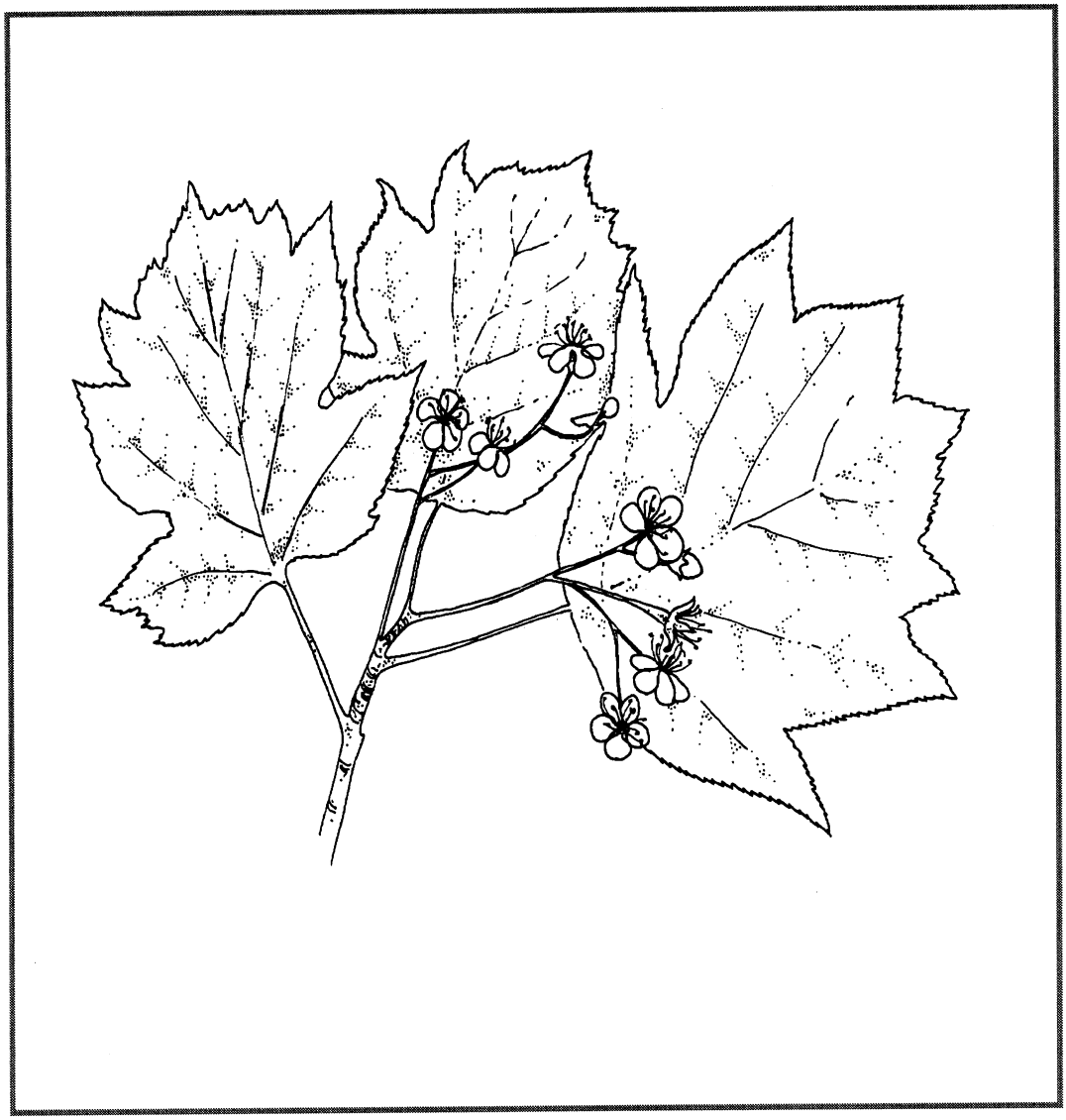
ENGLISH NATURE

Trends in vegetation cover and species richness in Wytham Woods, 1974 - 1999

No. 363 - English Nature Research Reports



working today
for nature tomorrow

English Nature Research Reports

Number 363

Trends in vegetation cover and species richness in Wytham Woods, 1974-1999

J.E. Hall
and
K.J. Kirby

English Nature
Northminster House
Peterborough
PE1 1UA

ISSN 0967-876X

Summary

Data from 24 permanent plots in Wytham Woods (out of a total set of 163) were available from 1974, 1985, 1991 and the most recent re-recording in 1999. These results were used to explore trends in vegetation cover, species richness and the abundance of particular species over a 25-year period. The main trends were confirmed as a decline in the shrub layer; broad stability in the canopy layer; high plot-to-plot variation in vegetation cover changes; no change in overall species richness; decline in bramble *Rubus fruticosus* cover; increases in cover of other species, notably *Brachypodium sylvaticum.*

Contents

Introduction

Between 1974 and 1976 Colyear Dawkins and David Field established a permanent plot system in Wytham Woods (owned by Oxford University (Dawkins & Field 1978)). Information on tree and shrub layers and on the ground flora composition was collected. A full re-survey of the plots was carried out in 1991-2 and comparisons made between the state of the wood in 1991 and 1974 (Kirby *et al* 1996; Kirby & Thomas 1999).

A criticism of the conclusions drawn in these studies is that they were based on just two data points. While there was strong supporting evidence that the main changes identified did represent broader trends this could not be proved. More regular re-recording of the plot system is planned and a quarter of them were recorded in 1999 as part of a rolling re-recording programme. These included 24 plots which had been looked at also in 1984/5, ie for these plots there are four sets of records.

This report presents data on some aspects of the vegetation cover and species frequency changes to illustrate the trends in the composition and structure of the Woods. Further results will be published once the remaining plots have been recorded for the third time.

Site

