2000).

The consequences of these ecological changes for nature conservation may be assessed at three scales. There are effects on individual stands which have been well-described through studies of permanently marked transects, for example at Lady Park Wood (Peterken & Jones 1987). At the other end of the spectrum are changes in woodland cover and distribution at a landscape scale as assessed by inventories and habitat censuses (eg Forestry Commission 2001; Spencer & Kirby 1992).

Less common are studies which consider the impact of the various changes at the 'meso' scale - a few tens to a few hundred hectares - the scale at which most site management and conservation takes place in England. In this paper we compare the structure and composition of the Warburg Nature Reserve in south Oxfordshire in 1973 with that in 1992 and assess the implications of the results in nature conservation terms: are there any signs that the richness of the site (in vascular plant terms) has changed; has the structural diversity altered which might have effects on the faunal richness; is there evidence for a change in naturalness through for example a change in the cover of introduced species? This study complements work done on a similar set of plots at another Oxfordshire site, Wytham Woods (Kirby *et al* 1996; Kirby & Thomas 1999, 2000). As a by-product of the data we compare the effect of different levels of sampling intensity on the assessment of species richness using sub-sets from the full study.

2. Site

The Warburg Reserve, near Henley in South Oxfordshire (National Grid Reference SU715880) covers about 100 ha and was acquired by the Berkshire, Buckinghamshire and Oxfordshire Naturalists' Trust (now the Wildlife Trust BBOWT) in 1967 (BBONT 1988). The site is a mosaic of ancient beech woodland (mainly W12 beech-dog's mercury woodland in National Vegetation Classification terms (Rodwell 1991; Appendix 1)), more mixed woodland and scrub, some of quite recent origin (mainly W8 ash-field maple- dog's mercury woodland), some plantations of conifers and small open areas which are mainly calcareous grassland.

The aim of the management since the reserve was acquired by BBONT has been to reduce the areas of non-native trees, particularly where this has allowed the restoration of calcareous grassland; to clear some of the developing scrub for the same reasons; and to maintain/recreate a diversity of structure within the native woodland through small-scale management, eg the restoration of coppicing in some of the beech stands. Much of the woodland is however designated as minimum-intervention (BBONT 1988).

3. Methods

3.1 Field survey

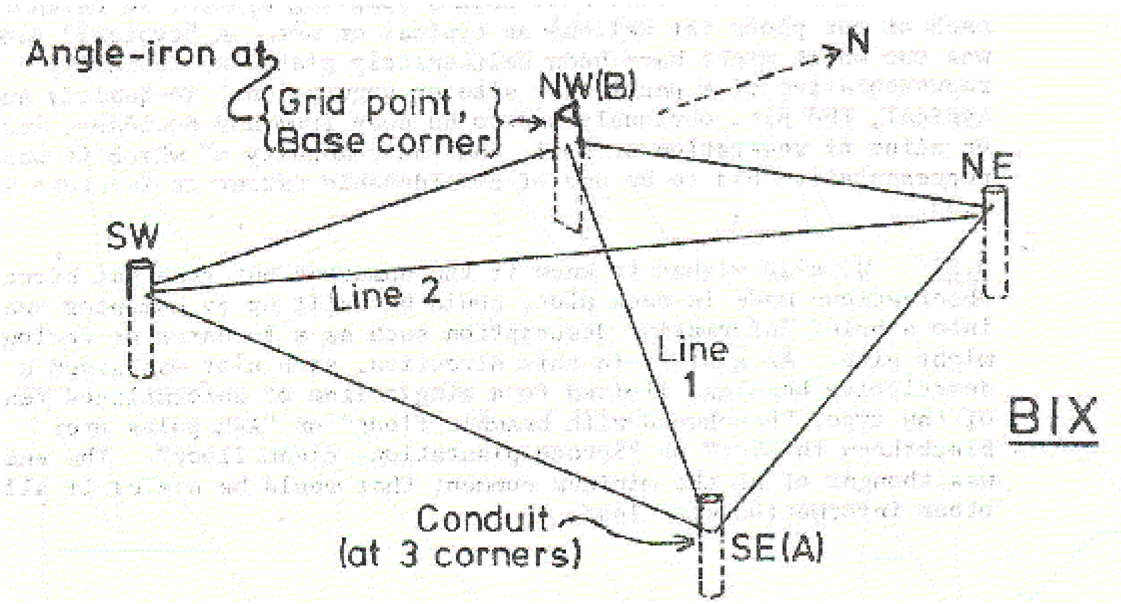
Shortly after its acquisition by BBOWT a 100 m grid was set up across the reserve and 10 x 10 m plots were recorded at the intersections (Dawkins and Field 1978). Each grid point formed the north-west corner of the plot. The corners of each plot were marked with underground metal markers so that they could be relocated precisely (Figure 1). In 1992 the plots were re-recorded. The recording on both occasions took place between April to August, but for each set of data each plot was visited only once.

The 1992 recording, with a few minor modifications, followed the original methodology (Dawkins & Field 1978).

a. A tape was laid across the north-west to south-east diagonal of the plot and percentage vegetation cover immediately above the tape was estimated by eye in three height bands: top or canopy cover > 2.5 m high; mid or shrub cover 0.5-2.5 m high; and ground cover < 0.5 m high. Bramble *Rubus fruticosus* and some other tall herbs made a major contribution to the mid-cover layer (0.5 - 2.5 m) in some places.

b. All vascular plants in the ground flora in the plot were listed but in the analysis seedlings and saplings of woody species were excluded. Nomenclature follows Stace (1991). The occurrence of species in 13 0.1 m^2 circlets spaced equally across the two diagonals of the plot was recorded. In 1992 (but not in 1973) all vascular plants were given a Domin score (1-10) based on their percentage cover within the plot as an alternative measure of species abundance. These data cannot be used in the comparison with the 1973 data, but a comparison between Domin values and Circlet scores for 1992 has been made.

c. The basal area of trees within the vicinity of the plot was estimated from relascope sweeps taken at south-east and north-west corners in 1974 and at all four corners in 1992. Relascope or angle-gauge sampling is a widely used forestry technique.



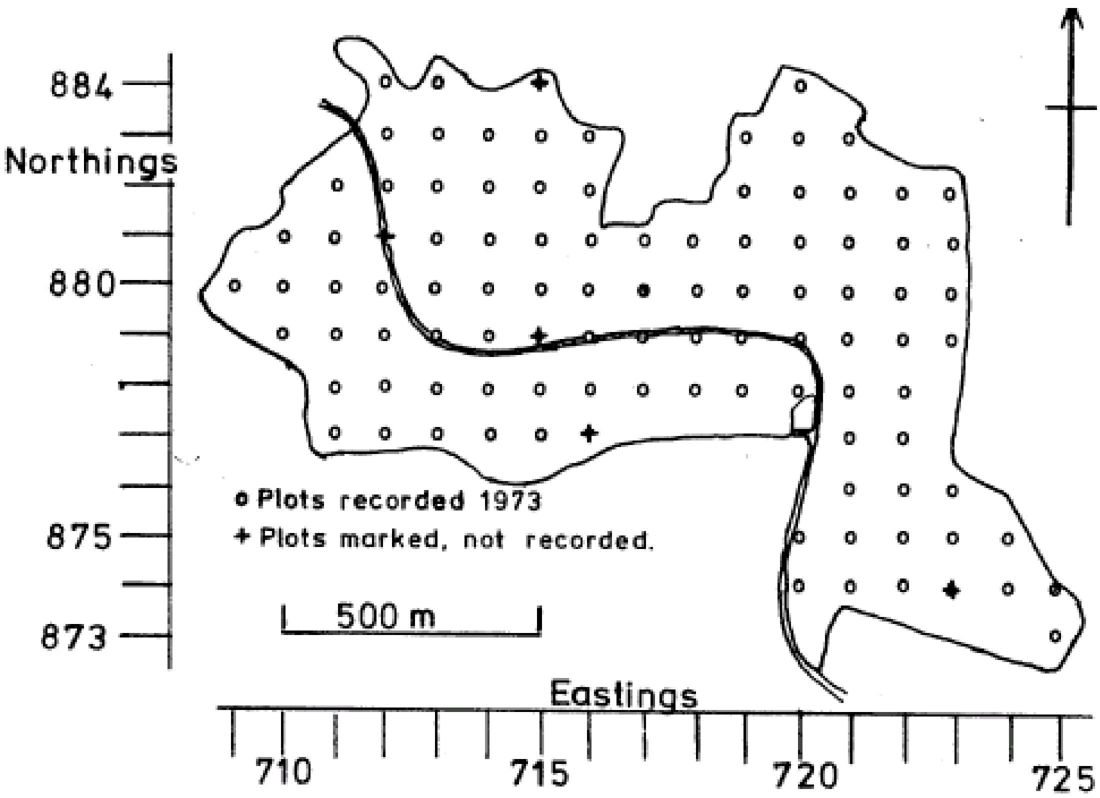
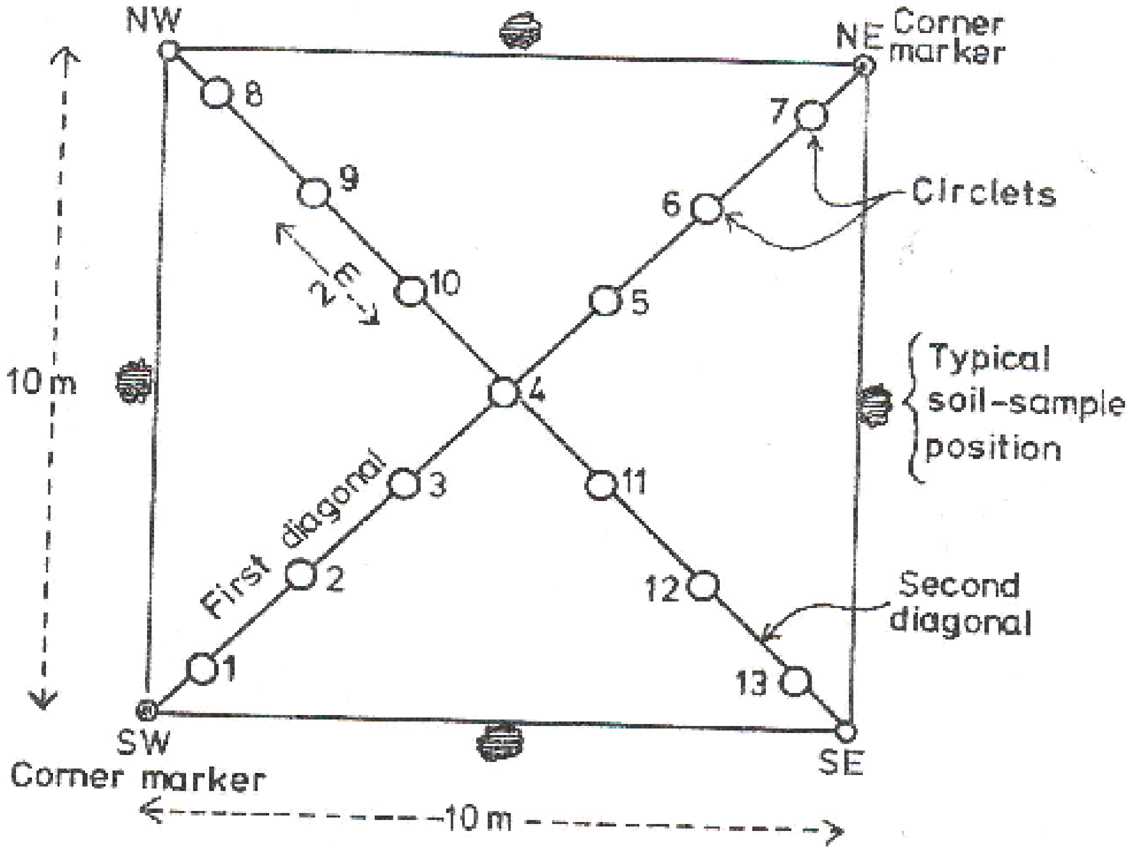


Figure 1 The layout of the plot and their distribution through the wood

(From Dawkins & Field 1978)


