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The restoration of replanted Ancient Woodland

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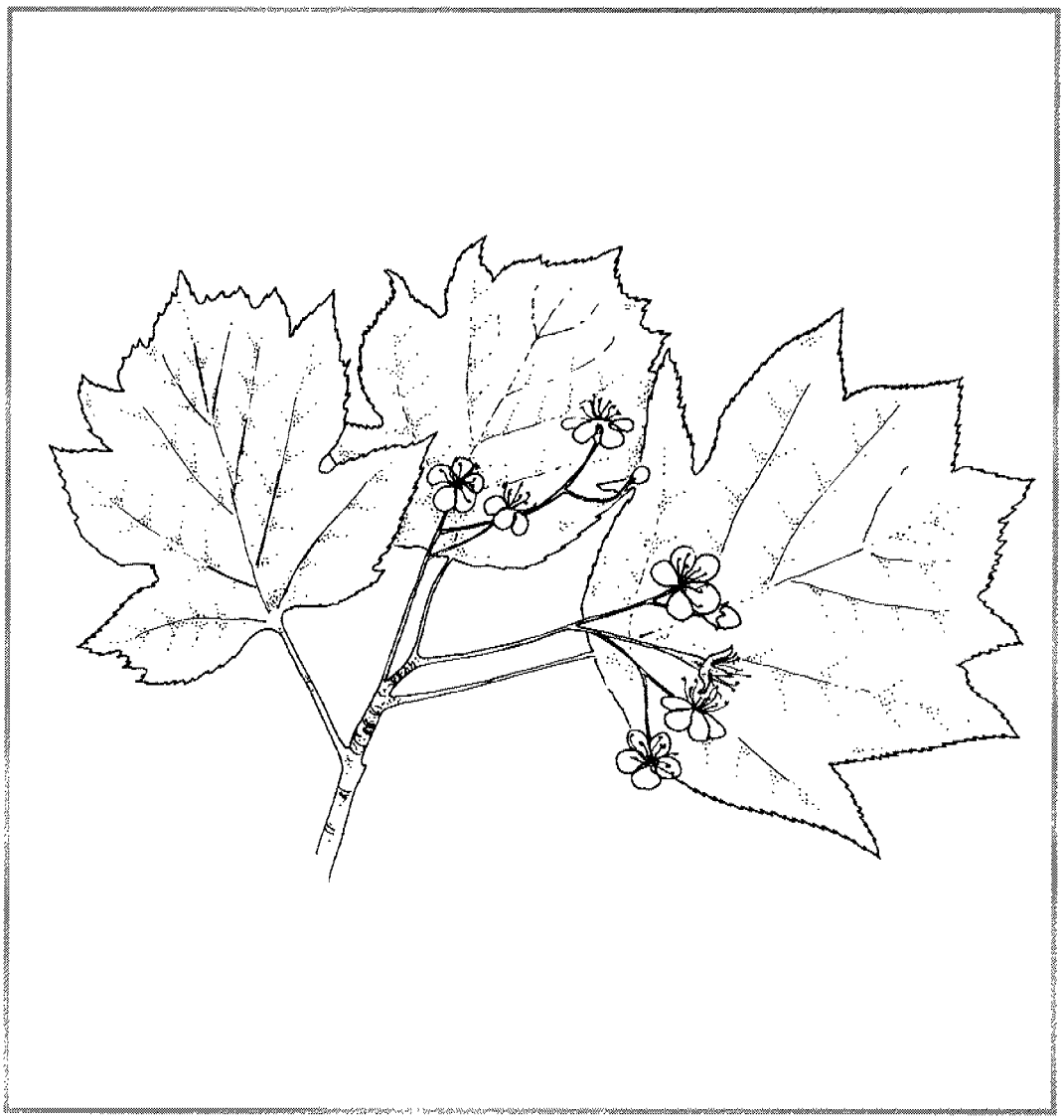

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English Nature Research Reports

No. 269
The Restoration of Replanted Ancient Woodland

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Dr Elaine Radford, MIEEM
7 Maybank Close
Chinley
High Peak, SK23 6EN

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SUMMARY

1. At four sites, Castor Hanglands NNR, Cambridgeshire, Foxley Wood SSSI, Norfolk, Mortimer Forest, Shropshire and Eaton and Gamston Woods SSSI, Nottinghamshire temporary 5m x 5m plots were used to assess the ground flora recovery and woody species regeneration in areas recently restored after conifer planting.

2. Comparisons were made with nearby original semi-natural stands and with remaining conifer stands.

3. Ten plots were placed within each treatment, and a vascular plant list produced for the field layer, including regeneration less then 2m high, the shrub layer and the canopy layer with domin values assigned to each species. An estimate of percentage cover was also made for each layer.

4. At most of the sites regeneration was occurring in the restored area, mainly from seedling establishment, with the mean number of regenerating species per plot at the sites between 1.5 and 3.2.

5. Regeneration was also occurring in the other treatments, although at one site, Eaton and Gamston Wood, it was a rather infrequent phenomenon in the original semi-natural stand, which had a closed canopy and in the conifer stand where there was a deep litter layer and which was very heavily shaded.

6. It was concluded that a semi-natural tree cover would develop although some intervention may be required to remove undesirable species, particularly conifer seedlings, at some sites.

7. Planting of conifers had suppressed the ground cover in comparison to that in the semi-natural stand, although the mean number of species per plot at each site remained similar. At two sites there was reasonable correlation between the species lists for the two stand types, including a similar number of ancient woodland indicator species.

8. In the restored areas there had been considerable expansion of the ground layer, and at two sites in particular, Foxley Wood and Castor Hanglands, a significant increase in the number of species in the plots compared with the semi-natural stand.

9. Generally the ground layer in the restored area included species characteristic of the semi-natural stand including a similar number of ancient woodland indicators, although often at a low frequency.

10. The new colonists, which usually contributed substantially to vegetation cover, were normally not woodland specialists. Many would be classed as competitive ruderals, or as intermediate between competitors or competitive ruderals, or as competitors (after Grime *et al* 1988). At one site there was also a significant number of new colonists which are classed as

ruderals.

11. These are species which have developed regenerative strategies which allow them to take advantage of disturbance, such as felling. However as they do not thrive in conditions where levels of stress are high they are thought unlikely to persist once a broad-leaved canopy develops.

12. From these findings it was concluded that a semi-natural ground layer would be restored successfully, at least at three sites. Mortimer Forest was the exception and the reasons are discussed.

INTRODUCTION

Since the 1930's about 38% of ancient broad-leaved woodland has been converted to plantations predominantly of coniferous species. After changes in policy, following the recognition of the importance of ancient woodland, coniferisation has now largely ceased. Now interest has arisen in the degree to which the replanted sites might be restored to their former broad-leaved / semi-natural state. Added impetus to this has come from the Habitat Action Plans that are being developed under the Biodiversity Action Plan process which include or are likely to include restoration targets.

Relatively few studies have however been done on how quickly areas from which conifers have been removed regain the ground flora species characteristic of a semi-natural stand , and a semi-natural tree cover.

The present study has therefore been commissioned to provide preliminary data on ground flora recovery and woody species regeneration from a small number of selected sites. The data will then be used to guide and assess the success of restoration proposals within the Habitat Action plans.