Wytham Woods to the west of Oxford (National Grid Reference SP4608) cover about 320 ha and are a mosaic of ancient and recent woodland, semi-natural stands and plantations of various ages and species, with small areas of open grassland and scrub (Elton 1966; Perrins 1989). Ancient and recent woodland were distinguished from historical data and field studies (Gibson 1986; Grayson & Jones 1955). Plantations were recognised using data from the forestry stock map and field observations. The ancient semi-natural areas (36%) are mainly former coppice; the recent semi-natural stands (31%) have grown up on former pasture over the last 100 years; most of the plantations were established in the last 50 years, either within the existing ancient woodland (12%) or on former open grassland (21%). The wood lies on a hill with corallian limestone on the top and heavier clay soils on the lower slopes. The ancient woodland is mainly on the lower slopes. Oak *Quercus robur*, ash *Fraxinus excelsior* and sycamore *Acer pseudoplatanus* are the main tree species - even the plantation areas are predominantly broadleaved - and the wood falls within the *Fraxinus excelsior-Acer campestre-Mercurialis perennis* type (W8) of the National Vegetation Classification 1991). The canopy and shrub cover both declined between 1974 and 1991, some shrubs became less frequent, but otherwise there was no major change in the tree and shrub composition of the wood (Kirby *et al* 1996).

Methods

Field survey

Between 1973 and 1976 (the 1974 survey) 164 10 x 10 m quadrats were established at alternative points on a 100 x 100 m grid throughout the wood (Dawkins & Field 1978) (Figure 1). Each plot was offset to the north-east (true north) from the grid-intersection marker posts by 14.1 m. Two corners of each plot were marked with underground metal markers so that they could be relocated precisely. In 1984/85 a sub-set of 28 plots were

recorded (*1985 results*); 1991 159 plots were re-recorded with a further four completed in 1992 (the *1991 data*). A fourth set of recording took place in 1999 (42 plots). The recording took place from April to August on each occasion

Vegetation cover was estimated across the south-west to north-east diagonal of the plot in three height bands: top or canopy cover >2.5 m high, which was partitioned between species (mainly trees); 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 places. All vascular plants in the ground flora in the plot were listed but in the analysis seedlings and saplings of woody species were excluded. Thirteen 0.1m^2 circlets were recorded across the diagonals in which all rooted vascular plants were recorded. Nomenclature follows Stace (1991).