NW
NE
Corner marker
8
9
7
6
Circlets
2 m
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Typical soil-sample position
First diagonal
3
11
2
12
Second diagonal
1
13
SW
Corner marker
SE
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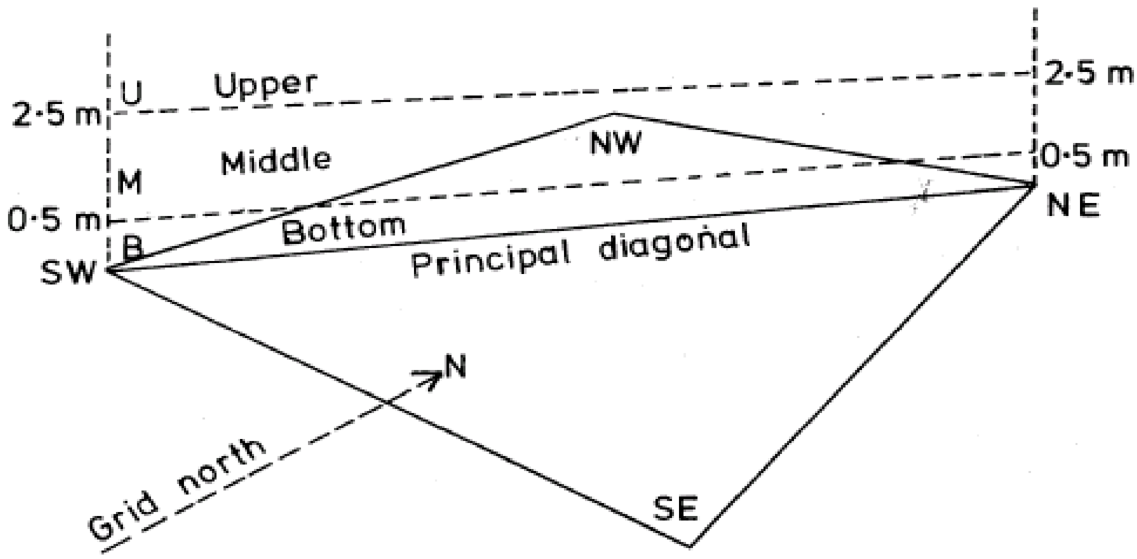

2·5 m
U
Upper
2·5 m
Middle
NW
M
0·5 m
0·5 m
NE
Bottom
B
Principal diagonal
SW
N
Grid north
SE

d. The four largest diameter trees rooted in the plot (or the four tallest for those less than 2cm diameter at breast height (dbh)) were identified and their locations noted by coordinates from the south-west corner. The height of the largest of the four was measured using a clinometer, or by direct measurement of those less than three metres. The largest tree (referred to as the leading tree) could be a seedling. In 1974 the four largest stems had to come from different stools if they were of coppice origin; in 1992 the four largest stems were measured even if two or more came from one stool. The alteration was made partly to avoid ambiguity - it is not always clear whether stems are part of the same stool. In addition there is ecologically little difference in the impact on the rest of the plot from stems from the same stool compared to two maiden trees growing close together. Comparisons are made in this paper using only data for the single largest tree in each plot, so the difference in recording procedure does not affect the results. By noting the coordinates within the plot of the leading tree at different dates we judged whether the leading tree had survived from one recording time to the next and, if not, whether the new leader was of the same or a different species.

(English names have been used for the common tree and shrub species in the text. A list of their scientific names are given in Table 5).

Sample results for plots are included in Appendix 4.

3.2 Treatment of the data

No large set of species records is completely accurate; species may be missed or misidentified. Different recorders have different biases (Kirby *et al* 1986; Sykes *et al* 1983). For the most part we accepted all records as correct and assumed that differing biases in recording consistency at the plot level would cancel each other out when the whole data set were put together.

Not all species, and not all changes in species abundance, are of equal meaning in nature conservation terms: greater nature conservation significance is likely to be placed on the loss of a rare species that was restricted to woodland habitats, than on an increase in a common species of open disturbed soil conditions. Three different ways of grouping species have therefore been explored in the interpretation of the changes found in the data.

Firstly species were classed as either 'ancient woodland indicators' for southern England (Marren 1990; Peterken 1974); other species associated with, but not necessarily exclusive to, woodland in Britain, using the list on survey form developed by the nature conservation agencies to define woodland species (Kirby 1988); or 'non-woodland' species, mainly those associated with grassland habitats. These groupings were defined independently of the Warburg surveys. They are based on people's experience rather than a formal evaluation, but they have been used in conservation evaluations over the last ten years (NCC 1989).

Secondly the species composition of different areas was analysed using 'Ellenberg Values' for the affinities of individual species for high or low light conditions, high or low soil nitrogen, pH and moisture (Ellenberg 1988; Ellenberg *et al* 1991). Ellenberg values are on a 1-10 scale (10 high) (see Appendix 2 for further details on these scales). The distribution of the

Ellenberg values was used to characterise different plot groupings using programs kindly provided by Dr D.G. Pyatt (Forestry Commission) (Hawkes, Pyatt & White 1997).

Thirdly plot and species sets were analysed for the occurrence of different plant attributes and strategy types developed by the Unit of Comparative Plant Ecology at Sheffield (Grime *et al* 1988; Hodgson *et al* 1995). This gives for a species list the percentage contribution to different 'strategy types' (Grime 1979) (see Appendix 3 for more details of the attributes and strategy types used).

The Ellenberg Values and attribute analysis may help to identify what lies behind changes in species abundance (increasing openness, higher nitrogen availability, more disturbed conditions etc), which in turn may be related to the management of the wood.

As well as using these pre-defined groupings of both species and plots the combined 1973 and 1992 data sets were analysed using DECORANA while the canopy cover (estimated across the first diagonal) was analysed using TWINSPAN (Hill 1979a, b).

Other statistical analyses were performed using MINITAB software (MINITAB 1995). All comparisons unless otherwise stated are based on the 96 plots for which records are available both in 1973 and 1992.

The effects of different survey methods was explored.

- The number of species detected in all 96 plots was compared with the known flora for the site, based on more detailed surveys across the wood (BBONT 1988).
- The effect of the number of plots recorded on the number of species found was examined by looking at different sub-sets of the data.
- Estimates of change in species richness based on comparing the same plots at both times were compared to a comparisons based on different sets of plots at each time.
- Comparisons were made between the variations in the tree and shrub layer and those in the ground flora.
- The Domin cover values for species were compared to the rooted frequency estimates obtained from the circlets.

4. Results – tree and shrub layer comparisons

4.1 Changes in vegetation cover

The wood as a whole is characterised by a relatively dense canopy cover, moderate shrub cover and abundant ground layer at both dates. The vegetation cover showed no significant change overall in the canopy cover; although there were small, but significant changes in the shrub layer and the field layer (Table 1). The mean values however hide some large changes in individual plots, with for example 25% of plots showing either declines or increases of more than 40% in the canopy (Figure 2).

Table 1 Changes in the vegetation cover across the south-east/north-west diagonal of the plot

Layer	Mean value 1973	SE[1]	Mean change to 1992	SE
Canopy layer (>2.5 m)	72.9	3.5	-3.1	3.9
Mid-cover (0.5 - 2.5 m)	32.5	2.9	-9.6	2.8
Field and ground layer (<0.5 m)	62.4	3.6	11.1	3.2
No of plots showing cover change	>40% increase		>40% decrease	
In canopy layer	11		13	
In mid-cover	2		8	
In field and ground layer	15		3	

[1]In this and subsequent tables S.E refers to the standard error of the mean.

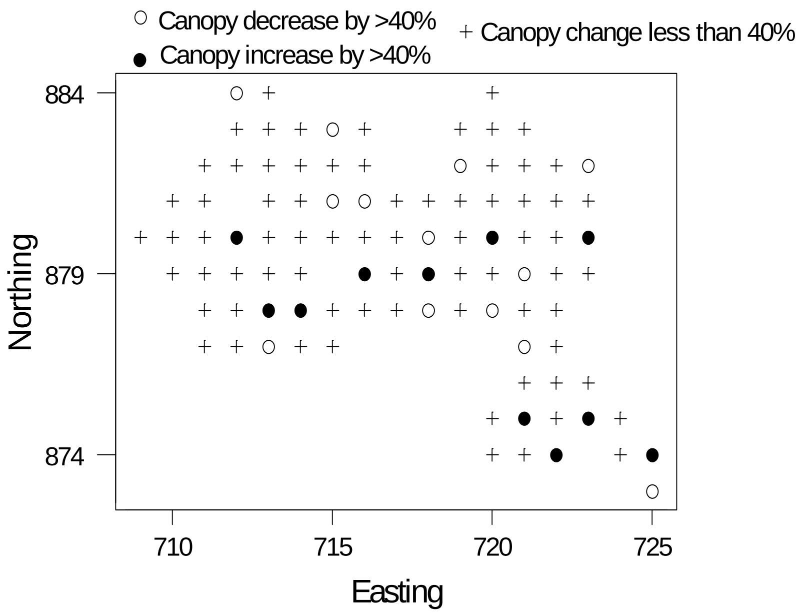


Figure 2 Distribution of plots showing large (> 40%) increases or decreases in canopy cover

Table 2 Distribution of cover values in the different layers (number of plots)

Cover value	Canopy layer >2.5 m high		Mid-cover layer 0.5-2.5 m high		Ground cover <0.5 m high	
	1973	1992	1973	1992	1973	1992
0	5	5	12	13	3	8
1-20%	6	10	44	30	8	12
21-40%	13	8	25	25	11	12
41-60%	10	7	11	12	8	12
61-80%	16	13	3	8	13	10
81-100%	46	53	1	8	53	42

High values for canopy cover (>60%, Table 2) and for ground cover (not necessarily in the same plot) are common at both dates, whereas most plots have relatively little in the way of shrub cover (<20%). The broad foliage height profile, which is important for many birds and some small mammals, has not changed.

Table 3 Composition of the Warburg reserve, assessed by canopy cover %, number of leading trees, or mean basal area (from the relascope sweeps)

Mean diameters (dbh) for the leading trees are also given. Standard errors for the means are given in brackets. Nr = not recorded.

	% cover		**Leading tree (no of plots)**		**Mean dbh for leading trees (cm)**		**Mean basal area (m^2ha^{-1})**	
Species	**1973**	**1992**	**1973**	**1992**	**1973**	**1992**	**1973**	**1992**
Beech	18.6 (3.7)	20.8 (3.7)	14	13	33.3 (5)	38.6 (6)	3.4 (0.6)	4.8 (0.8)
Ash	15.3 (2.8)	19.8 (2.9)	22	31	11.9 (2)	20.3 (2)	2.5 (0.4)	4.2 (0.6)
Sycamore	11.1 (2.8)	8.9 (2.4)	12	8	29.9 (5)	32.2 (6)	1.4 (0.4)	1.8 (0.4)
Hazel	10.6 (2.3)	8.1 (1.7)	nr	nr	nr	nr	nr	nr
Birch	3.6 (1.0)	4.8 (1.4)	9	15	15.6 (4)	16.9 (3)	0.8 (0.2)	1.0 (0.2)
Oak	2.8 (1.3)	2.2 (0.9)	9	7	22.6 (6)	37.7 (6)	0.7 (0.2)	1.1 (0.2)
Other broadleaf	5.7 (1.2)	7.2 (1.4)	12	13	17.7 (4)	20.1 (5)	1.2 (0.3)	1.6 (0.3)
Conifers (excl. yew)	9.8 (2.3)	3.6 (1.4)	18	14	28.7 (3)	38.0 (5)	3.0 (0.6)	2.8 (0.6)

4.2 Changes in canopy composition (1973-1992)

The composition of the canopy (based on the cover estimates for cover >2.5 m high) showed little difference except for a significant decrease in the cover of conifers (Table 3). In 1973 conifers occurred in 20 plots with a mean cover for those plots of 47% (S.E. 6), whereas by 1992 they were present in only 14 plots and their mean cover in these had dropped to 25% (S.E. 6). The relascope results show a similar pattern: all broadleaf species showed an increase in basal area, particularly for ash, but the conifer cover decreased slightly.

Young ash was common as the leading tree in scrubby plots or as seedlings in plots with no large tree present and ash increased in terms of the number of plots in which it occurred as a leading tree. However such small individuals do not contribute much to the canopy cover. Beech on the other hand frequently contributed to the cover of plots in which it did not occur; this is reflected in it making a bigger contribution to mean basal area in both years than it does as a leading tree. In just over half the plots (55 out of 96) the leading tree was different in 1992 to that which it had been in 1973, with this resulting in a change in species in 32 plots; ash and birch were the main beneficiaries of the changes.

The mean diameter increased for all species, not surprisingly since the trees had grown over the period concerned (Table 3). This measure was, however, affected by changes in the number of trees that contributed to that mean: removal of small trees leads to an increase in mean diameter. Hence the diameter distributions give a better picture of the differences between the species and between years (Table 4): the ash population was young and growing vigorously (a pattern shared with birch). Beech was fairly stable, but with two clear cohorts: the large old pollards and the smaller stems from the coppice poles and regeneration. The conifers were only represented in 1992 by the larger stems as more of the smaller ones had been removed.