METHODS

English Nature identified four sites in which the differences between recently restored areas in which the conifers had been felled, adjacent conifer stands and semi-natural woodland could be compared. These were

i) Castor Hanglands NNR, Cambridgeshire

ii) Foxley Wood, SSSI, Norfolk

iii)Mortimer Forest, Shropshire

iv) Eaton and Gamston Woods, SSSI, Nottinghamshire

Data from each site was collected in a standardised way based on temporary 5 x 5 m plots. Ten plots were placed in each of the treatment types:

- original semi-natural woodland

- remaining conifers

- restored

the relevant compartments at each of the sites having been identified prior to sampling by English Nature following consultations with the appropriate woodland managers, although before the site visit to Eaton and Gamston Woods there was some degree of uncertainty about the suitability of the compartments selected.

The plots were distributed as evenly as possible within the relevant compartments, whilst taking care to reflect the variation within any particular compartment. For example in some of the mature conifers stands there could be considerable localised variation in amounts of ground vegetation, which was often related to the degree of light reaching the woodland floor. The edges of the compartments adjacent to rides etc. were avoided when positioning the sample plots.

Within each plot a vascular plant list was produced for the field layer, including regeneration less than 2 m high, the shrub layer and the canopy layer with domin values assigned to each species. In addition separate estimates of the percentage cover of the following layers in each plot were also made:

Bare ground
Bryophytes
Litter
Wood(eg logs or stumps)
Exposed rock
Field layer
Shrub layer
Tree layer
Open sky ie the degree of open sky left when the tree and shrub layers were combined.

A standard recording sheet was used to assist in this process (Appendix 1). In addition notes were made about each plot, particularly the type of regeneration (from planted trees, coppice regrowth or natural regeneration) when appropriate.

The recording was undertaken between 11 August and the 12 September. At this time any spring-flowering species present in the stands had completely died back, or were represented only by the dead remains of their flower spikes. When dead flower spikes were encountered it was difficult to assign a domin value which would accurately reflect their true abundance. Consequently their presence was recorded and some notation of the number of flower spikes made.

Other plants were dying back and were difficult to identify to species level. In some instances, particularly at Castor Hanglands, it was difficult to distinguish between rough meadow-grass and wood meadow-grass. Where there was doubt the grass was recorded as *Poa sp.* Similarly some species in the vegetative state could not be accurately identified. These included violet, which was recorded as common dog-violet but could have been early dog-violet (*Viola reichenbachiana*). Both are ancient woodland indicator species and it has been assumed in the analysis that only one of the two species was present in any one plot.Very young seedlings could also present problems , so that for example no attempt was made to distinguish between common sallow and goat willow, which were recorded as *Salix sp.*

Analysis of the data

The data collected from each of the sites were analyzed in a standard manner. For each site the plant species with their assigned Domin values in each of the 5 m x 5 m plots were tabulated, with the data for each of the layers presented, including the regenerating trees and shrubs found in the field layer. The estimates of percentage cover in each of the layers were also included.

Numbers of regenerating trees and shrubs and of herbaceous species in the field

The number of regenerating trees and shrubs in the field layer were then calculated, as were the number of herbaceous species in the field layer. Woody climbers etc such as bramble and honeysuckle which were part of the field layer were included in the latter total. Reference to the number of herbaceous species in the field layer in the following account always includes these woody climbers. In addition the frequency with which regenerating trees and shrubs were encountered in the plots was also calculated.

Presence of ancient woodland indicator species in the field layer.

The lists of field layer constituents were then examined for species regarded as indicative of ancient woodland , as defined by Peterken (1981). Ancient woodland indicator species are strongly associated with ancient woods and relict hedges, especially in Eastern England. They are poor colonists, not normally found in secondary woodland and would probably re-colonise restored ancient woodland sites very slowly. The persistence of these species in the conifer plantations and the restored areas would therefore provide a reasonable indication that restoration to a typical ancient woodland ground flora community would be successful.

The total number of ancient woodland indicator species occurring in each plot was determined and the frequency with which each indicator occurred computed. However it must be remembered that the list of ancient woodland indicators is probably not exhaustive since many are early spring-flowering species which would have completely died back at the time the recording was undertaken, although it is still valid to make comparisons between the treatments. In addition very acidic woodland such as that at Mortimer Forest supports very few ancient woodland indicators and this is a less useful analysis tool in this type of woodland. Comparison can however be made with the typical NVC community type, and the ground flora composition evaluated in relation to this.

Assessment of the field layer in relation to the ecological strategies adopted by plants.

In addition these lists were also assessed in relation to the ecological strategies adopted by plants according to Grime , Hodgson and Hunt (1988). In particular plants which adopt a ruderal strategy, or a competitive strategy or are stress tolerant were noted. It was also considered relevant to include plants which adopt strategies which are intermediate between the main types. Those which are defined as competitive ruderals, intermediate between competitors and competitive ruderals and those intermediate between ruderals and competitive ruderals were grouped together and the lists scored for the presence of this group (subsequently referred to as Group One). Similarly the lists were scored for the presence of the group comprising stress tolerant ruderals, stress tolerant competitors, those whose strategy is intermediate between a competitor and a stress tolerant competitor, intermediate between a stress tolerator and a stress tolerant competitor, and intermediate between a ruderal and a stress tolerant ruderal, (subsequently referred to as Group Two).

The presence of these strategists or otherwise in the various treatment types were regarded as having implications for the successful restoration or otherwise of the restored stands.

a. Stress tolerant species.

Stress tolerant species are those which are capable of persisting in habitats where phenomena which restrict photosynthesis are in operation. These include shortages of light, particularly relevant in this study, water and mineral nutrients or sub-optimal temperatures. They cannot tolerate high levels of disturbance. They could therefore be expected to be a characteristic component of the undisturbed, semi-natural woodland stands, but may not be able to persist where there has been replanting or replanting followed by recent clearance. Several of the ancient woodland indicator species are also categorised as stress tolerators.

b. Ruderal species.

Ruderal species are at a competitive advantage in conditions of frequent and severe disturbance, but they are not able to tolerate stress. They would not be a typical constituent of an undisturbed semi-natural woodland ground flora, but may be able to establish in the restored stands, where there has been recent disturbance due to felling, thus opening up suitable gaps for colonisation. Ruderals would not be expected to persist once a more stable community, with a complete ground cover, developed. Nor would they be expected to be encountered in the conifer stands although they may well have colonised these areas when the original semi-natural stand was felled and the conifers planted.

c. Competitive species.

Competitors have various attributes which enable them to monopolize resource capture in productive, relatively undisturbed environments. These include a high potential relative growth rate , tall stature and a tendency to form a consolidated growth form by vigorous lateral spread above and below ground. They will probably fail in habitats where productivity is low and where resource availability is brief and unpredictable e.g. where light occurs as sunflecks and/or where mineral nutrients become available as short, rich pulses, as from intermittent decomposition events and prevail under the threat of competitive exclusion (Grime et al 1988). Some competitors are able to tolerate a degree of shade. Bracken, creeping soft-grass and stinging nettle are examples of this, but most competitors would not usually be found in an undisturbed ancient woodland ground flora. Their presence in the restored areas where they may successfully compete with any woodland herbs could be an indication that the restoration of a woodland community would not be assured. In addition any competitors in the treatment two stands may be able to expand once the canopy is removed and light levels increase and thus exclude other more desirable species.

d. Species with intermediate strategies.