In 1974 six common species were chosen (subjectively) which had different ecological characteristics: *Chamerion angustifolium, Hyacinthoides non-scripta, Mercurialis perennis, Pteridium aquilinum, Rubus fruticosus, Urtica dioica.* Their cover was estimated for each plot both in 1974 and 1991 on a six-point scale (0, 1 = 1.5% cover, 2 = 6.25%, 3 = 26.50%, 4 = 51-75%, 5 = 76-100%) and the mean cover per plot calculated using the mid-point of each cover class weighted by the frequency of that cover class.

DECORANA analysis (Hill 1979) was carried out using frequency data from the circlets as a measure of abundance (but including all species in the plot). The first run of the analysis separated the four records from plot 457080 which is on grassland on the top of the hill from the rest, so a second analysis was carried out omitting these records.

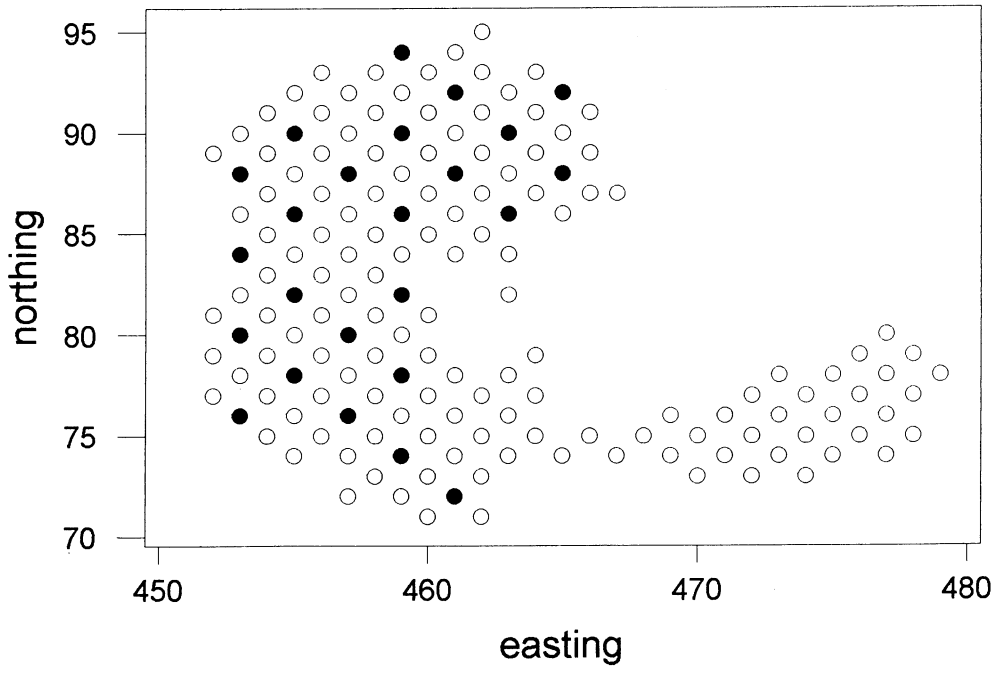


Figure 1 shows the distribution of the overall plot system (open circles) and those for which records also exist from 1985 and 1999 (closed circles).

Results

Appendix 1 contains examples of plot results.

Changes in vegetation cover

Canopy layer (>2.5m). Fluctuations in the overall mean canopy cover are relatively small for the 24 plots, but this masks considerable variation in the pattern or individual plots (Table 1).

Table 1. Changes in mean % canopy cover and that for selected plots

	1974	1985	1991	1999	Comment
Mean value (24 plots) (SE in brackets)	82 (5)	83(5)	73(6)	77(5)	
Change in selected plots					
457088	100	100	100	100	
457080	0	0	0	0	
455082	65	90	100	100	
453076	100	70	50	60	

Shrub layer (0.5-2.5m). While there is again variation in the individual plot responses there is overall a highly significant decline in the shrub layer (Table 2).

Table 2. Changes in mean % shrub layer cover and that for selected plots

	1974	1985	1991	1999	Comment
Mean value (24 plots) (SE in brackets)	43(7)	27(5)	25(5)	13(4)	
Change in selected plots					
453080	100	25	20	0	
457080	15	70	0	0	
459074	20	40	50	10	
463086	20	5	5	5	

Ground layer cover (<0.5m). There has been a slight decline overall in ground layer cover from 1974 compared to the later three dates but overall it is still quite high (Table 3).