Table 4 Diameter distribution patterns for selected leading tree species

Species	Diameter class mid-point (cm)					
	0	10	20	30	40	50+
Ash 1973	6	9	5		2	
Ash 1992	3	8	11	6	2	1
Beech 1973	1		5	2		6
Beech 1992	2		1	4		6
Conifers 1973	1	8	3	4	1	1
Conifers 1992			4	3	2	5

4.3 Variation in the wood based on canopy cover

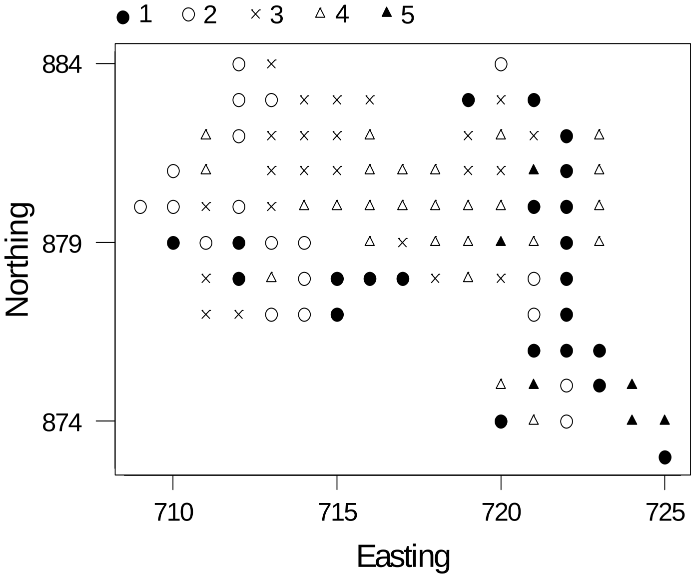
The TWINSPAN analysis indicated that the wood could be divided up into five broad plot types based on their woody composition (Table 5): a beech group; an oak-ash group; a sycamore-larch group; a birch-pine-shrub group; and a small number of plots that largely lacked tree cover. While most plots (70%, Figure 3) were put in the same group in each year there was some shifts, notably from groups 3 and 4, characterised by introduced trees (sycamore, larch, pine and spruce), towards group 2 which was composed predominantly of native species.

Table 5 Comparison of different plot types based on their mean percentage canopy cover

(Minor species have been excluded from the table although they were part of the analysis)

Group	1	2	3	4	5
No of plots in each group in 1973	22	19	23	26	6
1992	21	31	15	23	6
Mean cover across both years for:					
Canopy (>2.5m)	92	71	83	60	9
Shrub layer (0.5-2.5m)	14	29	27	37	31
Ground cover (<0.5m)	32	79	80	72	92
Mean cover in the canopy layer of:					
Beech *Fagus sylvatica*	81	4	0	0	0
Ash *Fraxinus excelsior*	10	57	7	1	0
Oak *Quercus robur*	1	9	0	3	0
Sycamore *Acer pseudoplatanus*	0	1	44	4	0
Larch *Larix* spp.	0	0	22	1	0
Spruce Picea spp.	0	0	3	1	0
Other conifers, mainly *Pinus* spp.	0	0	6	9	0
Birch *Betula* spp.	0	1	0	12	0
Hazel *Corylus avellana*	3	14	2	26	0
Hawthorn *Crataegus monogyna*	1	1	2	6	0
Sallow *Salix* spp.	0	0	0	3	0
Other shrubs	0	2	2	5	0

Figure 3a Distribution of TWINSPAN tree endgroups - 1973



Groups are as follows: 1 beech; 2 ash-oak; 3 sycamore-larch; 4 birch-pine-shrubs; 5 open

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Figure 3b Distribution of TWINSPAN tree endgroups - 1992

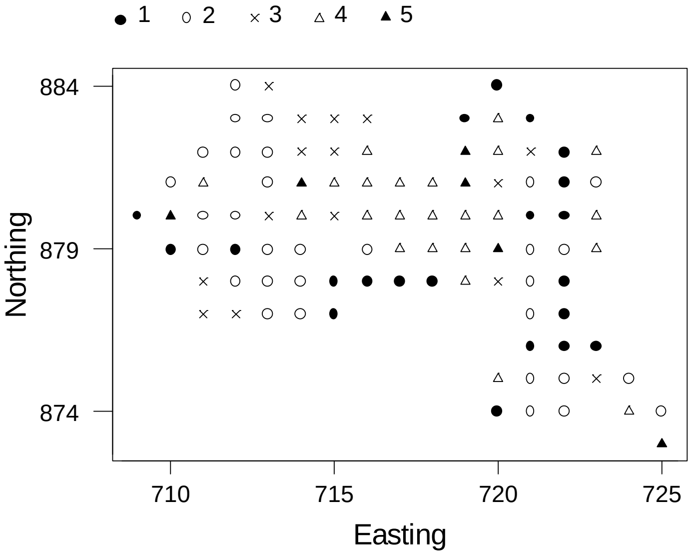


Figure 3 Distribution of canopy type groups 1-5 in 1973 and 1992

1 Beech; 2 Ash-oak; 3 Sycamore-Larch; 4 Birch-pine-shrubs; 5 Open.

4.4 Grouping of plots by ecological processes

As an alternative approach the plots were grouped according to the major ecological process that were operating between 1973 and 1992 in respect to canopy changes (Figure 4) as follows: no obvious major impact on the canopy (36 plots); young growth stands that were going through a rapid growth phase (25 plots); natural opening out of the canopy through tree death or significant windblow (14 plots); active clearance to create grassland or maintain rides (21 plots).

The 'no impact' plots and those affected by natural events such as tree death and windblow did not differ in their canopy, mid-cover or field layer covers in 1973: but the opening up of the canopy in the latter led to the much greater increase in the field layer than in the no impact plots (Table 6). The stands where the main change was rapid growth of young stands tended to have less canopy cover in 1973 and a greater cover in the shrub layer. The field layer declined in cover in these plots between 1973 and 1992 as the canopy cover increased. 'Active clearance' led to declines in canopy and some increases in field layer cover.

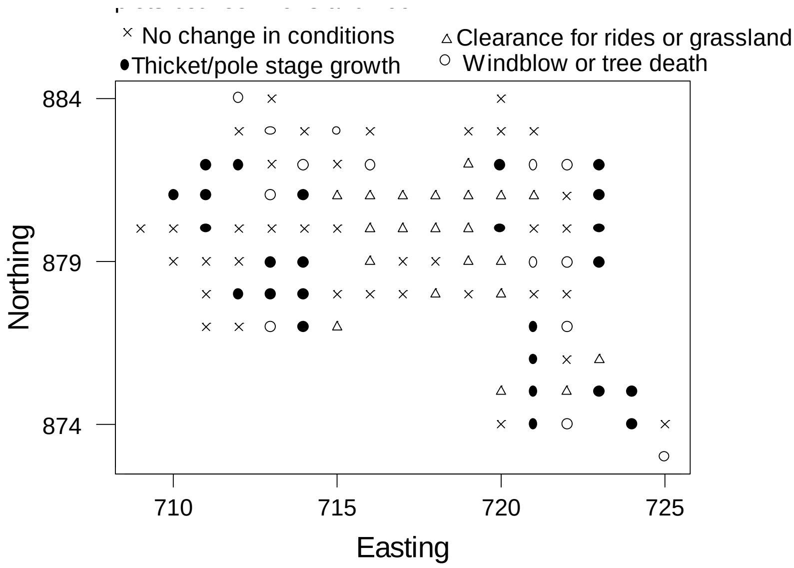


Figure 4 Distribution of plots showing different ecological processes (1973-1992)

Table 6 Characteristics of plots undergoing different types of ecological change

(Standard errors in brackets) (a) in terms of cover, (b) ground flora richness.

	No external impact		Natural opening of stands		Young growing stands		Active clearance		Signif. of diffs. between groups ANOVA
No of plots	**36**		**14**		**25**		**21**		
(a) Cover									
1973 canopy cover	84	(4)	85	(7)	56	(7)	66	(8)	***
Canopy change to 1992	6.5	(4)	-25	(12)	14.2	(7)	-25	(8)	***
1973 mid-cover	27.4	(4)	26.8	(7)	47.8	(6)	26.9	(5)	0
Mid-cover change	-11	(3)	-2	(6)	-16.8	(7)	-4	(7)	NS
1973 ground cover	58.7	(7)	44.6	(9)	74.2	(6)	66.7	(6)	NS
Ground cover change	10.4	(4)	31.9	(9)	-4.8	(6)	17.1	(6)	****
(b) Ground flora richness									
1973 number of species per plot	13.2	(2)	12.0	(2)	21.8	(2)	29.0	(2)	***
1992 number of species per plot	10.8	(1)	13.3	(2)	17.2	(2)	28.3	(2)	***
Number of species lost per plot	6.7	(1)	5.4	(2)	11.2	(1)	12.5	(1)	***
Number of species gained per plot	4.4	(1)	6.6	(2)	6.6	(1)	11.8	(1)	***

5. Results – ground flora comparisons

For the site as a whole the pattern of species diversity has been maintained - there is little change in the total number of species, the balance between common and scarce species, or between ancient woodland indicators and non-woodland species (Table 7). The frequency with which each species was recorded in 1992 was very strongly linked to that with which it occurred in 1973 (Figure 5); the regression of 1992 values on 1973 ones was highly significant (92freq)= 0.5 + 0.8(73freq), R^2=84%, $p<0.001$).

5.1 Species turnover and plot level differences

The flora of the site as a whole is very similar between the two dates (Table 7), but there was much more variation at the individual plot level. The mean number of species per plot was not significantly different in 1973 to that in 1992, but the mean similarity between the records for individual plots in terms of their species composition was only 53%: the number of species lost from plots (ie recorded in 1973 but not in 1992) was more-or-less matched by the gains (Table 8). Plots where the canopy decreased were more likely to gain species compared to those where the canopy cover increased (Figure 6).

Table 7 Comparison of species richness at plot and wood level

(Number of species occurrences in brackets)

	1974	1992
Total no of species (all plots)	161	145
No of species recorded on only one date	37	21
No of species present in >10% of plots	51	53
No of ancient woodland indicators	25 (228)	28 (240)
No of other woodland species	71 (1285)	67 (1152)
No of non-woodland species	65 (286)	50 (207)

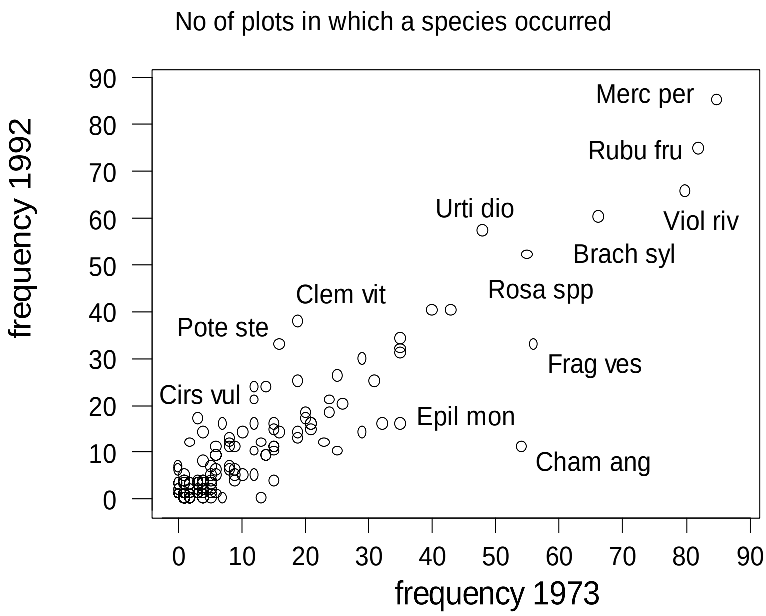


Figure 5 Regression of species frequency in 1992 on frequency in 1973 (all species)

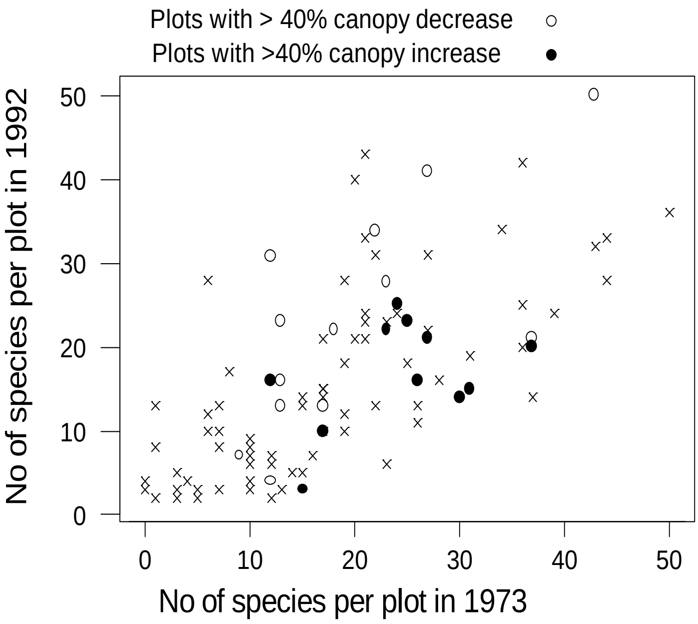


Figure 6 Number of species recorded in 1992 compared to the number recorded in 1973 for each plot

The five types of plot identified in Figure 2 and Table 5 (based on canopy variations) showed the expected variations in mean species number, with the beech plots having very low values and open plots the highest (Table 9). While this was partly due to more non-woodland species occurring in the open plots there were more woodland species also. The two plot types 3,4 which had the highest levels of introduced tree species did not in this instance have lower levels of species richness, but were generally similar to the ash-oak group 2. Common species across all five types of plot included *Viola riviana*, *Mercurialis perennis* and *Rubus fruticosus*.