Species with strategies intermediate between stress tolerators and ruderals or competitors(Group Two) could be expected to be encountered in any of the shaded compartments. Herbs which Peterken (1981) describes as fast colonising woodland species, often found in secondary woodland on former cultivated ground, frequently fall into this group. He states that these herbs are also usually characteristic components of communities in ancient woodland. Their presence in the restored areas may be regarded as an indication that a typical woodland community may develop, as the canopy begins to expand. These are the species which also could be expected to colonise the restored areas quite readily provided they are present in the adjoining woodland stands.

Strategists which are intermediate between competitors and ruderals(Group One) would not normally be associated with an ancient woodland ground flora. Some of these Group One species are described by Peterken (1981) as shade-bearing weeds, which have their headquarters in hedges and waste land and which in ancient woods are mostly restricted to wood margins and disturbed ground. They too rapidly colonise secondary woodland on former cultivated ground.

Overlap between the categories used in the analysis.

It must be noted that these categories are not mutually exclusive. As already stated, some stress tolerant species, e.g. barren strawberry and common dog-violet are also categorised as ancient woodland indicators. Group One and Group Two strategists, such as yellow archangel, wood melick, dog's mercury and common figwort, may also be ancient woodland indicators too. In addition

Peterken's lists of fast colonising woodland species and of shade-bearing weeds do not directly correspond with the group two species or the group one species respectively. For example hedge woundwort and black bryony, classified as fast colonising woodland species, are group one stategists, while stinging nettle also included in this list, is a competitor. There are also quite a number of additional species in both of Peterken's lists which do not fall into the strategy categories used in the analysis.

Calculation of the mean for each of the characteristics used in the analysis.

For each of the characteristics used in the analysis the mean (with SD) for the ten plots in each of the treatment types was then calculated and comparisons made between the mean values for each treatment.

THE SELECTED SITES AND THE COMPARTMENTS SAMPLED.

I. Castor Hanglands NNR, Cambridgeshire

a. The nature of the site

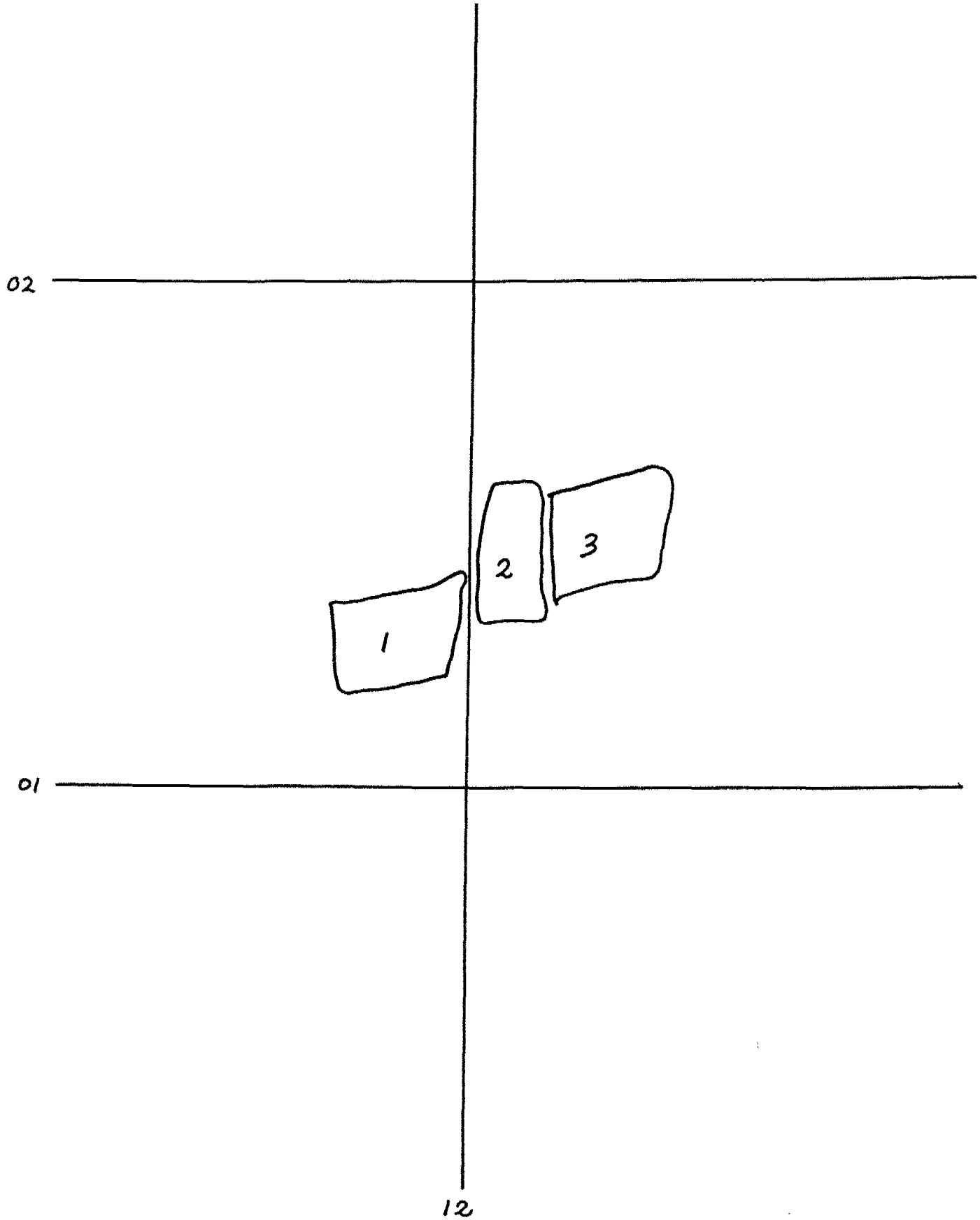
The site is situated a short distance west of Peterborough, and is managed by Forest Enterprise. The woodlands within the reserve boundary are primarily of an Ash-Maple type over soils of limestone, clay, cornbrash and sands. A large number of tree and shrub species are present and the ground flora holds many plants indicative of an ancient woodland. Additional habitats within the reserve include pockets of species rich limestone grassland, areas of acidic, neutral and marshy grassland and ponds and ditches. Conifers have been planted in the adjacent woodland east of the reserve. Arable fields surround the site.

b. The compartments in which recording was undertaken.

Part of the semi-natural oak-ash-maple woodland within the reserve was sampled, together with an adjacent stand of mature Norway spruce, and a nearby area , where the conifers had been felled in the winter of 1996 (Fig 1).