Table 3. Changes in mean % ground layer vegetation and that for selected plots

	1974	1985	1991	1999	Comment
Mean value (24 plots) (SE in brackets)	82 (6)	71(5)	66(6)	68(6)	
Change in selected plots					
453080	95	70	10	5	
459078	5	20	70	50	
461070	5	5	1	5	
459090	90	70	80	90	

Main tree species. Oak *Quercus robur*, ash *Fraxinus excelsior*, sycamore *Acer pseudoplatanus* and beech *Fagus sylvatica* have remained the main canopy species throughout the last 25 years but the cover of birch *Betula* spp., elm *Ulmus* spp. and conifers has declined (Table 4).

Table 4. Mean % cover in canopy layer of selected tree species

	1974	1985	1991	1999
Mean value (24 plots) (SE in brackets				
Oak	16 (5)	13 (4)	10 (4)	10 (4)
Ash	21 (6)	28 (6)	23 (6)	28 (6)
Sycamore	26 (8)	27 (8)	23 (7)	26 (7)
Beech	6 (4)	6 (4)	5 (4)	7 (5)
Birch	4 (4)	4 (4)	4 (4)	2 (2)
Elm	1	0	0	0

Changes in ground flora composition

Mean and total richness. There has been no change in the mean species richness per plot over the recording period; and little difference in the total number of species found in the whole set of 24 plots in each year (Table 5).

Table 5. Mean number of ground flora species per plot and total number in the set of 24 plots

	1974	1985	1991	1999	Comment
Mean no. per plot (SE in brackets	19.4 (2)	16.6 (2)	18.5 (2)	17.7 (2)	
Total no. in 24 plots	108	95	106	98	144 species in all lists combined

Change in abundance of selected species. Fourteen species showed a tendency to decline over the 25 years; 12 to increase. Increase/decline was defined as a difference of five or more in the frequency with which a species was recorded in the results for 1974 and 1985 combined compared to 1991 plus 1999 combined (Table 6).

Table 6. Change in frequency (out of 24 plots) for selected species

Declines	1974	1985	1991	1999
Ajuga reptans	6	5	2	4
Angelica sylvestris	9	6	4	3
Bromopsis ramosus	3	6	0	0
Carex pendula	13	10	7	11
Chamerion angustifolium	8	3	2	0
Circaea lutetiana	22	17	13	13
Heracleum sphondylium	6	4	2	0
Hypericum tetrapterum	4	5	4	0
Lonicera periclymenum	7	6	5	1
Mercurialis perennis	21	21	20	17
Rubus caesius	6	8	1	3
Rubus fruticosus	24	24	21	21
Stachys sylvatica	4	3	1	1
Tamus communis	6	4	4	1
Increases				
Arum maculatum	8	6	14	10
Brachypodium sylvaticum	6	15	20	21
Cardamine flexuosa	1	1	8	6
Deschampsia cespitosa	11	12	16	19
Hyacinthoides non-scripta	4	2	8	6
Poa trivialis	17	15	22	22
Potentilla sterilis	2	1	5	4
Scrophularia nodosa	1	3	5	4
Sonchus oleraceus	1	0	3	3
Veronica chamaedrys	4	6	7	10
Viola riviniana	5	5	8	10

'Ecosig' scores. Changes in area cover for the five 'ECOSIG' scores are most marked for bramble *Rubus fruticosus* (Table 7).

Table 7. Changes in cover for species based on ECOSIG scores

	1974	1985	1991	1999
Rosebay *Chamerion angustifolium*	1.3 (0.6)	0.3 (0.2)	0.2 (0.2)	0
Nettle *Urtica dioica*	18 (5)	7 (4)	11 (4)	10 (4)
Bracken *Pteridium aquilinum*	12 (4)	5 (2)	8 (2)	8 (2)
Dog's mercury *Mercurialis perennis*	32 (6)	22 (5)	26 (6)	18 (5)
Bluebell *Hyacinthoides non-scripta*	3 (1)	6 (3)	7 (3)	10 (4)
Bramble *Rubus fruticosus*	41 (6)	30 (6)	8 (3)	5 (2)
ECOSIG scores for bramble (no. of plots)				
0	-	-	3	3
1 (1-5%)	3	8	15	18
2 (6-25%)	5	6	4	2
3 (26-50%)	7	2	1	1
4 (51-75%)	6	7	1	-
5 (76-100%)	3	1	-	-

