ENGLISH NATURE

Phase 2 woodland NVC surveys 1988-1991 in England and Wales

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Contents

Summary

Over 600 selected woods were surveyed in different regions of England and Wales. A total of 2146 separate stands occupying 12911 ha were classified using the National Vegetation Classification (NVC). This report gives the results of these surveys and provides updated NVC distribution maps for W9, W16, W8g, W10e and W11b, which were found to have a wider distribution than previously thought. Estimates of the total area of each NVC community based upon these results are given, and a comparison between the NVC and Stand Type classification method is provided.

Acknowledgements

Surveys were also carried out by Geoff Barber, Jamie Bevan, Mel Heath, Helen Oakes, Gavin Saunders and Tony Whitbread to whom thanks are due. Throughout the project we were based in NCC regional offices and are grateful for the help and encouragement received from staff there. Finally, this project could not have been undertaken without the cooperation of the many hundreds of landowners who granted us permission to work in their woods. Various members of staff from both English Nature and the Countryside Council for Wales made helpful comments on an early draft of this report.

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Introduction

In 1981 the Nature Conservancy Council (NCC) began a project, using existing information sources, which has resulted in a national inventory of ancient woods (Spencer & Kirby in press; Roberts et al in press). Provisional reports have been produced for each county in England and Wales, and for each district in Scotland. These list all ancient semi-natural woods and all plantations on ancient sites (Kirby et al 1984; Walker & Kirby 1989).

The inventory is used by the Forestry Commission to help identify woods requiring special treatment under the Woodland Grant Scheme (Forestry Commission 1988). It provides a factual base upon which planning decisions, nature conservation advice and countryside management can be based and is a base line against which changes in the woodland area can be measured (eg Peterken & Allison 1989; Spencer 1989).

As was recognised from the outset, some of the information upon which the inventory is based was out of date or incomplete and required checking by field survey. Such field survey of sites was a normal part of NCC's work, (and is now a part of its successor bodies work), but additional checks were carried out in response to enquiries from woodland owners or managers.