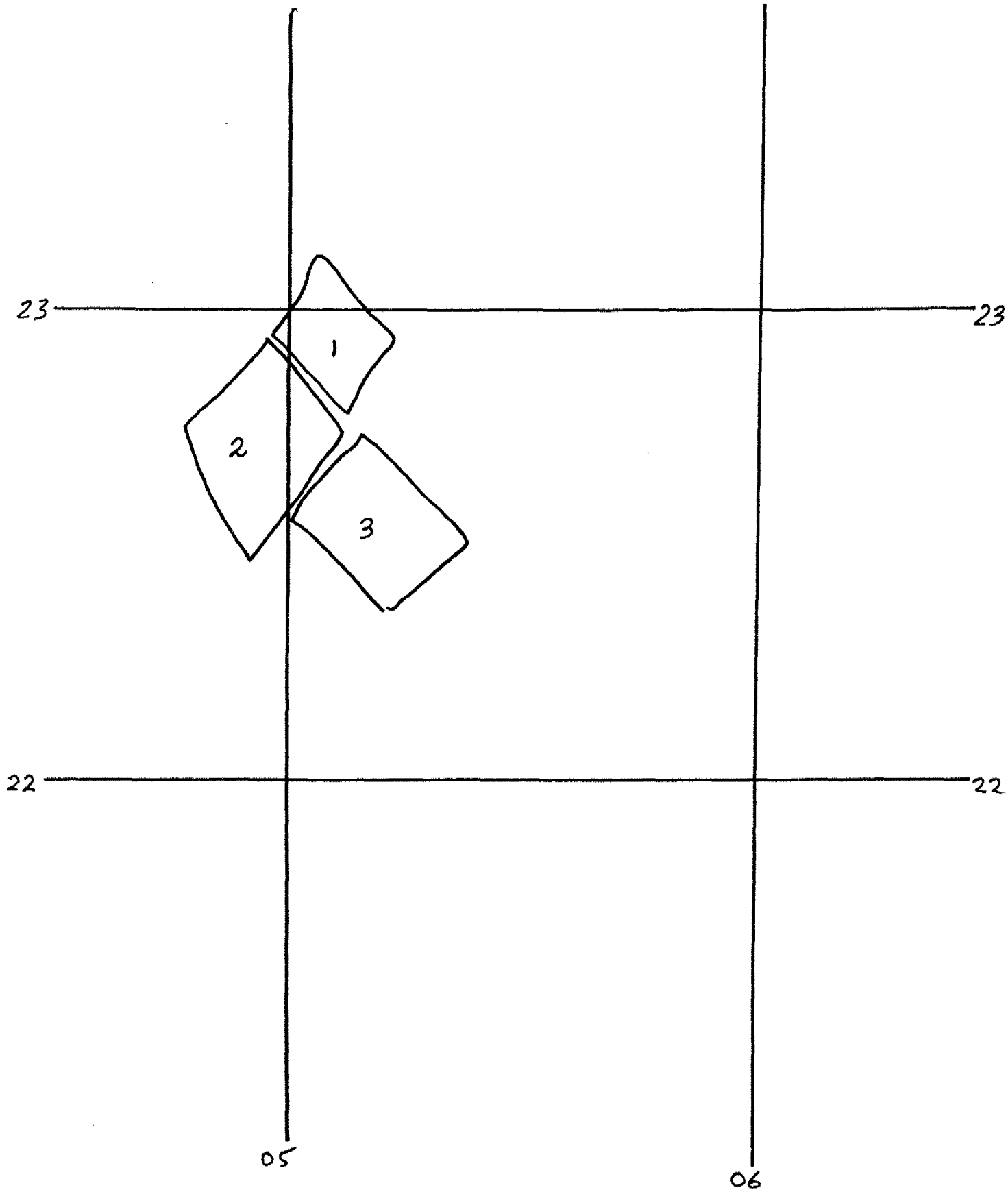
The mature conifer stand has been thinned at various stages and some of the brash left on the ground within the stand. Occasionally conifers have toppled and these too have been left within the stand. In the restored area the brash arising when felling took place has been left in piles along the planting lines . In places the ground is rutted, and still holds some standing water, where large vehicles had been brought on site, during felling.

Fig. 1 The compartments in which the plots were placed at Castor Hanglands.



1 Semi-natural broad-leaved stand
2 Remaining conifers
3 Recently restored

Fig. 2 The compartments in which the plots were placed at Foxley Wood.



1 Semi-natural broad-leaved stand
2 Remaining conifers
3 Recently restored

II Foxley Wood

a. The nature of the site

Foxley Wood is designated as a SSSI and is a Norfolk Wildlife Trust Nature Reserve, now owned and managed by the Trust. It is situated in the centre of the county, on a plateau of calcareous boulder clay which is overlain within parts of the wood by acid sandy tills, and, at over 120 ha, is the largest remaining block of ancient woodland in Norfolk. Traditionally it was managed as a coppice with standards woodland , with pedunculate oak and ash the main standards and ash and hazel coppice. The coppice became neglected in the 20th century as the demand for traditional coppice products declined and in the 1960's parts of the wood were planted with conifers. The Trust are now starting to remove the blocks of conifers and to re-instate the traditional coppice management. The site is largely surrounded by arable land.

b. The compartments in which recording was undertaken.

An area of pedunculate oak-hazel high forest was selected for sampling, north-east of the main ride,(see Fig 2). Part of the stand had been coppiced recently ('92 /'93) and these areas were avoided when positioning the sample plots. A compartment planted with Corsican pine in 1966, south-west of the main ride, and opposite the broad-leaved area was also sampled together with an adjacent area in which the Scot's pine planted in 1971 were removed in 1994/95. The felled area supported quite a number of young ash, approximately 5-6 m tall, which judging by their age, may have been present amongst the conifers and been retained when the remainder of the stand was felled. There was very little evidence of the felling process other than the cut stumps of the conifers, now largely hidden by the growth of ground vegetation, and there was also good tree and shrub regeneration so that several of the sample plots already had a moderate shrub layer.

III. Mortimer Forest

a. The nature of the site.

Mortimer forest covers an extensive area, just west of Ludlow and is managed by Forest Enterprise. Much of the site has been planted with conifers, although there are some areas of broadleaves.

b. The compartments in which recording was undertaken

The compartments selected for sampling are located near the northern edge of the site (see Fig 3). They comprised an area of acidic sessile oak woodland, which is thought to be representative of the original semi-natural woodland at the site, a compartment which had been planted with Western Hemlock, now reaching maturity and a compartment in which the conifers had been felled recently. Some oaks had been planted with the conifers in both of these compartments.

These compartments were not very extensive and in the restored area, in particular, it necessitated the sample plots being quite closely spaced. This was exacerbated by a rather dense growth of young birch and western hemlock, approximately 5 m tall, on the edge of the area where it was considered it would be unrepresentative to locate plots. The whole of the restored area was scattered with immature oak and rowan, which had been retained when the conifers were felled, and the ground was covered with quite large amounts of brash left from the felling.

Beech had been planted on the edge of the selected broad-leaved stand , and, as directed these areas were avoided when placing the sample plots. However beech has started to colonise the remainder of the stand and many plots contained immature specimens of beech. A reasonable distribution of sample plots could not have been achieved if those areas where there had been colonisation were ignored.

The stand of remaining conifers had been thinned and brash left on the ground at various localities throughout. There was quite a lot of regeneration of hemlock within the stand,with seedlings in the plots up to 120 cm tall, and a quite dense growth of young trees, approximately 4-5 m tall , on the western edge. Plots were not placed in this area.