Table 8 Plot richness and species turnover

	1973	1992
Mean species number (96 plots)	18.7	16.7
Mean species number recorded on only one time	9.0	6.9
Mean Sorensen similarity index	53%	
Plot canopy cover decreased by >40% (13 plots)	19.9	23.3
Plot canopy cover increased by >40% (11 plots)	24.3	16.8
Plot canopy cover change <40% (74 plots)	17.7	15.4

The plots that appeared to have suffered no external impact showed only a small, non-significant decline in species richness (Table 6b). Those plots where some form of natural opening up of the canopy had occurred did not differ initially in species richness but the change, though again small, was for an increase in richness. This was, however, very small compared to the increase in ground flora cover in these plots (Table 6a). The other two sets of plots started with much higher levels of species richness in line with their more open canopies. However, while the 'active clearance' plots retained their richness, as well as expanding ground flora cover (Table 6a), the 'young, growing stands' lost significantly more species than they gained.

Table 9 Differences in the flora between plots under different canopies

Number of species for the different plot types (both years' data combined)	All species		Non-woodland spp,	
	Mean no	**Total no**	**Mean no**	**Total no**
1. Beech plots (43 records)	9.8	108	1.0	29
2. Ash-oak plots (50 records)	16.2	122	1.5	34
3. Sycamore-larch (38 records)	16.2	119	1.9	34
4. Birch-pine-shrubs plots (49 records)	24.2	143	4.0	42
5. Open plots (12 records)	30.2	116	9.0	43

	Species frequency under different canopy types I 1-20%, II 21-40%, III 41-60%, IV 61-80%, V 81-100%				
	Percentage of plots in which a species occurred				
	Beech	**Ash-oak**	**Sycamore-larch**	**Birch-pine-shrubs**	**Open**
No of records	43	50	38	49	12
Species					
Viola riviniana	III	IV	IV	V	V
Mercurialis perennis	III	IV	IV	V	IV
Rubus fruticosus	II	IV	V	V	V
Chamerion angustifolium	II	III	III	IV	V
Brachypodium sylvaticum	II	III	IV	IV	V
Rosa spp	II	III	III	IV	IV
Urtica dioica	II	III	III	III	III
Hypericum hirsutum	II	III	III	III	III
Fragaria vesca	II	II	IV	IV	IV

5.2 Species changes between 1973 and 1992

Species whose frequency had changed by at least 10 plots (ie more than 10% of the sample) were identified to see if they suggested any major changes in the conditions present in the wood in 1992 compared to 1973 (Table 10). (Smaller differences in the frequency with which individual species were recorded between the surveys might be due to recording errors.)

The relative abundance of *Chamerion* and *Epilobium* in 1973 compared to 1992 may reflect relatively high levels of disturbance in the site following the planting in the 1960s prior to the wood's acquisition as a reserve. Both these species showed a decline over the same period at Wytham Woods (Kirby & Thomas 1999, 2000). However unlike at Wytham Woods and Monks Wood, Cambridgeshire (Crampton *et al* 1998) there has not been the systematic decline in woodland herbs and increase in tall grasses (*Poa trivialis*, *Deschampsia cespitosa*, *Brachypodium sylvaticum*), believed there to be due to excessive deer grazing (Kirby 2001). The differences for *Potentilla/Fragaria* might be partly recorder errors, but comparison of in which plots they were recorded on each occasion suggests this is not the case.

Of the 58 species that were only recorded in only one year, the majority (49) were recorded only in one or two plots; only one species *Poa pratensis* was found in more than 10 plots and recording error may be a factor in its differential recording.

Table 10 Species whose frequency changed by a minimum of 10 plots between the two recording dates

Ellenberg scores are L (light), N (nitrogen), F (moisture) - the higher the score the greater the requirement of the species for light, nitrogen and moisture respectively. See Appendix 2 for explanation.

Species	1973 freq.	1992 freq.	Change	Ellenberg scores		
				L	N	F
Clematis vitalba	19	38	19	7	7	5
Potentilla sterilis	16	33	17	5	6	5
Cirsium vulgare	3	17	14	8	8	5
Bromopsis ramosus	12	24	12	6	6	5
Geum urbanum	14	24	10	4	7	5
Mycelis muralis	4	14	10	4	6	5
Sonchus oleraceus	2	12	10	7	8	4
Listera ovata	15	4	-11	6	7	6
Potentilla reptans	23	12	-11	6	5	6
Poa pratensis	13	0	-13	6	6	5
Viola riviniana	80	66	-14	5		4
Agrostis stolonifera	25	10	-15	8	5	7
Clinopodium vulgare	32	16	-16	7	3	4
Epilobium montanum	35	16	-19	4	6	5
Fragaria vesca	56	33	-23	7	6	5
Chamerion angustifolium	5	11	-43	8	8	5

5.3 Ellenberg scores analysis

Ellenberg scores were compared for the species lists from the wood, although values were not available for some species for some characters. The species show a spread of light values reflecting the mixture of open and closed habitats on site; average to high available nitrogen values; neutral to basic soil reaction scores; and average dampness values (Table 11). (The interpretation of the Ellenberg values is given in Appendix 2). Changes in the light regime (through plots becoming more open, or closing over) or nitrogen deposition from the atmosphere might show up as a difference in the numbers of high scoring species in the lists for the two years. Therefore this was examined further.

When the number of occurrences of all species was used there was a significant difference in the light scores - relatively fewer occurrences in 1992 of high light score species. This would suggest that the wood has become more shaded, although this is not reflected by the canopy and shrub layer cover data (Table 1). There was no difference for the nitrogen scores.

There was no consistent pattern to the scores when those that showed the most increases were compared with those showing high decreases in frequency (Table 10). For species recorded on only one occasion there was significant difference for nitrogen scores but not for light (Table 11). However the nitrogen score change was the reverse of what might have been expected if there had been a significant increase in nutrient levels from (for example) air pollution - the species recorded only in 1973 had higher scores than those recorded only in 1992.

Table 11 Distribution of Ellenberg indicator scores (Ellenberg 1988)

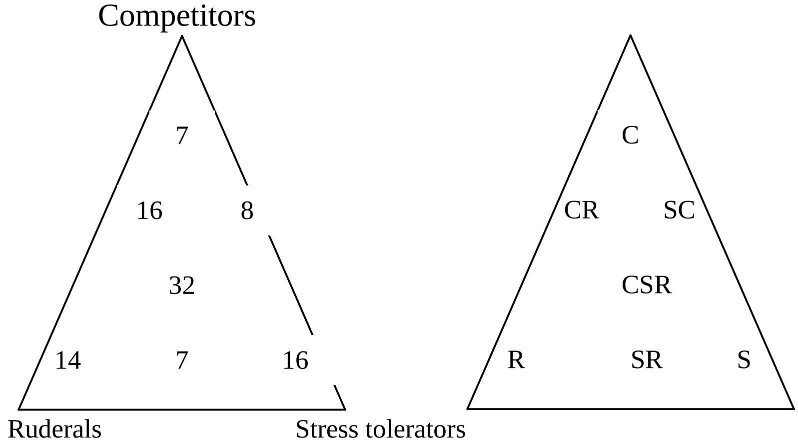
	No of species with a score of:							
Score	1-3	4	5	6	7	8	9	
Combined list - Light	15	18	13	32	51	24	4	
- Nitrogen	26	15	25	35	24	21	3	
- Moisture	9	26	70	19	14	5	1	
- Soil pH	8	7	9	19	43	27	3	
	No of species occurrences with a score of:							
All species:	1-3	4	5	6	7	8	9	
1973 records - Light	196	186	186	425	424	163	18	chi-sq. = 17
1992 records - Light	193	199	183	353	363	103	9	P=0.02 *
1973 records - Nitrogen	171	83	307	466	337	131	51	chi-sq. = 0.3
1992 records - Nitrogen	136	61	269	415	344	132	58	NS
Species recorded only once:								
In 1973 -Light	1		3	5	12	5	2	chi.sq. =0.1
In 1992 - Light		1	2	3	7	2		NS
In 1973 - Nitrogen	4	4	2	9	2	5	1	chi-sq.=6.3
In 1992 - Nitrogen	8		3	2	1			P=0.01*

5.3.1 Functional attribute analysis of the Warburg flora

The standard outputs from the functional attributes analysis (Grime *et al* 1988) are given in Figure 7. Further information on the meaning of the different categories is given in Appendix 3. The relatively high percentage of species that were classed as having something other than woodland as their main habitat (based on the results from the Sheffield surveys) reflects the species associated with the open grassland. The two sets of records (1973 and 1992) are very similar in almost every respect, providing further support for the idea that the flora for the wood as a whole changed little over the nineteen years.

(a) 1973 data. The numbers are the percentage of the flora in each category.

PLANT STRATEGY



MAIN HABITAT (based on area around Sheffiled)

Wetland	3
Skeletal	8
Arable	15
Pasture	27
Spoil	19
Wasteland	31
Woodland	27

(Some species have two habitats)

POLYCARPIC PERENNIALS	68

PRESENT STATUS

Decreasing	41
Uncertain	21
Increasing	38

GEOGRAPHICAL RESTRICTION

(A) LATITUDINAL

Northern	0
Slight northern	0
No lat. restriction	35
Slight southern	33
Southern	32

(B) LONGITUDINAL

Western	2
Slight western	2
No long. restriction	96
Slight eastern	0
Eastern	0

CANOPY STRUCTURE

Leafy	48
Semi-basal	38
Basal	14
Floating	0
Other	0

HEIGHT

<100 mm	13
100-299	30
300-599	24
600-999	13
1000-3000	17
>3000	2

REGENERATIVE STRATEGY

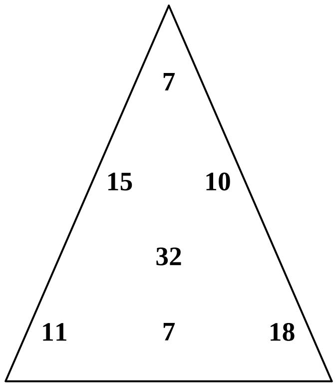
Persistent seed bank	68
Numerous widely dispersed seeds	16
Vegetative fragments important	12

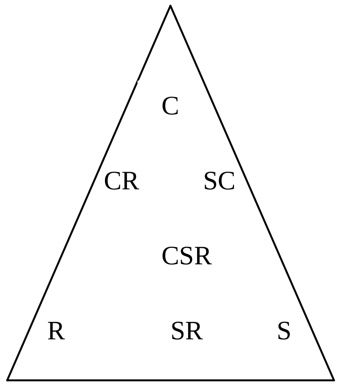
Figure 7 Analysis of the Warburg plot flora using plant attributes (Grime *et al*. 1988)

(a) 1992 data. The numbers are the percentages of the flora in each category

MAIN HABITAT	
Wetland	5
Skeletal	9
Arable	16
Pasture	28
Spoil	19
Wasteland	27
Woodland	30

POLYCARPIC PERENNIALS	75





PRESENT STATUS	
Decreasing	38
Uncertain	26
Increasing	36

GEOGRAPHICAL RESTRICTION

(A) LATITUDINAL	
Northern	0
Slight northern	0
No lat. restriction	32
Slight southern	34
Southern	34

(B) LONGITUDINAL	
Western	2
Slight western	4
No long. restriction	94
Slight eastern	0
Eastern	0

CANOPY STRUCTURE	
Leafy	52
Semi-basal	32
Basal	16
Floating	0
Other	0

HEIGHT	
<100 mm	15
100-299	32
300-599	25
600-999	12
1000-3000	14
>3000	2

REGENERATIVE STRATEGY	
Persistent seed bank	65
Numerous widely dispersed seeds	16
Vegetative fragments important	12

5.3.2 DECORANA analysis

The Detrended Correspondence Analysis (DECORANA) was carried out on the ground flora data using data from both years, but keeping the plot records for each year separate. The output is presented in terms of the species and plot distributions on selected axes in Figures 8 and 9. For species, axes 1 and 4 separate out ancient woodland indicators, other woodland species and non-woodland species, probably reflecting the differing shade tolerances of these species groups: axis 1 is correlated with the Ellenberg light scores. Axis 2 shows a weaker but significant correlation with Ellenberg nitrogen scores.