In the DECORANA analysis the first axis reflected differences in shadiness of the plots with species associated with open conditions separating out from more shade-tolerant woodland specialists. A similar separation occurred in the comparison of all plots between 1991 and 1974 (Kirby & Thomas 1999). There was no significant difference in the position of records from different years on either Axis 1 or 2 but they were separated on Axis 3 and 4, with the two intermediate years (1985, 1991) in between the others (Figure 2). This trend is also seen in the separation of those species which from the 1991/1974 (Kirby & Thomas 1999)comparison for the whole wood were considered to be increasing or decreasing (Figure 3).

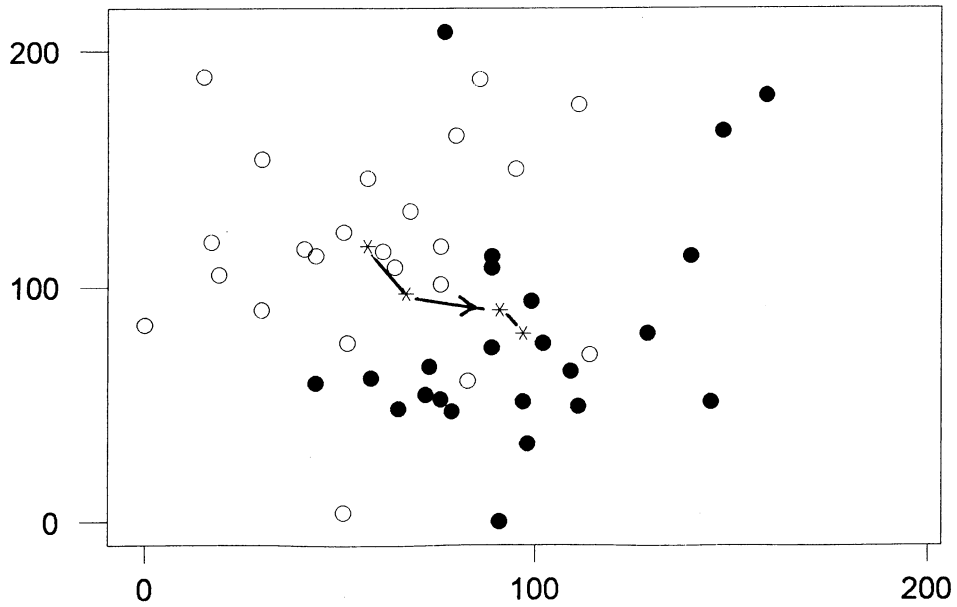


Figure 2. Location of 1974 plot records (open circles) and 1999 plot records (closed circles) on axes 3 and 4 of the DECORANA analysis. The mean positions for all four years are shown by asterix; the line connecting them indicates the direction of movement.