IV Eaton and Gamston Woods

a. The nature of the site

Eaton and Gamston woods are scheduled as a SSSI as they represent one of the best examples of an ash-oak-maple wood in Nottinghamshire and are representative of semi-natural woodland developed on clay soils in Central and Eastern England. The ground vegetation includes a variety of plants indicative of ancient woodland.

The site is owned and managed by the Nottinghamshire Wildlife Trust. Eaton Wood is open to the public, while access to Gamston Wood is restricted to Trust members.

b. The compartments in which recording was undertaken.

Compartments thought to be appropriate for sampling were initially identified in Eaton Wood. However in the field it was found that there were no conifer stands in Eaton Wood, although many compartments contained some conifers and there are narrow bands of conifers on the woodland edge. An area of conifers remaining in Gamston Wood, outside the SSSI boundary, was therefore sampled (Fig 4). This was less extensive than shown on the site plan, approximately half of the compartment now being occupied by broad-leaves. In the stand of remaining conifers (pine) broad-leaves have been planted occasionally where there are suitable gaps in the canopy. These areas were avoided when siting the sample plots. The stand had been thinned with cut stumps visible amongst the standing crop, and an occasional fallen pine left on the ground.

Fig. 3 The compartments in which the plots were placed at Mortimer Forest.

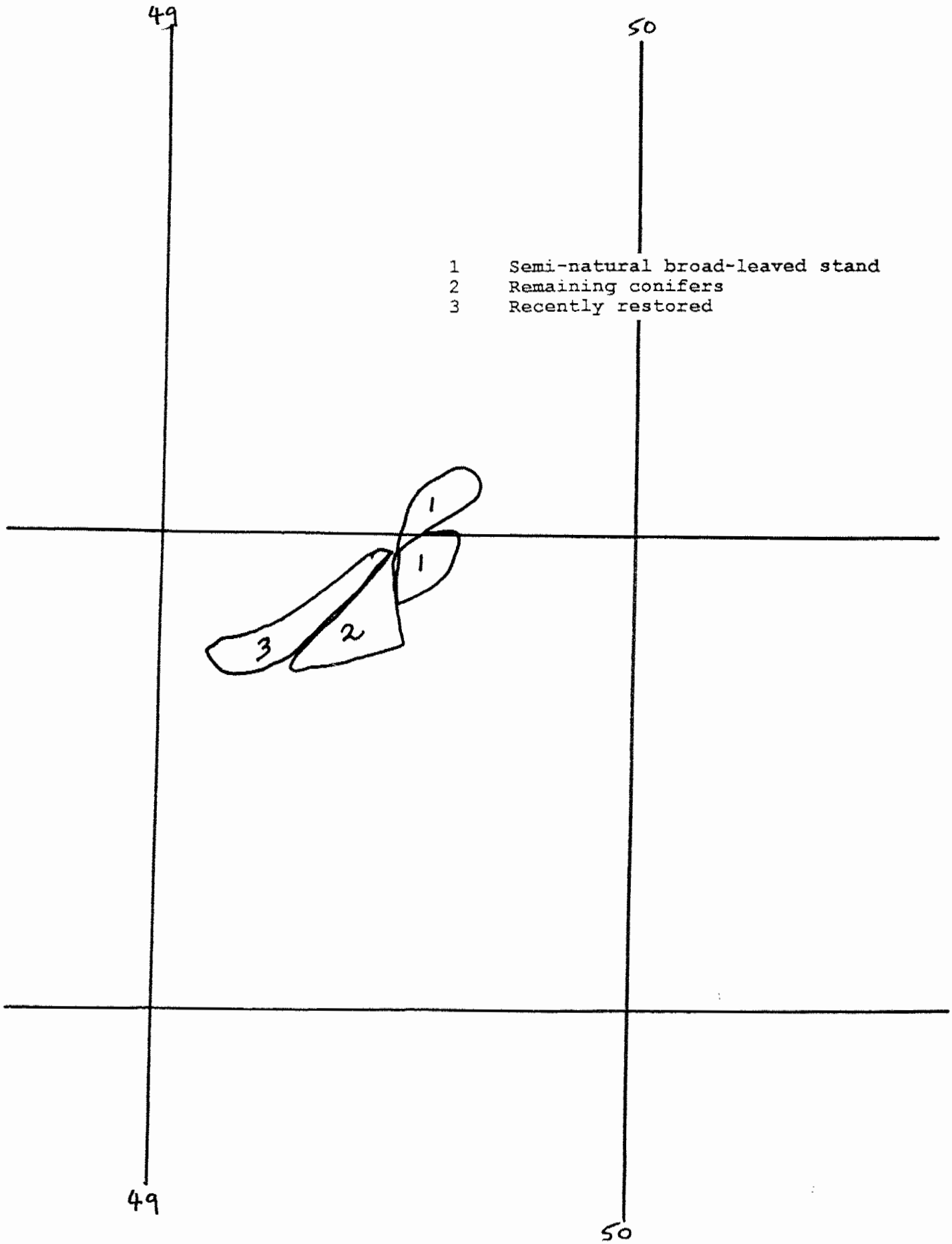
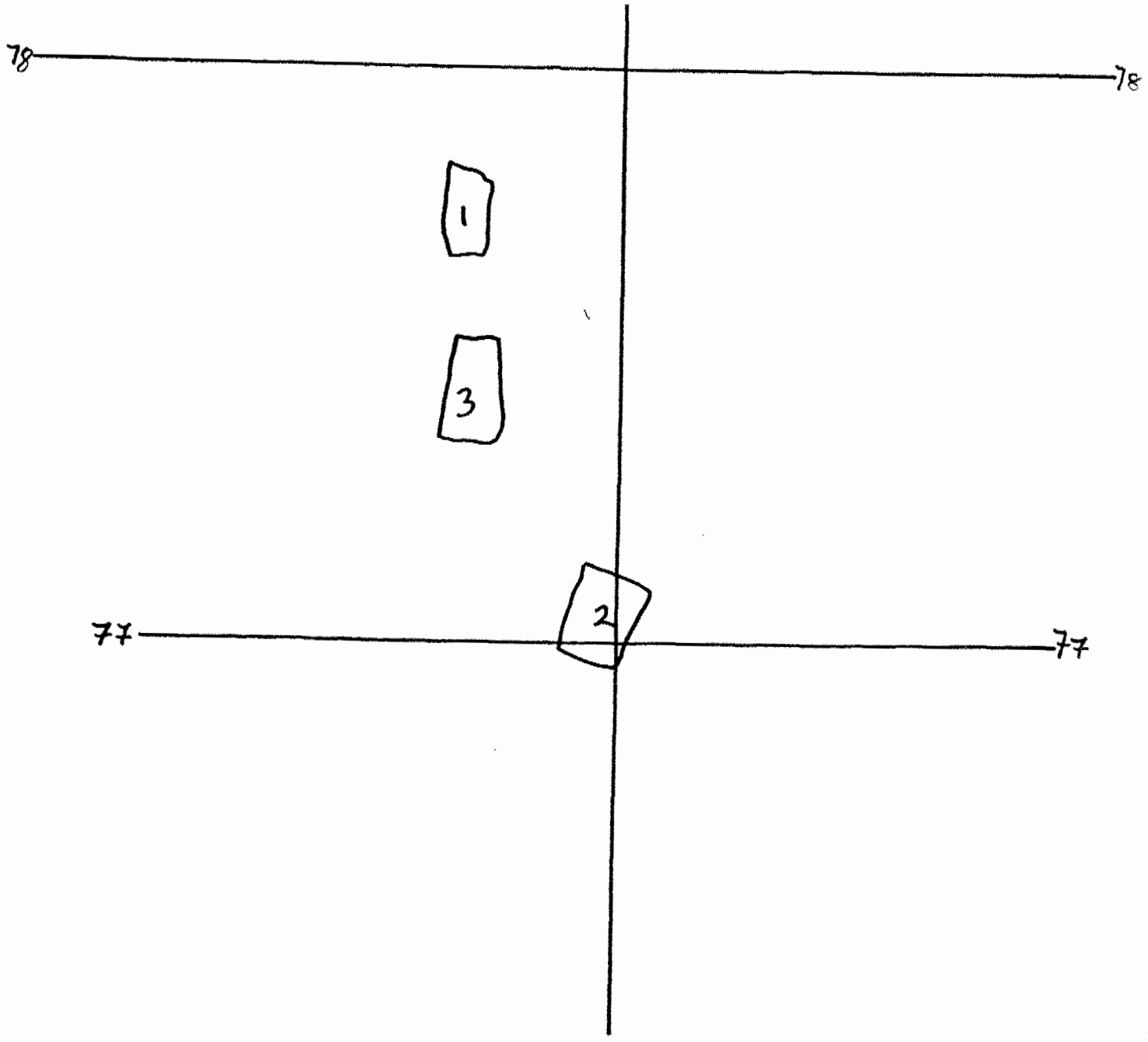