There is a strong correlation between plot species richness and its position along Axis 1 (R^2=25%)which may also be related to the light factor. There is a significant but weak correlation between the position of plots on axis 1 and the canopy cover estimates for each plot (which tend to determine the shade experienced by the ground flora) and a slight (significant) separation of the tree groups (Table 5). The open plots are concentrated at the high end of Axis 1 and the closed canopy groups 1 and 2, are more at the lower end of this axis; however there is considerable overlap in the distribution of the individual plots (Figure 9) reflecting the similarity in the common ground flora species present (Table 9).

There is a slight shift in plot positions between the years on Axis 4, but as with the tree groups the overlap between the two years is considerable.

The analysis emphasises therefore the variation within the site between open and closed conditions, but the broad similarity across years.

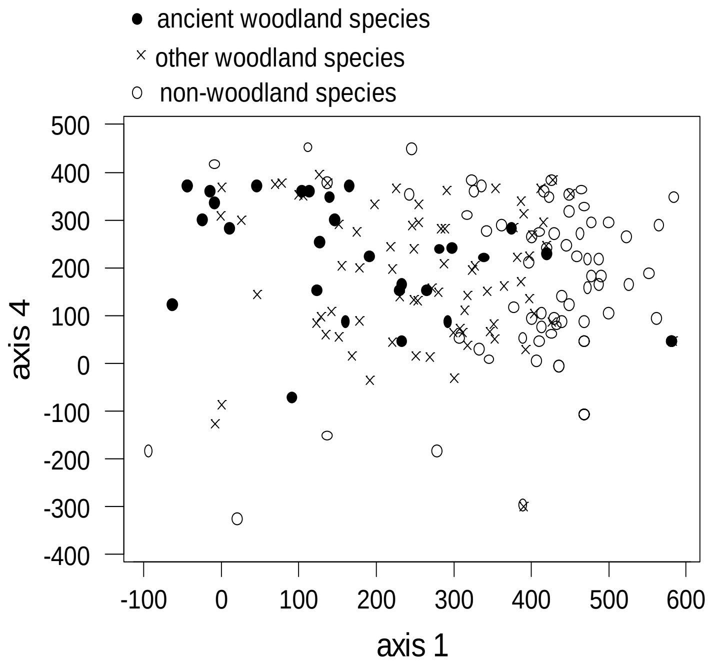


Figure 8 DECORANA analysis: distribution of species groups

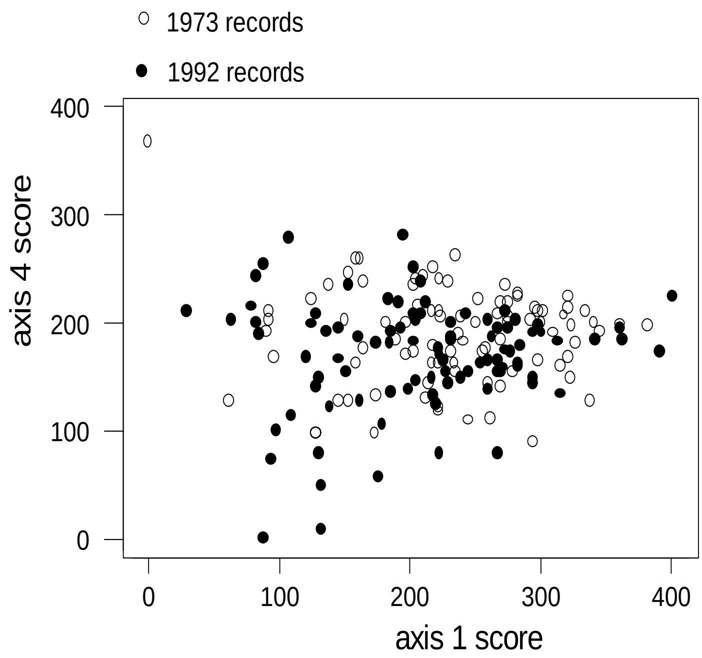


Figure 9 DECORANA analysis: plot distributions 1973, 1992

6. Using the results to explore different approaches and intensities of sampling.

How much of the flora was detected?

Any plot recording system detects only some of the species present and in particular is likely to miss the rarer species that may be the more interesting in conservation terms. The plant list for the reserve is over 300 vascular plants, but only about 200 (including the trees and shrubs) appeared in the plots.

Had a smaller number of plots been recorded the proportion of species detected would be corresponding less (Figure 10). The accumulation of species for a set of plots using the 1973 records with the 1992 records tended to be lower as the total number of species recorded in 1992 was less when plots were added in the same order as for the 1973 curve. However the shape of the curve at the lower end is determined by which particular plots are included and a second curve is shown for 1992 which is drawn from a completely separate set of plots to those used in the 1973 curve. Unlike with the 'same plots' comparison the 1992 curve is actually above that for 1973 up until the 40-plot sample. The curve was not continued beyond 40 samples because there would inevitably then be overlap between the two sets of plots and the two 1992 curves must inevitably converge. Extrapolation of species accumulation curves from relatively low numbers of plots must therefore be done with care.

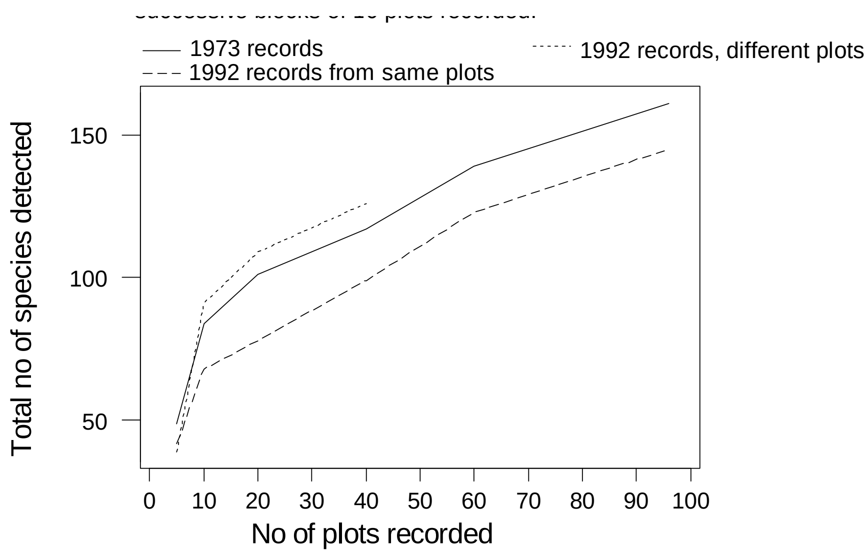


Figure 10 Accumulation of species with successive blocks of 10 plots recorded

Effects of sample size on estimating mean species richness

Mean plot-richness may be of interest as a measure of how the diversity of the reserve is, is not changing over time. Table 12 compares the range of values obtained from five randomly chosen (and non-overlapping) sets of plots, with 5, 10 and 15 plots respectively in a set. In each case results are given for both 1973 and 1992, in order that comparisons can be made between the consequences for mean plot-richness of using the same plots in the estimates (permanent samples) compared to using a different set of plot positions (equivalent to temporary sampling). The mean difference in plot richness between years is not significantly different, even with only five samples, as long as the same plots are recorded each time. The actual estimate of the mean varied, even with 15 plots in a sample, between 11.9 (se = 2.1) for one 1992 set to 27.1 (se 3.7) for one 1973 set. Had these two sets of temporary sample plots (unwittingly) been used the conclusion would have been reached that mean species richness had more than halved.

Table 12 Estimates of mean species richness per plot using different numbers of sample plots

Different plots were used in each of the runs with different sample numbers in each set. Within each run the plots in the different replicates do not overlap. The differences for each year-to-year comparison were non-significant where the comparison uses the same plots.

		Mean species richness per plot				
No of samples in each replicate	**Year**	**Replicate 1**	**2**	**3**	**4**	**5**
5	1973	19.6	17.0	23.2	16.4	15.2
	1992	23.8	17.4	17.4	11.2	17.6
10	1973	18.8	18.2	13.4	16.7	12.0
	1992	18.2	16.8	11.0	18.5	8.1
15	1973	17.5	19.1	18.8	15.4	27.1
	1992	17.9	18.0	15.7	11.9	23.2

More importantly reducing the sample size makes it impossible to explore within-site differences such as those shown in Table 9 or Figure 6. This same limitation applies to other plot measures such as mean canopy cover.

Estimating abundance within plots – how reliable are Domin?

Dawkins and Field (1978) were sceptical of the value of subjective estimates of species cover, although they did use them for a small number of species in the plots set up subsequently at Wytham Woods and Holton Forest. In the 1992 plots Domin values were assigned to all the ground flora records. This allows us to test how well these relate to a more objective measure, the frequency of species occurrence in the circlets (thirteen $0.1m^2$ quadrats distributed across the diagonals of the plots). For virtually all the plots the two types of species record were made by different individuals so that they can be treated as independent estimates.

Many more species occurrences were recorded in the plots as a whole than were picked up in the circlets (which counted only rooted individuals) (Table 13). The extra species were however for the most part relatively minor components of the vegetation with typically Domin scores of 3 or less. Where species were more frequent as estimated by the circlet records then this was reflected in the assigned Domin values. No great weight should be attached to minor differences in Domin scores, but they are useful in providing a record of which species are widespread through the plot as opposed to just occurring as single plants or a thin scatter of individuals.

Table 13 Comparison of circlet frequencies (out of 13 per plot) and Domin cover scores (out of 10) in 1992 for all species

The numbers in the cells are all species occurrences

Domin	1-3	4-5	6-7	8	9-10
% cover	<4	4-25	26-50	51-75	76-100
Circlet records					
0	862	904	3	0	0
1-3	0	432	24	1	0
4-7	0	74	20	9	2
8-10	0	24	17	9	0
11-13	0	9	6	9	23

In the circlet recording, species were often detected that had been missed in the more general survey of the rest of the plot, because of the greater attention being given to a small area. Hence there is a value in sub-sampling within a large plot to improve the detection of species,as well as assessing the abundance of species using Domin (or percentage cover) values for the plot as a whole.

Differences in the relationship between rooted frequency (as estimated from the circlets) and cover as assessed by Domin values, would be expected in relation to species growth habit and plant architecture. The circlet-Domin results were therefore analysed for some of the common species individually (Table 14)

Table 14   Cover score (Domin) versus rooted frequency (circlet frequency) for (a) *Rubus fruticosus* and (b) *Mercurialis perennis*

Domin score	1-3	4-5	6-7	8	9-10
% cover	<4	4-25	26-50	51-75	76-100
Rooted frequency (out of 13 circlets					
(a) Rubus fruticosus					
0	14	7	1	0	0
1-3	0	20	9	0	0
4-7	0	4	8	2	0
8-10	0	1	10	5	0
11-13	0	0	1	3	1
(b) Mercurialis perennis					
0	4	4	0	0	0
1-3	0	9	0	0	0
4-7	0	3	4	0	2
8-10	0	0	5	3	0
11-13	0	0	5	10	22

Mercurialis perennis with upright single stems had higher levels of rooted frequency at high cover values than the sprawling *Rubus fruticosus* but both show good agreement between the two types of measure.

7. Discussion

The surveillance system has fulfilled its originator's aims in that both plots and records survived and have generated data of interest to future managers and researchers at the site.

The results suggest that at the site level there has been considerable stability in terms of the gross structure of the woods (eg canopy cover, shrub layer, ground cover), broad composition in both tree and shrub, and ground flora terms, and the commonest species. The main change has been the reduction in the extent of non-native conifers in response to the management aims and some increase in open conditions.

This stability is in spite of considerable changes in all the attributes recorded in some individual plots.   Surveillance programmes are often developed from research studies that are established to look at particular processes (eg the effect of management, of grazing, or of minimum intervention) rather than what is happening across the site as a whole. For the manager interested in change at the site level, as well as what is happening in individual stands, it is essential that the surveillance is representative of all the major processes and types of habitat present, not just those that are the initial focus of research. It would be very easy to have gained a false impression of what has been happening in the reserve if the surveillance had been concentrated only on those areas where change was expected to occur because active management was taking place, or alternatively only in the areas of minimum intervention (Table 6). The starting points and changes that occurred are very different.

The interval between recordings was too long. At Wytham Woods, where a comparable system of plots were established, a rolling programme is being instigated to ensure that they are looked at at least every 10 years. The same approach will be explored at the Warburg Reserve. The main improvement we propose to the procedures is the addition of a cover estimate for all ground flora species: Domin values do not take much time to do and they do show a broad link to more objective assessments of species abundance.

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Appendix 1. Summary of NVC woodland types present

W8 *Fraxinus excelsior - Acer campestre - Mercurialis perennis* woodland

A community most abundant in the relatively warm, dry, lowlands of southern and eastern Britain. It occurs on various types of calcareous soils in areas where the effects of leaching are limited.