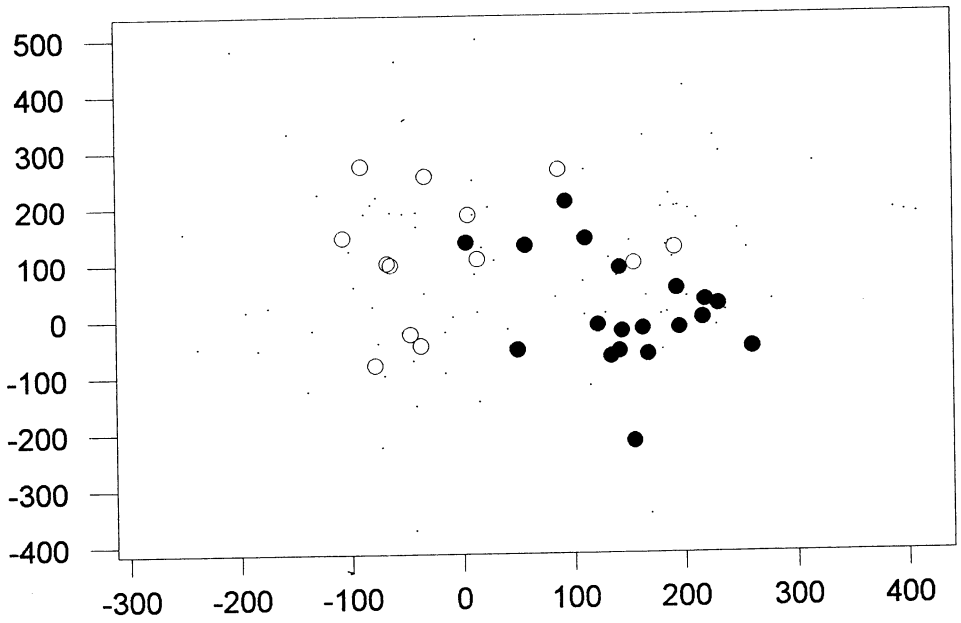


Figure 3. Species which Kirby & Thomas (1991) (Appendix 2) identified as increasing (solid circles) from 1974 to 1991 are separated out from those identified as decreasing (open circles) on axes 3 and 4 of the DECORANA analysis.

Discussion

The results are from only a sub-set of the full series of 163 plot, but tend to confirm the main trends identified in the comparisons between the 1991 results and those from 1974 (Kirby *et al* 1996; Kirby & Thomas 1999):

- only small changes overall in the canopy and ground vegetation layers, but a large and significant decline in the shrub layer;
- no change overall in the abundance of the four main tree species but some changes in the minor components;
- considerable plot level changes in vegetation cover, too large to be put down simply to observer differences;
- no change in overall species richness, either in terms of mean number of species per plot or in the total number of species in the set as a whole;
- high turnover of species at the plot level;
- significant changes in the frequency and abundance of particular species (eg increase n *Brachypodium sylvaticum*; decrease in *Rubus fruticosus*).

- The conclusions from the 1974-1991 comparison that changes in canopy cover and the impact of deer browsing on the vegetation were the main causes of the variation observed appear to be supported.

- It is planned that the remaining 121 plots will be recorded over the next 2-3 years providing a third reference point for the whole wood.

Acknowledgements

Colyear Dawkins designed the plot system and with David Field did the first recording. Subsequent recordings have involved a wide range of people but we acknowledge the help in particular of Amanda Horsfall, Rachel Thomas, Hannah Iles and Mike Morecroft. Finally our thanks go to Oxford University for permission to work in Wytham Woods.

References

DAWKINS, H.C.D. & FIELD, D.R.B. 1978. *A long-term surveillance system for British woodland vegetation.* Oxford: Commonwealth Forestry Institute Occasional Paper 1.

ELTON, C.S. 1966. *The pattern of animal communities.* London: Methuen.

GIBSON, C.W.D. 1986. Management history in relation to changes in the flora of different habitats on an Oxfordshire estate, England. *Biological Conservation,* **38**, 217-232.

GRAYSON, A.J. & JONES, E.W. 1955. *Notes on the history of the Wytham Estate with special reference to the woodlands.* Oxford: Imperial Forestry Institute.

HILL, M. O. 1979. *DECORANA a FORTRAN program for detrended correspondence analysis and reciprocal averaging.* Ithaca, Cornell University.

HORSFALL, A.S. & KIRBY, K.J. 1985. *The use of permanent quadrats to record changes in the structure and composition of Wytham Woods, Oxfordshire.* (Research and survey in nature conservation No. 1). Peterborough: Nature Conservancy Council.

KIRBY, K.J. & THOMAS, R.C. 1999. Changes in the ground flora of Wytham Woods, southern England, 1974-1991, and their implications for nature conservation. Peterborough: *English Nature Research Reports*, No. 320.

KIRBY, K.J., THOMAS, R.C. & DAWKINS, H.C. 1996. Monitoring of changes in tree and shrub layers in Wytham Woods (Oxfordshire), 1974-1991. *Forestry,* **69**, 319-334.

KIRBY, K.J. & WOODELL, S.R.J. 1998. The distribution and growth of bramble *Rubus fruticosus* L. agg. in British semi-natural woodland and their implications for nature conservation. *Journal of Practical Ecology and Conservation,* **2**, 31-41.

PERRINS, C.M. 1989. Wytham Woods. *The Biologist,* **36**, 5-9.

Appendix 1. Examples of results

Examples of results

453088	5/7/74	24/8/84	2/7/91	22/6/99		

1974 Tall herbs under sparse ash; cut wood on plot. 1984. Boundary of two young plantations. 1991 Ash plantation and some sycamore; no understorey. 1999 Increasing sycamore.