Fig. 4 The compartments in which the plots were placed at Eaton and Gamston Woods.



1 Semi-natural broad-leaved stand
2 Remaining conifers
3 Recently restored

Similarly there were no recently felled conifer stands so that a small mixed compartment within Eaton Wood from which the conifers had been selectively removed between 1994 and 1997 was used. Consequently the plots had a very irregular distribution, some were quite closely spaced and often were partially shaded by the surrounding broad-leaves. Brash remaining after removal of the conifers tended to be left within the stand ,and there was also one very small area within the stand where brash had been burnt .

The broad-leaved compartment selected for sampling ,is dominated by ash, and is currently a non-intervention compartment although at some time in the past the area may have been felled and allowed to regenerate naturally. It contained a very occasional conifer, at least some of which may be self-sown and there has been a little sycamore invasion , especially on the edges of the stand.

RESULTS

The species composition of the plots at each of the sites.

The plant species occurring in the plots at each of the sites are listed in Appendices 2 to 5, together with the percentage cover of each of the layers in the plots.

The summarised data for the characteristics of each of the treatment types at each site is presented in Table 1, and the frequency with which species in the various groups of ecological strategists occur in each of the treatments at each site shown in Appendix 6.

I. Castor Hanglands

a. Broad-leaved woodland.

The broad-leaved woodland canopy above the plots was dominated by ash and in 40% of the plots there was some oak, often with a sparse shrub layer, through which there was little open sky visible (range 5% to 30%; mean 13%).

The plots had a good ground cover (mean 90%[28.2]), the majority of the cover usually being accounted for by false wood-brome and varying amounts of dog's mercury. A variety of other species are present, (mean number of herbaceous species 11.7[3.8]), though usually at a low cover. The list includes ancient woodland indicator species such as nettle-leaved bellflower, wood sedge, bluebell and hairy St John's-wort, most of which are rather infrequent,(Table 2) generally occurring in 30 % of the plots or fewer. Dog's mercury is an exception, occurring in all the plots, with a Domin value ranging between 3(< 4 % cover) and 9 (76 % - 90 %).

Four stress tolerant species, three-veined sandwort, barren strawberry, sanicle and common dog violet, two of which are also regarded as ancient woodland indicators, were recorded in the plots(Appendix 6), although generally not occurring frequently (20 -30 %).The total number of stress tolerators in each of the plots was not high (mean 0.8[0.6]). Group Two species, of which there were seven overall in the plots, were more frequent, with for example stress tolerant competitors, such as bramble and dog's mercury , occurring in most plots, and with between two and five Group Two species in any one plot (mean 3.4[1]).

None of the plots contained ruderal species and competitive species were infrequent(in 40% of the plots) with each of these plots supporting only a very low cover of stinging nettle. Group One species, such as enchanter's nightshade and wild angelica, were also only seen occasionally (Mean No in Plots 0.7[0.7]), and at a low cover.

Table 1 Summary of the characteristics of each of the treatments at each site. Mean with Standard Deviation

	Castor Hanglands			Foxley Wood			Mortimer Forest			Eaton and Gamston Woods		
	Broad-leaved woodland	Remaining conifers	Restored area	Broad-leaved woodland	Remaining conifers	Restored area	Broad-leaved woodland	Remaining conifers	Restored area	Broad-leaved woodland	Remaining conifers	Restored area
No of regenerating trees and shrubs	1.5 (1.4)	1.5 (1)	1.5 (1.2)	1.4 (0.7)	2.3 (1.3)	3.2 (1.6)	2.2 (0.8)	1.7 (0.7)	1 9 (0.7)	0 6 (0.7)	0.1 (0.3)	2 9 (1)
No of species in the field layer	11.7 (3.8)	11.2 (4 4)	29.8 (4.3)	7.8 (2.7)	13.8 (4.4)	20.3 (2.9)	3.4 (0.7)	3.9 (2.3)	4.5 (1.5)	6.4 (1.1)	4 1 (1.9)	7.6 (2.5)
No of Ancient Woodland Indicator Species	3 5 (1.6)	3.9 (1 2)	4.9 (1.3)	3.2 (1 3)	4.3 (0.8)	2.6 (0.8)	0	0.1 (0.3)	0	1.4 (0 7)	0	1.6 (1)
No of ruderals in the field layer	0	0.3(0.48)	1.6 (0.8)	0	0	0	0	0	0.1 (0.3)	0	0	0.1 (0.3)
No of competitors in the field layer	0.4 (0.5)	0.5 (0.5)	3.5 (0.5)	0	0.1 (0.3)	2 (0.5)	0.7 (0.5)	0.6 (1.1)	0.9 (0.6)	0.6 (0.5)	0.2 (0 4)	0.7 (0.7)
No of CR;C/CR:R/CR in field layer (Group one)	0.7 (0.7)	0.6 (0.7)	5.3 (1.9)	0.7 (0.7)	2.3 (2)	3.6 (1.4)	0	0	0	1.1 (0.6)	0	2.3 (1.1)
No of SR:SC;S/SC C/SC;R/SR in field layer (Group two)	3.4 (1)	3.1 (1.4)	3.5 (1.2)	2.3 (0.9)	3.1 (1.1)	4.4 (1)	2.5 (0.5)	1.2 (0.8)	1.4 (0.7)	1.7 (0.8)	2.5 (1 1)	2 (0.7)
No of stress tolerators in the field layer	0.8 (0.6)	0.9 (0.6)	1.3 (0.7)	1.6 (1)	2.2 (0.4)	0.2 (0 4)	0	0.2 (0.4)	0.1 (0.3)	0.2 (0.4)	0	0.2 (0.4)
Open sky visible above plot (%)	13 (8.9)	20 (18.6)	100 (0)	0.5 (1.58)	11 (16.5)	98.5 (3 37)	2.9 (2.33)	24 (18.4)	95.5 (8.32)	2.7 (2.21)	2.9 (3 31)	76 (21.7)
Percentage cover:												
Canopy	87 (8.9)	80 (18.6)	0	87 (16)	87.5 (15.9)	0.5 (1.58)	97.1 (2.33)	76 (18.4)	4.5 (4.5)	92.3 (8.07)	97.1 (3.31)	22 (21)
Shrub layer	23 (30 8)	2.0 (6.32)	0	85.5 (15)	6.5 (15.5)	15 (20)	8.0 (15.5)	0	0.5 (1.58)	30.5 (22.5)	1.0 (2.11)	2.5 (6.24)
Field layer	90 (28 2)	39.3 (38.8)	87.5 (18.9)	59 (20.9)	65.5 (27.8)	97.7 (6.29)	94.1 (6.95)	21.6 (19.7)	38.3 (34.1)	68.5 (18.4)	58.3 (38.1)	87.5 (17.5)
Bryophytes	9.3 (15.4)	19.6 (17.7)	3.5 (6.13)	8.0 (6.11)	30.7 (23 7)	9.7 (24.7)	1.3 (0.67)	17.7 (18.1)	1.5 (0.97)	62 (18.8)	4.0 (4.06)	11.0 (11.3)
Litter	0	58.3 (37.5)	6.3 (9.5)	32.2 (34.1)	25 (30.3)	0	5.3 (5.4)	67 (31.1)	63 (45.2)	4.7 (5.46)	90.3 (9.36)	6.0 (6.58)
Wood	2.2 (3.26)	5.6 (7.46)	11.7 (14)	1.5 (2.12)	1.5 (2.12)	2.1(1.52)	2.0 (1.7)	45 (34.4)	46 1 (42.0)	5.8 (4.69)	4.1 (3.54)	18 (18)
Bare ground	1.5 (2.42)	0.3 (0.95)	1.1 (3.14)	15.5 (20.9)	0	0.3 (0.95)	0	0	0	4.5 (4.06)	1.5 (3.17)	0.2 (0.63)