Ash, field maple and hazel are characteristic of W8, but may play quite a minor role, as other species that are occasional in the community as a whole can be locally abundant. Such species include blackthorn (particularly as ride-side and post-coppice vegetation in the *Deschampsia* sub-community), dogwood, elder (in more eutrophic situations), guelder rose, hawthorn, privet (on more base-rich soils), spindle, wayfaring tree, *Salix caprea* and *S. cinerea*. Lime and elm may also be local dominants, as may be sycamore in disturbed or secondary stands.

This community encompasses a wide range of floristic variation. Seven sub-communities have been identified, that are based chiefly on the dominant field layer species. Within these, the tree and shrub layers can vary greatly.

Mercurialis perennis (also common in W9) is the most distinctive field layer species, and *Arum maculatum, Circaea lutetiana, Geum urbanum, Hyacinthoides non-scriptus,* and *Viola riviniana/ reichenbachiana* are often frequent. Less common, but still characteristic, are *Adoxa moschatellina*, *Carex sylvatica*, *Conopodium majus*, *Lamiastrum galeobdolon* and *Sanicula europaea*. *Brachypodium sylvaticum* and *Hedera helix* are common in some sub-communities. With increased deer browsing over the last fifteen years the predominance of *Mercurialis* in some woods has declined, to be replaced by *Brachypodium sylvaticum*. These species are found in other communities but usually with a different canopy or with other species that are typically scarce in W8.

Rubus fruticosus can be common, with occasional *Lonicera periclymenum, Ribes uva-crispa, Rosa canina, Rubus caesius,* and *R. idaeus*. These may suppress the growth of *Mercurialis perennis* so that the community can resemble W10. The presence of scattered *Arum maculatum, Circaea lutetiana* and *Geum urbanum* will usually aid separation. *Pteridium aquilinum,* characteristic of W10, is usually rare in W8.

Relationships to other communities

On the lighter, base-rich soils of southern England, beech and yew are common, forming transitions between W8 and W12 (*Fagus sylvatica* - *Mercurialis perennis* woodland) and W13 (*Taxus baccata* woodland). Yew woodland is also often present as part of the mosaic with W8 in the southern Lake District.

Sub-community descriptions

W8a, b and c have a generally south-eastern distribution. They are particularly common in woods which have been managed as coppice-with-standards. The canopy / shrub layer structure of high forest is often absent, although this is changing where coppicing has been abandoned. English oak is the most common woody species after ash, maple and hazel, and is strongly preferential to this group. Hazel is the most frequent shrub, although hawthorns are common, and midland hawthorn is preferential, particularly in long-established stands. Other species may dominate locally, including small-leaved lime, hornbeam and invasive elms. Lime and hornbeam can form dense, single species stands, often accentuated by generations of coppicing. Field layer species include *Anemone nemorosa, Deschampsia cespitosa, Glechoma hederacea, Poa trivialis* and *Primula vulgaris* (*P. elatior* in East Anglia). The abundance of *Mercurialis perennis*, and the type of sub-community, varies according to the duration and extent of soil water-logging.

W8a *Primula vulgaris - Glechoma hederacea* sub-community

This is the most common sub-community. Lime and hornbeam can be locally abundant. The ground flora is dominated by *Mercurialis perennis* (except where grazed out), with frequent *Ajuga reptans, Glechoma hederacea, Poa trivialis, Primula* spp. *Hyacinthoides non-scriptus* is more prominent on damper soils.

W8b *Anemone nemorosa* sub-community

This sub-community becomes more common where soils remain wetter for longer in spring, on heavy clay soils in the south-east, and locally on wet sites in the north-west. *Anemone nemorosa* and *Ranunculus ficaria* are vernal dominants and *Hyacinthoides non-scriptus* is often more abundant than *Mercurialis perennis*. The few other preferentials include *Carex acutiformis C. pendula, C. remota, C. strigosa* and *Rumex sanguineus*. Separation of W8a and W8b can be difficult in late summer where *Anemone nemorosa* and *Ranunculus ficaria* have died back, and stands may have to be left as W8a/b

W8c *Deschampsia cespitosa* sub-community

Characteristic of heavy, wet, often trampled soils, which are free from water-logging for only a short period in the summer. Abundant *Deschampsia cespitosa* is the most obvious feature, especially in open conditions, such as young coppice and rides. *Mercurialis perennis* and *Hyacinthoides non-scriptus* are less common than in the other sub-communities. In disturbed situations diversity is often increased by ruderal species, especially *Cirsium* spp.*, Epilobium* spp.*, Hypericum* spp.*, Juncus conglomeratus, J. effusus* and *Rumex* spp.

W8e, f and g are more common to the north and west. Sessile oak and oak hybrids are more abundant here, as are wych elm and sycamore. A high forest structure is more common than in W8a-c. Water-logging plays a lesser role in the distinctions between these sub-communities. Species of clay soils (eg *Hyacinthoides non-scriptus*) give way to those more typical of free-draining soils, like *Brachypodium sylvaticum* and *Geranium robertianum*.

W12 *Fagus sylvatica - Mercurialis perennis* woodland

A community of free-draining base-rich calcareous soils (pH between 7 and 8) in the south-east lowlands of Britain, generally limited to the steeper drift-free faces of chalk escarpments. To the north-west, late frosts, low summer temperatures and heavier rainfall hinder beech dominance by their effects on mast production and regeneration, although beech woods can form well to the north-west of its natural range.

Beech is dominant throughout the community. Ash and sycamore are often present, often readily colonizing gaps. Pedunculate oak may occur but does not persist under deep shade. Whitebeam and yew are characteristic of the community, either as relicts of an early successional stand or persisting in areas where beech is not too tall. Yew is shade tolerant and may persist as a shrub layer. Apart from this, the shrub layer is usually sparse, although a wide range of species, including patches of hazel, hawthorn, field maple or holly, may occur.

Small gaps in the beech canopy may be dominated by ash, oak or sycamore but are often best treated as part of the beech community. Larger regeneration zones (more than about 75m across) where beech is absent should be referred to the appropriate non-beech type.

The field layer consists of species characteristic of base-rich soils such as *Allium ursinum, Arum maculatum, Brachypodium sylvaticum, Circaea lutetiana, Galium odoratum, Melica uniflora, Mercurialis perennis, Mycelis muralis* and *Sanicula europaea*. *Hedera helix* can form a complete carpet and *Rubus fruticosus* is occasionally abundant, but where the shade is dense the field layer may be virtually absent. Plants of moist base-rich conditions such as *Ajuga reptans, Anemone nemorosa*, *Deschampsia cespitosa, Poa trivialis* or *Primula vulgaris* are rare.

Rubus fruticosus can also be abundant in W14 *(Fagus sylvatica* - *Rubus fruticosus* woodland), but in the latter *Mercurialis* and other calcicolous herbs and grasses tend to be rare, and more acidophilous species, such as *Lonicera periclymenum, Luzula pilosa, Oxalis acetosella* and *Pteridium aquilinum* are more common. However, even on base-rich soils, a field layer more typical of acid soils often occurs immediately around the base of beech trees, because of ‘acid’ run-off from the trunks.

Sub-community descriptions

W12a *Mercurialis perennis* sub-community

This sub-community occurs on deeper, moister soils than the others, usually on gently sloping ground. Ash and sycamore are frequent associates of beech with oak occasional. The understorey is patchy but better developed than in the other sub-communities. The field layer is dominated by *Mercurialis perennis*, and is consequently lush but species poor, with a few taller herbs, such as *Brachypodium sylvaticum, Circaea lutetiana* or *Hyacinthoides non-scripta*, as well as *Hedera helix* and *Rubus fruticosus*.

W12b *Sanicula europaea* sub-community

This sub-community occurs on fairly steep slopes with shallow, well drained soils. The canopy is overwhelmingly dominated by beech, and the shrub layer is less extensive than in W12a. The drier soils limit the growth of *Mercurialis perennis*, and so the ground flora is more diverse. *Sanicula europaea* can be abundant, and *Mycelis muralis* is strongly preferential with *Brachypodium sylvaticum, Melica uniflora* and *Poa nemoralis* often giving a grassy appearance. A rich variety of orchids, including *Cephalanthera damasonium, Listera ovata* and *Neottia nidus-avis,* are also found in some stands.

W12c ***Taxus baccata*** **sub-community**

This sub-community is often found on still steeper, usually south facing slopes with extremely thin and well-drained soils. Beech grows more slowly than in other the sub-communities, and species such as yew and whitebeam can keep pace, and become relatively common. The canopy height is consequently low, but casts a very deep shade, and so the shrub layer is very sparse, with some elder, hawthorn, privet, *Clematis vitalba* and occasionally box. The ground flora is often absent because of the shade, with scattered *Arum maculatum, Circaea lutetiana, Geum urbanum, Mycelis muralis* and *Melica uniflora* and some shade tolerating mosses like *Brachythecium rutabulum* and *Eurhynchium praelongum*. Other bryophytes, such as *Ctenidium molluscum*, *Encalypta streptocarpa* and *Homalothecium sericium*, can be abundant in open areas.

Appendix 2. Meaning of selected Ellenberg Values

Ellenberg Indicator Values (Elenberg 1988; Ellenberg *et al* 1992)

Values have been assigned on a 1-9 (12) scale for a species's affinity for/tolerance of a range of factors.

T Temperature: low values equate to tolerance of low temperature regimes

K Continentality: low values are indicative of more Atlantic distributions for a species

R Soil reaction: low values indicate occurrence in acid soil conditions

F Soil moisture	L Light	N Soil nitrogen
1 Plants of extreme dryness	1 Plants in deep shade	1 Sites poor in available N
2 Between 1 and 3	2 Between 1 and 3	2 Between 1 and 3
3 Dry site indicators	3 Shade plants	3 More often N-deficient soils
4 Between 3 and 5	4 Between 3 and 5	4 Between 3 and 5
5 Moist site indicators	5 Plants of half shade	5 Average N availability
6 Between 5 and 7	6 Between 5 and 7	6 Between 5 and 7
7 Damp site indicators	7 Generally in well-lit places	7 More often N-rich sites
8 Between 7 and 9	8 Light-loving plants	8 Between 7 and 9
9 Wet site indicators	9 Plants of full light	9 Extremely rich N soils
10-12 Flooded/aquatic conditions		

Appendix 3. Function attributes analysis

Attributes considered in the functional attribute analysis programs used in this study (Hodgson *et al* 1995; for further detail of the attributes see Grime *et al* 1988)

(a) Strategy type: C Competitive, S Stress-tolerant, R Ruderal, CR Competitive-Ruderal, SC Stress-tolerant competitive, SR stress-tolerant ruderal, CSR intermediate CSR strategist

(b) Commonest habitat type in which species occurred in surveys in central England.

(c) No of polycarpic perennials (more likely to occur in undisturbed conditions)

(d) Regenerative strategy (production of persistent soil seed bank, production of widely dispersed seeds, seed weight)

(e) Geographical distribution in Europe -no of species showing some latitudinal or longitudinal bias to their distribution

(f) Present status (whether increasing or decreasing in Britain, where data available)

(g) Height of mature plants

(h) Distribution of leaves on stem (canopy structure)

Appendix 4. Examples of plot records

PLOT 721878

Percentage Cover across the main diagonal (nw-se) top (>2.5m) middle (0.5-2.5m) and bottom (<0.5m)

plot-cov	top73	mid73	bot73	top92	mid92	bot92
721878	100	10	100	95	40	100

Relascope totals and leading tree data

Columns are 1 - plot no; 2 , 3, 4, relascope totals for 1973 nw+se corners, 1992 nw+se corners and 1992 sw+ne corners respectively; 5 leading tree species code 1973 and 6 its diameter; 7 leading tree code 1992 and 8 its diameter. The key for the leading tree codes is as follows:

1	oak	2	sycamore	3	ash
4	beech	5	field maple	6	sallow
7	birch	8	elm	9	larch
10	spruce	11	other conifer	12	other b/l

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
721878	13	15	14	3	41	3	58

Cover across the leading diagonal by species (>2.5m) in 1973

Columns are 1 year, 2 oak, 3 sycamore, 4 beech, 5 ash, 6 other broadleaves, 7 hazel, 8 other shrubs, 9 larch, 10 field maple, 11 birch, 12 spruce, 13 other conifers, 14 hawthorn, 15 elm, 16 sallow, 17 blackthorn. Columns blank in both years have been omitted where this will reduce line overruns.

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
1973	0	0	0	90	0	50	0	0	0	0	0
1992	10	0	0	90	0	30	0	0	0	0	0

Basal area estimates from 1973 by species: sum of values for north-west and south-east corners (directly equivalent to cubic metres per ha)

Columns are 1 year, 2 oak, 3 sycamore, 4 ash, 5 beech,6 field maple, 7 sallow, 8 birch, 9 larch, 10 spruce, 11 other conifers, 12 other broadleaves, 13 elm.