Cover (%)

Year	Bottom	Mid	Top
1974	100	100	90
1985	80	25	95
1991	85	20	95
1999	70	0	95

Little change in overall canopy cover, but major reduction in mid-layer, mainly loss of tall herbs. Major reduction in species richness.

No of species (g/f)

1974	34
1985	20
1991	9
1999	8

Top cover broken down by main species (%)

	Oak	Ash	Beech	Sycamore
1974	0	80	0	10
1985	0	95	0	30
1991	0	80	0	30
1999	0	50	0	50

Species lists. The first four columns of figures show occurrence and circlet data combined. 1 = present in plot but not in circlets; 2 = present in plot and in one circlet, ...14 present in plot and in all 13 circlets. The last two columns of figures show Domin values for 1991 and 1999 recordings.

Species	74	85	91	99	91d	99d
Agrop can	0	1	0	0	0	0
Ajuga rep	3	2	0	0	0	0
Angel syl	2	1	1	0	1	0
Arum mac	0	1	1	1	1	2
Brach syl	3	8	11	5	4	5
Bromu ram	1	1	0	0	0	0
Campa tra	1	0	0	0	0	0
Carex acu	2	0	0	0	0	0
Carex fla	2	0	0	0	0	0
Carex pen	1	1	0	0	0	0
Carex syl	1	1	0	0	0	0
Circa lut	4	1	0	1	0	1
Cirsi arv	1	0	0	0	0	0
Cirsi vul	1	0	0	0	0	0
Clema vit	0	0	0	1	0	1
Desch cae	1	1	1	3	1	2
Epilo hir	2	0	0	0	0	0
Festu gig	1	0	0	0	0	0
Galiu apa	2	0	0	0	0	0
Geum urb	1	1	0	0	0	0
Glech hed	7	12	3	0	2	0
Herac sph	1	0	0	0	0	0
Hyper hir	1	0	2	0	1	0

Lysim nem	2	0	0	0	0	0
Mercu per	13	14	13	12	7	7
Poa pra	2	0	0	0	0	0
Poa tri	6	2	2	2	1	3
Poten rep	2	0	0	0	0	0
Ranun fic	0	0	0	2	0	1
Pteri aqu	3	0	0	0	0	0
Ribes syl	0	1	0	0	0	0
Rubus cae	2	3	0	0	0	0
Rubus fru	4	2	0	0	0	0
Solan dul	1	0	0	0	0	0
Stach syl	3	5	0	0	0	0
Symph off	1	0	0	0	0	0
Tamus com	1	0	0	0	0	0
Urtic dio	0	1	1	0	3	0
Veron cha	2	0	0	0	0	0
Viola riv	2	2	0	0	0	0

455082	455082	23/8/84	23/5/91	23/6/99		

1974 sparse sycamore among old oak and ash; felling stumps. 1984 sycamore over bramble and bracken. 1991 pole and mature sycamore; no shrub layer, sparse ground flora. 1999 sycamore dominant.

Cover (%)

Year	Bottom	Mid	Top
1974	100	60	65
1985	80	10	90
1991	30	0	100
1999	50	0	100

Ground and shrub cover declining, but species richness increasing. Possibly loss of bramble allowed more scope for smaller plants to establish.

No of species (g/f)

1974	11
1985	13
1991	16
1999	19

Top cover broken down by main species (%)

	Oak	Ash	Beech	Sycamore
1974	0	0	0	65
1985	0	5	0	90
1991	0	0	0	100
1999	0	0	0	90

Species lists. The first four columns of figures show occurrence and circlet data combined. 1 = present in plot but not in circlets; 2 = present in plot and in one circlet, ...14 present in plot and in all 13 circlets. The last two columns of figures show Domin values for 1991 and 1999 recordings.