Table 2 The frequency (%) with which ancient woodland indicator species were encountered in the plots at Castor Hanglands.

	Broad-leaved woodland	Remaining conifers	Restored area
Campanula trachelium	10	10	0
Carex remota	0	10	10
Carex sylvatica	10	30	70
Galium odoratum	0	10	30
Hyacinthoides non	40	0	0
Hypericum hirsutum	50	30	70
Lamiastrum galeobdolon	0	50	0
Lysimachia nemorum	0	10	0
Melica uniflora	30	0	0
Mercurialis perennis	100	100	80
Potentilla sterilis	30	0	10
Primula vulgaris	0	80	10
Scrophularia nodosa	10	20	90
Stellaria holostea	10	0	0
Valeriana officinalis	0	0	40
Veronica montana	30	0	0
Viola riviniana	80	70	90

Seedlings of trees and shrubs were found in the field layer of 70 % of the plots with from one to four species present in each plot. Field maple and hawthorn were seen most often, while dogwood and ash were encountered less frequently (Table 3).

There was very little bare ground in these plots (mean 1.5%) and only small amounts of decaying wood, such as fallen branches. Bryophytes were noticeable in some plots but in others were not present or had only a very low cover(range 0 - 50 %; mean 9.3). A variety of species accounted for the cover , the most frequent of these being Eurhynchium praelongum and Mnium hornum.

b. Remaining conifers

In the plots in the remaining conifer stand the ground cover was very variable ranging from <1% to approximately 95%, with a mean of 39.3%. Those plots where there was little vegetation cover tended to have a dense cover of needle litter and there was usually an almost closed canopy above them. Plots in which there was some vegetation cover had a more open canopy.

Bare ground was only very occasionally visible, although most

plots (80 %) had a certain amount of dead wood, composed either of brash or fallen timber. All plots had some bryophyte cover ranging from 2% to 50% (Mean 19.6[17.7]). The main contributor was *Eurhynchium praelongum*. A similar number of herbaceous species were found in the field layer of the plots (mean 11.2[4.4]) to those in the broad-leaved woodland , although most only occurred at a low cover. Dog's mercury accounted for the bulk of the cover in each of the plots, nearly always accompanied (90% of the plots) by small amounts of false wood-brome, which featured prominently in the plots in the broad-leaved stand. Overall the range of species present were similar to those in the broad-leaved stand , with one or two exceptions. Primrose and yellow archangel were frequently found in the plots in the conifer stand (80% and 50% respectively) but were not recorded in the plots in the broad-leaved woodland, whilst conversely wood avens occurred in 80% of the broad-leaved woodland plots and was absent from the conifer plots.

Table 3 The frequency (%) with which regenerating trees and shrubs were encountered in the plots at Castor Hanglands.

	Broad-leaved woodland	Remaining conifers	Restored area
Acer campestre	60	0	0
Betula sp.	0	0	20
Cornus sanguinea	20	0	0
Corylus avellana	0	0	10
Crataegus monogyna	40	20	20
Fraxinus excelsior	30	7	10
Prunus domestica	0	0	20
Quercus robur	0	20	10
Rosa sp.	0	30	0
Salix sp.	0	10	40
Sambucus nigra	0	0	20
Overall frequency	**70**	**90**	**80**

Ancient woodland indicator species had persisted beneath the conifers, with a comparable number in the plots (mean 3.9 [1.2])to those in the broad-leaved woodland, although the overall list of indicators was rather different (Table 2). As already noted yellow archangel and primrose, both of which are indicators, were not found in the broad-leaved woodland plots nor were woodruff, remote sedge and yellow pimpernel whereas bluebell, greater stitchwort, barren strawberry and wood speedwell were not seen in the conifer plots.

Two stress-tolerant species, three-veined sandwort and common dog-violet, which is also an ancient woodland indicator, were present, both occurring at a relatively high frequency (Appendix 6), while the mean number of stress tolerators in the plots (0.9 [0.6]) was similar to that in treatment one.

Again Group Two species , of which there were 6 overall in the plots, were more frequent than the stress tolerant species. Also there was a similar list of species to that for the broad-leaved woodland plots, and the mean number of Group Two species in the plots (3.1[1.4])was of a similar order. Of these dog's mercury, false wood-brome , male fern and yellow archangel occur most frequently, although most have only a low domin value.

Ruderals are generally absent from the conifer plots. Only one ruderal species, chickweed, was recorded occurring at a low frequency (30%) and never contributing significantly to the cover in the plots. Species with a competitive strategy are also rarely seen and, like the broad-leaved woodland plots, have stinging nettle, which is shade tolerant, as the only representative. This occurs in 50% of the plots, always with a low domin value (1- 3).