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
1973	2	0	8	1	0	0	0	0	0	0	2	0
1992	1	0	7	7	0	0	0	0	0	0	0	0

Ground flora results

Columns are:
1 no of plot 2 plot code 3 species abbreviation
4 occurrence (1) in 1973 5 no of circlets in which a species occurred in 1973
6 occurrence (1) in 1992 7 no of circlets in which a species occurred in 1992 8 domin cover score for 1992

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
721878	71	*arum mac*	1	1	1	0	1
721878	71	*mercu per*	1	13	1	13	9
721878	71	*paris qua*	1	2	1	2	2
721878	71	*urtic dio*	1	1	1	1	5

Ash stand with dense *Mercurialis perennis* in both years. Some increase in understorey. Little other change.

PLOT 711881

Percentage cover across the main diagonal (nw-se) top (>2.5m) middle (0.5-2.5m) and bottom (<0.5m)

plot-cov	top73	mid73	bot73	top92	mid92	bot92
711881	80	80	50	90	40	85

Relascope totals and leading tree data

Columns are 1 - plot no; 2 , 3, 4, relascope totals for 1973 nw+se corners, 1992 nw+se corners and 1992 sw+ne corners respectively; 5 leading tree species code 1973 and 6 its diameter; 7 leading tree code 1992 and 8 its diameter. The key for the leading tree codes is as follows:

1	oak	2	sycamore	3	ash
4	beech	5	field maple	6	sallow
7	birch	8	elm	9	larch
10	spruce	11	other conifer	12	other b/l

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
711881	3	12	7	1	9	7	10

Cover across the leading diagonal by species (>2.5m) in 1973

Columns are 1 year, 2 oak, 3 sycamore, 4 beech, 5 ash, 6 other broadleaves, 7 hazel, 8 other shrubs, 9 larch, 10 field maple, 11 birch, 12 spruce, 13 other conifers, 14 hawthorn, 15 elm, 16 sallow, 17 blackthorn. Columns blank in both years have been omitted where this will avoid line overruns.

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
1973	15	0	0	0	0	10	40	0	0	15	0	0	0
1992	0	0	0	0	0	0	0	0	0	40	0	0	50

Basal area estimates from 1973 by species: sum of values for north-west and south-east corners (directly equivalent to cubic metres per ha)

Columns are 1 year, 2 oak, 3 sycamore, 4 ash, 5 beech, 6 field maple, 7 sallow, 8 birch, 9 larch, 10 spruce, 11 other conifers, 12 other broadleaves, 13 elm.

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
1973	0	0	0	0	0	0	3	0	0	0	0	0
1992	0	0	2	0	0	0	10	0	0	0	0	0

Ground flora results

Columns are:
1 no of plot 2 plot code 3 species abbreviation
4 occurrence (1) in 1973 5 no of circlets in which a species occurred in 1973
6 occurrence (1) in 1992 7 no of circlets in which a species occurred in 1992 8 domin cover score for 1992

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
711881	9	*arum mac*	0	0	1	0	1
711881	9	*athyr fil*	1	0	0	0	0
711881	9	*brach syl*	1	1	1	0	1
711881	9	*carex syl*	1	1	0	0	0
711881	9	*chama ang*	1	4	0	0	0
711881	9	*circa lut*	1	2	1	0	1
711881	9	*dryop fil*	1	0	1	0	1
711881	9	*galiu odo*	1	0	0	0	0
711881	9	*geran rob*	1	1	0	0	0
711881	9	*geum urb*	0	0	1	0	1
711881	9	*hyper per*	1	1	0	0	0
711881	9	*lonic per*	1	1	0	0	0
711881	9	*mercu per*	1	6	1	13	9
711881	9	*miliu eff*	1	1	0	0	0
711881	9	*poa tri*	1	2	0	0	0
711881	9	*rosa spp*	1	0	1	0	2
711881	9	*rubus fru*	1	11	1	0	1
711881	9	*urtic dio*	1	1	1	1	3
711881	9	*veron cha*	1	0	0	0	0
711881	9	*viola riv*	1	4	1	0	1

The plot was rather scrubby in 1973, with quite high mid-cover (80%), much bramble and *Chamerion angustifolium*. By 1992 the birch poles had become the main feature; ground cover had increased, but species richness decreased. Mercurialis perennis had assumed dominance.

Classed as Birch-(pine)-shrub type in both years.

PLOT 712879

Percentage Cover across the main diagonal (nw-se) top (>2.5m) middle (0.5-2.5m) and bottom (<0.5m)

plot-cov	Top 73	Mid 73	Bot 73	Top 92	Mid 92	Bot 92
712879	100	50	10	100	10	10

Relascope totals and leading tree data

Columns are 1 - plot no; 2 , 3, 4, relascope totals for 1973 nw+se corners, 1992 nw+se corners and 1992 sw+ne corners respectively; 5 leading tree species code 1973 and 6 its diameter; 7 leading tree code 1992 and 8 its diameter. The key for the leading tree codes is as follows:

1	oak	2	sycamore	3	ash
4	beech	5	field maple	6	sallow
7	birch	8	elm	9	larch
10	spruce	11	other conifer	12	other b/l

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
712879	15	23	24	4	49	4	56

Cover across the leading diagonal by species (>2.5m) in 1973

Columns are 1 year, 2 oak, 3 sycamore, 4 beech, 5 ash, 6 other broadleaves, 7 hazel, 8 other shrubs, 9 larch, 10 field maple, 11 birch, 12 spruce, 13 other conifers, 14 hawthorn, 15 elm, 16 sallow, 17 blackthorn. Columns blank in both years have been omitted where this is helpful to save line overrun.

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
1973	0	0	100	5	0	0	0	0	0	0	0
1992	0	0	100	0	0	0	0	0	0	0	0

Basal area estimates from 1973 by species: sum of values for north-west and south-east corners (directly equivalent to cubic metres per ha)

Columns are 1 year, 2 oak, 3 sycamore, 4 ash, 5 beech,6 field maple, 7 sallow, 8 birch, 9 larch, 10 spruce, 11 other conifers, 12 other broadleaves, 13 elm.

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
1973	0	0	8	7	0	0	0	0	0	0	0	0
1992	0	0	9	14	0	0	0	0	0	0	0	0

Ground flora results

Columns are:
1 no of plot 2 plot code 3 species abbreviation
4 occurrence (1) in 1973 5 no of circlets in which a species occurred in 1973
6 occurrence (1) in 1992 7 no of circlets in which a species occurred in 1992 8 domin cover score for 1992

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
712879	13	*ajuga rep*	1	0	0	0	0
712879	13	*carex syl*	1	0	0	0	0
712879	13	*chama ang*	1	0	0	0	0
712879	13	*circa lut*	1	0	0	0	0
712879	13	*dryop fil*	1	0	1	0	1
712879	13	*eupho amy*	1	0	0	0	0
712879	13	*fraga ves*	1	1	0	0	0
712879	13	*galeo lut*	1	4	1	2	1
712879	13	*luzul pil*	1	0	0	0	0
712879	13	*mercu per*	1	4	1	3	5
712879	13	*poten ste*	0	0	1	0	1
712879	13	*pteri aqu*	0	0	1	0	3
712879	13	*rubus fru*	1	4	1	0	3
712879	13	*viola riv*	1	0	1	0	1

Beech dominated plot with little ground flora cover in 1973; some loss of understorey and reduction in species richness by 1992. as the beech growth has continued. Otherwise little change.

Beech type in both years.

PLOT 713883

Percentage Cover across the main diagonal (nw-se) top (>2.5m) middle (0.5-2.5m) and bottom (<0.5m)

plot-cov	Top73	Mid 3	Bot 3	Top 2	Mid 2	Bot 2
713883	100	25	25	95	35	100

Relascope totals and leading tree data

Columns are 1 - plot no; 2 , 3, 4, relascope totals for 1973 nw+se corners, 1992 nw+se corners and 1992 sw+ne corners respectively; 5 leading tree species code 1973 and 6 its diameter; 7 leading tree code 1992 and 8 its diameter. The key for the leading tree codes is as follows:

1	oak	2	sycamore	3	ash
4	beech	5	field maple	6	sallow
7	birch	8	elm	9	larch
10	spruce	11	other conifer	12	other b/l

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
713883	15	21	23	7	15	3	20

Cover across the leading diagonal by species (>2.5m) in 1973

Columns are 1 year, 2 oak, 3 sycamore, 4 beech, 5 ash, 6 other broadleaves, 7 hazel, 8 other shrubs, 9 larch, 10 field maple, 11 birch, 12 spruce, 13 other conifers, 14 hawthorn, 15 elm, 16 sallow, 17 blackthorn. Columns blank in both years have been omitted where this will avoid line overruns.

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
1973	0	10	0	90	0	0	0	0	0	20	0
1992	0	0	0	95	0	0	0	0	0	0	0

Basal area estimates from 1973 by species: sum of values for north-west and south-east corners (directly equivalent to cubic metres per ha)

Columns are 1 year, 2 oak, 3 sycamore, 4 ash, 5 beech, 6 field maple, 7 sallow, 8 birch, 9 larch, 10 spruce, 11 other conifers, 12 other broadleaves, 13 elm.

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
1973	0	2	12	0	0	0	1	0	0	0	0	0
1992	0	5	15	0	0	0	0	0	0	1	0	0

Ground flora results

Columns are:
1 no of plot 2 plot code 3 species abbreviation
4 occurrence (1) in 1973 5 no of circlets in which a species occurred in 1973
6 occurrence (1) in 1992 7 no of circlets in which a species occurred in 1992 8 domin cover score for 1992

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
713883	23	*black per*	1	0	0	0	0
713883	23	*brach syl*	1	9	0	0	0
713883	23	*bromo ram*	1	0	0	0	0
713883	23	*carex syl*	0	0	1	0	1
713883	23	*centa umb*	1	0	0	0	0
713883	23	*circa lut*	1	1	0	0	0
713883	23	*clino vul*	1	0	0	0	0
713883	23	*epipa hel*	1	1	0	0	0
713883	23	*festu rub*	1	1	0	0	0
713883	23	*fraga ves*	1	2	0	0	0
713883	23	*galiu apa*	1	0	0	0	0
713883	23	*hyper hir*	1	0	0	0	0
713883	23	*hyper per*	1	0	0	0	0
713883	23	*inula con*	1	0	0	0	0
713883	23	*luzul pil*	1	2	0	0	0
713883	23	*mercu per*	1	3	1	13	9
713883	23	*poa tri*	1	1	0	0	0
713883	23	*poten ste*	1	1	0	0	0
713883	23	*prune vul*	1	0	0	0	0
713883	23	*ranun rep*	0	0	1	0	1
713883	23	*rubus fru*	1	10	1	2	3
713883	23	*sonch ole*	0	0	1	0	1
713883	23	*urtic dio*	1	0	1	0	3
713883	23	*veron cha*	1	2	0	0	0
713883	23	*viola hir*	1	0	0	0	0
713883	23	*viola riv*	1	6	0	0	0

Some loss of sycamore and birch cover from within the plot; expansion of ground flora cover, largely through spread of *Mercurialis perennis* at the expense of *Rubus fruticosus*. Reduction in species richness.

Ash-oak type in both years

PLOT 715877

Percentage Cover across the main diagonal (nw-se) top (>2.5m) middle (0.5-2.5m) and bottom (<0.5m)

plot-cov	top73	mid73	bot73	top92	mid92	bot92
715877	100	0	40	95	0	65

Relascope totals and leading tree data

Columns are 1 - plot no; 2 , 3, 4, relascope totals for 1973 nw+se corners, 1992 nw+se corners and 1992 sw+ne corners respectively; 5 leading tree species code 1973 and 6 its diameter; 7 leading tree code 1992 and 8 its diameter. The key for the leading tree codes is as follows:

1	oak	2	sycamore	3	ash
4	beech	5	field maple	6	sallow
7	birch	8	elm	9	larch
10	spruce	11	other conifer	12	other b/l

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
715877	28	32	27	3	13	3	20

Cover across the leading diagonal by species (>2.5m) in 1973

Columns are 1 year, 2 oak, 3 sycamore, 4 beech, 5 ash, 6 other broadleaves, 7 hazel, 8 other shrubs, 9 larch, 10 field maple, 11 birch, 12 spruce, 13 other conifers, 14 hawthorn, 15 elm, 16 sallow, 17 blackthorn. Columns blank in both years have been omitted where this will avoid line overruns.

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
1973	0	0	100	45	0	0	0	0	0	0	0
1992	0	0	90	20	0	0	0	0	0	0	0

Basal area estimates from 1973 by species: sum of values for north-west and south-east corners (directly equivalent to cubic metres per ha)

Columns are 1 year, 2 oak, 3 sycamore, 4 ash, 5 beech, 6 field maple, 7 sallow, 8 birch, 9 larch, 10 spruce, 11 other conifers, 12 other broadleaves, 13 elm.