Species	74	85	91	99	91d	99d
Anemo nem	0	0	1	0	1	0
Brach syl	0	0	1	1	1	3
Carda fle	0	0	1	2	1	2
Carex pen	4	1	1	1	1	3
Carex syl	1	1	1	1	1	2
Circa lut	5	2	0	0	0	0
Desch cae	0	0	0	2	0	2
Dryop aus	0	1	0	1	0	2
Dryop fil	1	1	1	1	1	2
Epilo mon	0	0	0	1	0	1
Endym non	2	0	2	1	3	3
Lonic per	2	7	1	0	1	0
Luzul pil	0	1	2	0	1	0
Lysim nem	0	1	1	2	1	2
Mercu per	4	4	3	5	5	5
Oxali ace	0	0	0	3	0	2
Poa tri 2	1	4	6	2	3	
Poten ste	0	0	1	1	1	2
Primu vul	1	1	1	1	1	2
Pteri aqu	3	6	4	1	5	3
Rubus fru	10	10	5	3	3	3
Senec jac	0	0	0	1	0	1
Viola riv	0	0	0	2	0	1

461082	22/8/74	27/8/84	2/7/91	21/6/99		
1974 blackthorn thicket under birch with some oak. 1984. Birch over blackthorn and bramble. 1991 birch, sycamore, hazel, some fallen blackthorn; sparse ground flora. 1999 neglected former coppice.						

Cover (%)

Year	Bottom	Mid	Top
1974	40	90	100
1885	40	15	95
1991	15	30	80
1999	5	5	90

Canopy composed of birch, and other species. Loss of blackthorn has not led to increase in species richness, but some shift towards more grasses.

No of species (g/f)

1974	8
1985	11
1991	13
1999	9

Top cover broken down by main species (%)

	Oak	Ash	Beech	Sycamore
1974	0	0	0	0
1985	0	0	0	0
1991	0	0	0	0
1999	0	20	0	0

Species lists. The first four columns of figures show occurrence and circlet data combined. 1 = present in plot but not in circlets; 2 = present in plot and in one circlet, ...14 present in plot and in all 13 circlets. The last two columns of figures show Domin values for 1991 and 1999 recordings.

Species	74	85	91	99	91d	99d
Agros sto	0	0	1	0	1	0
Brach syl	0	1	1	1	1	3
Carex pen	0	1	0	0	0	0
Carex syl	1	1	1	1	1	2
Clema vit	0	1	0	0	0	0
Desch cae	3	2	2	1	1	2
Dryop fil	2	2	2	1	1	1
Holcu mol	0	0	0	1	0	1
Lonic per	2	2	1	0	1	0
Luzul pil	2	1	0	0	0	0
Mercu per	1	0	0	0	0	0
Oxali ace	0	0	2	1	1	1
Poa tri	0	2	2	2	1	2
Poten ste	0	0	1	0	1	0
Primu vul	1	0	0	0	0	0
Rosa spp	0	1	2	0	1	0
Rubus fru	6	8	3	2	3	3
Urtic dio	0	0	1	0	3	0
Veron cha	0	0	0	1	0	1

Appendix 2. Species showing significant increases or decreases in the 1974-1991 comparison

Location on the 1974-1999 DECORANA Axes 3 and 4 for those species that were identified as increasing or decreasing from 1974 to 1991

	Axis	3	4
Ajuga rep	decreasing	-47	-38
Angel syl	decreasing	125	191
Chama ang	decreasing	254	-34
Circa lut	decreasing	185	5
Dacty glo	decreasing	145	-107
Epilo hir	decreasing	-81	-79
Epilo mon	decreasing	100	-68
Equis tel	decreasing	272	-91
Galiu apa	decreasing	265	86
Herac sph	decreasing	96	-65
Pteri aqu	decreasing	97	154
Rubus cae	decreasing	-27	-47
Rubus fru	decreasing	107	13
Arum mac	increasing	136	3
Brach syl	increasing	-68	133
Carda fle	increasing	0	216
Carex syl	increasing	-23	143
Cirsi vul	increasing	-218	154
Clema vit	increasing	-55	49
Desch cae	increasing	-18	162
Glech hed	increasing	-12	121
Hyper hir	increasing	-64	167
Juncu eff	increasing	24	230
Poa tri	increasing	142	110
Ranun rep	increasing	90	141
Scrop nod	increasing	52	193
Senec jac	increasing	-53	260
Sonch ole	increasing	130	56
Veron cha	increasing	-17	195
Veron ser	increasing	-58	141
Rumex spp	increasing	208	92
Tarax off	increasing	31	218