Group One species , of which there are a total of five in the overall list, were also rather more conspicuous, occurring in 60% of the plots, with either one or two such species in each plot, and a mean for the ten plots of 0.6[0.7]. This is a similar pattern to that found in the broad-leaved woodland, although there is only a limited amount of overlap in the list of group two species recorded from the two treatment types (Appendix 6). Enchanter's nightshade and common figwort are common to both, while wild angelica and cleavers are not found in the conifer plots and large bittercress, ragwort and hedge woundwort are not found in the broad-leaved woodland plots.

Tree and shrub regeneration was noted in 90% of the plots (Table 3), with ash seedlings most frequently recorded. Hawthorn, oak, rose and willow seedlings were much less frequent. Individual plots contained between one and three regenerating species (mean 1.5 [1]).

c. Restored area

A significantly greater number of herbaceous species were present in the field layer of these plots (mean 29.8 [4.3]) than in either of the other two treatment types (Table 1). The total list of herbaceous species for the ten plots showed some similarities with the other treatment types. Twenty-one species were common to the list for the broad-leaved woodland plots, in which there was a total of thirty seven field layer species, and this treatment, while twenty seven species occurred in both this treatment and the conifer plots, where the total list amounted to thirty five species. Eighteen species were common to all treatment types, the most frequently recorded of which were false wood-brome, dog's mercury and common violet.

Several of the species common to all the plots are ancient woodland indicators, with all the treatments having a mean number of indicators of a similar order (Table 1). However some of the indicator species such as hairy St John's-wort, wood sedge, common figwort and common valerian occur more frequently in this treatment than in the broad-leaved woodland (Table 2), while other such as nettle-leaved bellflower, wood melick and wood speedwell are absent from these plots.

With the exception of dog's mercury most indicators have only a low cover (domin values 1-4). Dog's mercury often constitutes significantly to the cover in individual plots in the broad-leaved woodland, and quite frequently in the conifer stand. However in the restored area plots it is much less conspicuous.

The mean number of stress tolerators and of Group Two strategists in each of the three treatments are also of a similar order.

A number of the additional species confined to the restored area plots are categorised as ruderals, including shepherd's purse, redshank and sticky groundsel, competitors e.g. rosebay willowherb, creeping thistle and great hairy willowherb or are Group One strategists such as creeping bent, creeping buttercup, prickly sow-thistle and coltsfoot. Most of these types of stategists found in the broad-leaved plots or the conifer plots are also found in the restored area plots, such as stinging nettle, cleavers and chickweed. Some are especially frequent in the restored area plots with the ruderals redshank and chickweed, the competitors rosebay willowherb, creeping thistle, stinging nettle and great hairy willowherb and the Group One strategists prickly sow-thistle and creeping bent occurring in 70% or more(Appendix 6).

Regeneration of trees and shrubs is occurring in 90% of the plots, although in this treatment type it is attributable to both coppice regrowth (of dogwood, hazel and hawthorn) and seedling regeneration. There is a greater variety of regenerating species than in the other treatments, although overall the frequency is similar in each treatment. Willow seedlings are most often encountered (Table 3), while elder, wild plum and birch, which are not present in the other treatment types, are occasionally seen.

Most of the plots have a good ground vegetation cover, with a mean of 87.5%[18.9]. However the species which contribute significantly to this cover vary from plot to plot. Creeping bent, a competitive ruderal in Group One which has a marked capacity to exploit pockets of nutrient enrichment and canopy gaps, occurring in 70% of the plots, shows the most consistency, with a domin value of 5 or 6 in all but one plot. False wood-brome, a Group Two species, described by Peterken as a fast colonising woodland species, and a community constant often abundant in the broad-leaved woodland plots, occurs in all of these plots, with a domin value of 5 or 6 in five of them, a domin value of 8 in one but a domin value between 2 and 4 in four plots. Meadow-grass was also recorded in all of these plots , but

generally at a low cover, while jointed rush, an effective colonist, which occurs in six of the plots contributes significantly to the cover in two of them. Other species tend to have low domin values.

Bryophytes are only found in 60% of the plots and the cover is usually not extensive (5% or less), while litter and wood such as cut stumps and brash account for up to 50% of the cover in any one plot. Bare ground is rarely visible.

II. Foxley Wood.

a. Broad-leaved woodland

Ash and oak provide the canopy cover in these plots, beneath which there is a well-developed shrub layer (mean cover 85.5[15]), usually of hazel, often with some field maple, or of field maple. Other shrub layer constituents are infrequent. Open sky is not usually visible above the plots through these layers, with only one plot having approximately 5% open sky above it.

Dog's mercury and bramble are the main components of the field layer. Common dog-violet also occurs frequently (90% of the plots), but has a low domin value (2 to 3). Other associates, seen less often, also have low domin values. The most frequently encountered(in 50% or more of the plots) are wood sedge, enchanter's nightshade, tufted hair-grass, wood avens and ground ivy, with the majority of plots having seven or eight species in the field layer.

Table 4 The frequency (%) with which ancient woodland indicator species were encountered in the plots in Foxley Wood.

	Broad-leaved woodland	Remaining conifers	Restored area
Carex pendula	10	20	90
Carex remota	*20*	*10*	*0*
Carex sylvatica	*50*	*90*	*10*
Geum rivale	*20*	*10*	*0*
Hypericum hirsutum	*0*	*50*	*80*
Mercurialis	90	90	20
Potentilla sterilis	30	10	0
Primula vulgaris	0	20	0
Veronica montana	10	0	0
Viola riviniana	90	100	10

The total list of twenty two herbaceous species for all the plots includes eight ancient woody indicator species (Table 4), with

a mean of 3.2 indicator species in each plot.

The three stress tolerant species occurring in the plots, are also categorised as ancient woodland indicators. Ninety percent of the plots included one or more of these species with a mean of 1.6 (1) per 5 m x 5 m plot. Group Two species, such as false wood brome (S/SR),pendulous sedge (S/SC) and dog's mercury (SC), which also showed some overlap with the ancient woodland indicators, occurred at a similar frequency (100%), with a mean of 2.3 [0.9] per plot.

Neither ruderals nor competitors were found in the plots, although two Group One species, wild angelica and enchanter's nightshade, were recorded, with usually only one of these species occurring in any one plot and a treatment mean of 0.7 [0.7].

Most of these plots had either a quite substantial area covered by litter, or there were areas of bare ground and often a reasonable cover of bryophytes (from between 5 to 20 % cover in 6 of the 10 plots). The majority of the plots supported both Eurhynchium praelongum and Fissidens sp.(Appendix 2).

Table 5 The frequency of occurrence (%) of regenerating trees and shrubs in the 5 m x 5 m plots in each treatment in Foxley Wood.

	Broad-leaved woodland	Remaining conifers	Restored area
Acer campestre	30	0	20
Acer pseudoplatanus	10	0	0
Betula sp.	0	10	0
Cornus sanguinea	0	0	10
Corylus avellana		40	30
Crataegus monogyna	40	50	40
Fraxinus excelsior	40	30	20
Ilex aquifolium	10	20	0
Malus domestica	0	0	10
Pinus sp.	0	0	50
Prunus spinosa	0	0	10
Quercus robur	0	20	30
Rosa sp.	10	40	40
Salix caprea	0	0	30
Salix cinerea	0	0	10
Sambucus nigra	0	20	0
Overall frequency of regeneration	**100**	**100**	**100**