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
1973	0	0	15	13	0	0	0	0	0	0	0	0
1992	0	0	12	20	0	0	0	0	0	0	0	

Ground flora results

Columns are:
1 no of plot 2 plot code 3 species abbreviation
4 occurrence (1) in 1973 5 no of circlets in which a species occurred in 1973
6 occurrence (1) in 1992 7 no of circlets in which a species occurred in 1992 8 domin cover score for 1992

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
715877	31	*carex syl*	1	0	0	0	0
715877	31	*circa lut*	1	0	0	0	0
715877	31	*dryop fil*	1	0	1	0	2
715877	31	*eupho amy*	0	0	1	0	1
715877	31	*fraga ves*	1	0	0	0	0
715877	31	*melic uni*	1	0	0	0	0
715877	31	*mercu per*	1	0	0	0	0
715877	31	*pteri aqu*	1	0	1	0	5
715877	31	*rubus fru*	1	7	1	11	7
715877	31	*tamus com*	1	1	0	0	0
715877	31	*viola riv*	1	0	0	0	0

An increase in cover of *Rubus fruticosus*; some loss of species richness; spread of ground flora. Rideside with ash, but nearby beech overhanging the plot.

Beech type in both years.

PLOT 722875

Percentage Cover across the main diagonal (nw-se) top (>2.5m) middle (0.5-2.5m) and bottom (<0.5m)

plot-cov	top73	mid73	bot73	top92	mid92	bot92
722875	20	85	100	40	5	90

Relascope totals and leading tree data

Columns are 1 - plot no; 2 , 3, 4, relascope totals for 1973 nw+se corners, 1992 nw+se corners and 1992 sw+ne corners respectively; 5 leading tree species code 1973 and 6 its diameter; 7 leading tree code 1992 and 8 its diameter. The key for the leading tree codes is as follows:

1	oak	2	sycamore	3	ash
4	beech	5	field maple	6	sallow
7	birch	8	elm	9	larch
10	spruce	11	other conifer	12	other b/l

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
722875	0	9	8	3	1	3	13

Cover across the leading diagonal by species (>2.5m) in 1973

Columns are 1 year, 2 oak, 3 sycamore, 4 beech, 5 ash, 6 other broadleaves, 7 hazel, 8 other shrubs, 9 larch, 10 field maple, 11 birch, 12 spruce, 13 other conifers, 14 hawthorn, 15 elm, 16 sallow, 17 blackthorn. Columns blank in both years have been omitted where this will avoid line overruns.

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
1973	0	0	0	25	0	0	0	0	0	0	0
1992	0	0	0	40	0	0	0	0	0	0	0

Basal area estimates from 1973 by species: sum of values for north-west and south-east corners (directly equivalent to cubic metres per ha)

Columns are 1 year, 2 oak, 3 sycamore, 4 ash, 5 beech, 6 field maple, 7 sallow, 8 birch, 9 larch, 10 spruce, 11 other conifers, 12 other broadleaves, 13 elm.

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
1973	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	9	0	0	0	0	0	0	0	0	

Ground flora results

Columns are:
1 no of plot 2 plot code 3 species abbreviation
4 occurrence (1) in 1973 5 no of circlets in which a species occurred in 1973
6 occurrence (1) in 1992 7 no of circlets in which a species occurred in 1992 8 domin cover score for 1992

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
722875	77	*agros sto*	1	1	1	0	1
722875	77	*arcti min*	1	1	0	0	0
722875	77	*brach syl*	1	10	1	6	4
722875	77	*carex fla*	1	4	1	1	1
722875	77	*chama ang*	1	4	0	0	0
722875	77	*cirsi vul*	1	1	0	0	0
722875	77	*clema vit*	1	3	1	0	1
722875	77	*clino vul*	1	0	1	0	1
722875	77	*dacty glo*	1	1	0	0	0
722875	77	*daphn lau*	0	0	1	0	1
722875	77	*epilo mon*	1	1	0	0	0
722875	77	*fraga ves*	1	1	1	0	1
722875	77	*galiu apa*	1	1	0	0	0
722875	77	*galiu mol*	1	1	0	0	0
722875	77	*galiu odo*	1	6	1	1	1
722875	77	*geran rob*	1	0	0	0	0
722875	77	*geum urb*	1	0	0	0	0
722875	77	*glech hed*	1	1	0	0	0
722875	77	*holcu lan*	1	0	0	0	0
722875	77	*hyper hir*	1	0	1	0	1
722875	77	*inula con*	1	2	1	0	1
722875	77	*leont his*	1	1	0	0	0
722875	77	*loliu per*	1	1	0	0	0
722875	77	*mercu per*	1	7	1	3	3
722875	77	*miliu eff*	1	0	0	0	0
722875	77	*mycel mur*	1	6	1	0	1
722875	77	*origa vul*	1	1	0	0	0
722875	77	*poten ste*	0	0	1	3	1
722875	77	*ranun rep*	1	2	1	0	1
722875	77	*rosa spp*	1	0	1	1	1
722875	77	*rubus fru*	1	4	1	2	3
722875	77	*solan dul*	1	0	0	0	0
722875	77	*sonch ole*	1	1	1	0	1
722875	77	*tarax off*	1	0	1	0	1
722875	77	*urtic dio*	1	0	1	0	3
722875	77	*veron cha*	1	1	0	0	0
722875	77	*viola hir*	1	1	0	0	0
722875	77	*viola riv*	1	5	1	4	1

Rather open stand in 1973, closing over more by ash thicket growth by 1992. Loss of some of the open grassland species (*Leontodon*, *Galium mollugo*), but also some recent clearance.

Ash-oak type in both years.

PLOT 722882

Percentage Cover across the main diagonal (nw-se) top (>2.5m) middle (0.5-2.5m) and bottom (<0.5m)

plot-cov	top73	mid73	bot73	top92	mid92	bot92
722882	100	10	5	100	5	1

Relascope totals and leading tree data

Columns are 1 - plot no; 2 , 3, 4, relascope totals for 1973 nw+se corners, 1992 nw+se corners and 1992 sw+ne corners respectively; 5 leading tree species code 1973 and 6 its diameter; 7 leading tree code 1992 and 8 its diameter. The key for the leading tree codes is as follows:

1	oak	2	sycamore	3	ash
4	beech	5	field maple	6	sallow
7	birch	8	elm	9	larch
10	spruce	11	other conifer	12	other b/l

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
722882	6	30	27	1	16	1	25

Cover across the leading diagonal by species (>2.5m) in 1973

Columns are 1 year, 2 oak, 3 sycamore, 4 beech, 5 ash, 6 other broadleaves, 7 hazel, 8 other shrubs, 9 larch, 10 field maple, 11 birch, 12 spruce, 13 other conifers, 14 hawthorn, 15 elm, 16 sallow, 17 blackthorn. Columns blank in both years have been omitted where this will avoid line overruns.

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
1973	0	0	70	0	0	40	0	0	0	0	0	0	5
1992	0	0	70	0	0	30	0	0	0	0	0	0	10

Basal area estimates from 1973 by species: sum of values for north-west and south-east corners (directly equivalent to cubic metres per ha)

Columns are 1 year, 2 oak, 3 sycamore, 4 ash, 5 beech, 6 field maple, 7 sallow, 8 birch, 9 larch, 10 spruce, 11 other conifers, 12 other broadleaves, 13 elm.

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
1973	1	0	0	4	0	0	0	0	0	0	1	0
1992	2	0	0	17	8	0	0	0	0	0	3	0

Ground flora results

Columns are:
1 no of plot 2 plot code 3 species abbreviation
4 occurrence (1) in 1973 5 no of circlets in which a species occurred in 1973
6 occurrence (1) in 1992 7 no of circlets in which a species occurred in 1992 8 domin cover score for 1992

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
722882	84	brach syl	1	0	0	0	0
722882	84	eupho amy	1	1	0	0	0
722882	84	heder hel	1	1	1	0	1
722882	84	lonic per	1	1	1	1	1
722882	84	mercu per	1	1	1	0	3
722882	84	orchi spp	1	0	0	0	0
722882	84	pteri aqu	1	0	0	0	0
722882	84	rosa spp	1	0	0	0	0
722882	84	rubus fru	1	2	0	0	0
722882	84	viola riv	1	3	0	0	0

Beech stand that had been coppiced in the past; dense cover contributing to the low cover and richness of the ground flora.

Beech type in both years.

PLOT 723875

Percentage Cover across the main diagonal (nw-se) top (>2.5m) middle (0.5-2.5m) and bottom (<0.5m)

plot-cov	top73	mid73	bot73	top92	mid92	bot92
723875	5	85	100	95	10	5

Relascope totals and leading tree data

Columns are 1 - plot no; 2 , 3, 4, relascope totals for 1973 nw+se corners, 1992 nw+se corners and 1992 sw+ne corners respectively; 5 leading tree species code 1973 and 6 its diameter; 7 leading tree code 1992 and 8 its diameter. The key for the leading tree codes is as follows:

1	oak	2	sycamore	3	ash
4	beech	5	field maple	6	sallow
7	birch	8	elm	9	larch
10	spruce	11	other conifer	12	other b/l

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
723875	0	14	21	3	1	3	14

Cover across the leading diagonal by species (>2.5m) in 1973

Columns are 1 year, 2 oak, 3 sycamore, 4 beech, 5 ash, 6 other broadleaves, 7 hazel, 8 other shrubs, 9 larch, 10 field maple, 11 birch, 12 spruce, 13 other conifers, 14 hawthorn, 15 elm, 16 sallow, 17 blackthorn. Columns blank in both years have been omitted where this will avoid line overruns.

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
1973	0	0	5	0	0	0	0	0	0	0	0
1992	0	5	25	30	0	0	0	0	20	25	0

Basal area estimates from 1973 by species: sum of values for north-west and south-east corners (directly equivalent to cubic metres per ha)

Columns are 1 year, 2 oak, 3 sycamore, 4 ash, 5 beech, 6 field maple, 7 sallow, 8 birch, 9 larch, 10 spruce, 11 other conifers, 12 other broadleaves, 13 elm.

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
1973	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	5	3	0	0	6	0	0	0	0	0

Ground flora results

Columns are:
1 no of plot 2 plot code 3 species abbreviation
4 occurrence (1) in 1973 5 no of circlets in which a species occurred in 1973
6 occurrence (1) in 1992 7 no of circlets in which a species occurred in 1992 8 domin cover score for 1992

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
723875	85	*agros sto*	1	3	0	0	0
723875	85	*atrop bel*	1	0	0	0	0
723875	85	*brach syl*	1	1	1	1	1
723875	85	*carex fla*	1	13	1	0	1
723875	85	*carex syl*	0	0	1	0	1
723875	85	*chama ang*	1	7	0	0	0
723875	85	*cirsi arv*	1	0	0	0	0
723875	85	*clema vit*	1	1	1	2	1
723875	85	*clino vul*	1	1	0	0	0
723875	85	*crepi cap*	1	0	0	0	0
723875	85	*dacty glo*	1	4	0	0	0
723875	85	*epilo mon*	1	1	0	0	0
723875	85	*eupho amy*	1	1	0	0	0
723875	85	*fraga ves*	1	6	1	1	1
723875	85	*galiu mol*	1	0	0	0	0
723875	85	*galiu odo*	1	4	1	0	1
723875	85	*geran rob*	1	0	0	0	0
723875	85	*glech hed*	1	3	1	0	1
723875	85	*holcu lan*	1	6	0	0	0
723875	85	*hyper hir*	1	1	1	1	1
723875	85	*hyper per*	1	2	1	0	1
723875	85	*inula con*	1	2	0	0	0
723875	85	*litho off*	1	0	0	0	0
723875	85	*mercu per*	0	0	1	0	3
723875	85	*mycel mur*	0	0	1	0	1
723875	85	*myoso arv*	1	1	0	0	0
723875	85	*ranun rep*	1	0	0	0	0
723875	85	*rosa spp*	1	1	1	1	1
723875	85	*rubus fru*	1	9	0	0	0
723875	85	*solan dul*	1	0	0	0	0
723875	85	*tamus com*	0	0	1	0	1
723875	85	*urtic dio*	1	0	0	0	0
723875	85	*viola hir*	1	1	0	0	0
723875	85	*viola riv*	1	1	1	0	1

Shift from rather open scrubby stand in 1973 to ash-birch thicket in 1992; loss of *Rubus fruticosus* and *Chamerion angustifolium*, with general thinning out of the ground flora generally.

Classed as beech in 1973, but as Sycamore(-larch) type in 1992, though not a good fit in either year.

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Top left: Identifying moths caught in a moth trap at Ham Wall NNR, Somerset.
Paul Glendell / English Nature 24,888
Middle left: Using a home-made moth trap.
Peter Wakely / English Nature 17,396
Bottom left: English Nature bat warden with a whiskered bat near Holme, Devon.
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