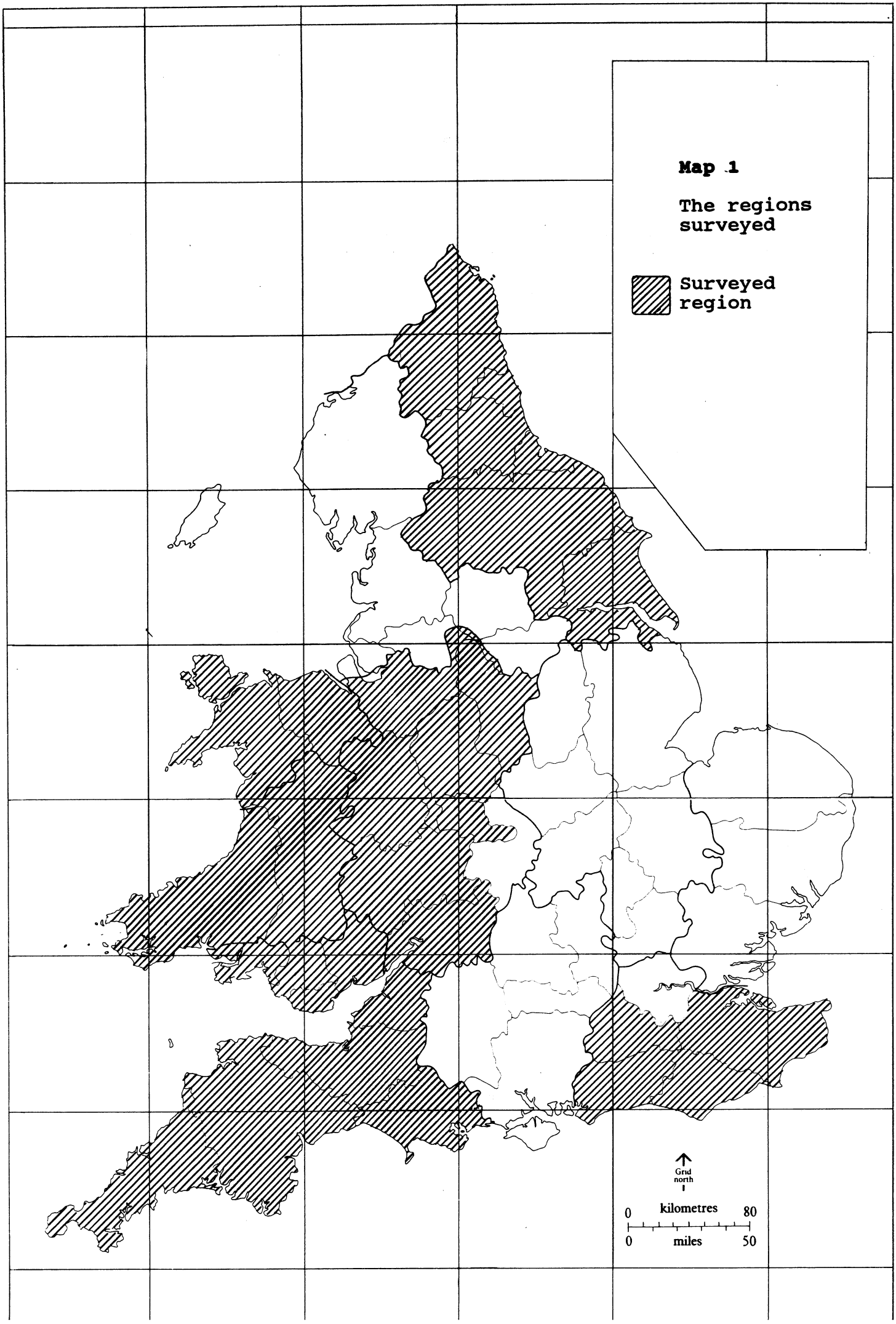
As work on the draft inventories came to an end, a five year survey programme was initiated in 1988 in England and Wales to carry out a more systematic survey of woods. (A similar programme was already in operation in Scotland eg MacKintosh 1988, 1990.) During the five years the intention was that two teams of two surveyors would each spend a year in each of the three Welsh and eight English regions of the NCC.

The Government's decision to reorganise the NCC (HMSO 1990) truncated this programme. At the time of reorganisation about two thirds of the programme had been completed, with the three Welsh Regions and the North East, South East, South West and West Midlands Regions of England covered (see Map 1). (In fact the Regions of North Wales and West Midlands were surveyed in a single year by a single team for logistic reasons.) The English Regions which were not surveyed during this project were South, North West, East Midlands and East Anglia. The latter two are now combined into the East Region of English Nature (EN), the successor body to the NCC in England.

This report brings together the results of these field surveys in Wales and the four English Regions, previously reported on individually as Chief Scientist Directorate Research Reports (Barber & Cooke 1990; Cooke & Saunders 1989, 1990; Heath & Bevan 1991; Heath & Oakes 1990; Oakes & Whitbread 1990).

Aims of the project

The aims of the project were threefold: to introduce the National Vegetation Classification (NVC) (Rodwell 1991) and help establish


Map 1
The regions surveyed
Surveyed region
Grid north
0
kilometres
80
0
miles
50

it as the main method of woodland classification, and to increase our knowledge of the extent and distribution of communities; to survey some of the larger ancient semi-natural woods for which there was little or no botanical survey information; and within the constraints of the above, to revise and amend the draft ancient woodland inventories.

Site selection

Sites were selected subjectively; no attempt was made to choose a random, statistically valid sample. This was primarily because of the multiple aims of the survey. In general the woods selected for survey were the largest ancient semi-natural woods for which only limited botanical information was available, covering the range of geological and edaphic variation within the region, and occurring in as many different aspects as possible. In practice the selected list was modified by sites considered to be in urgent need of survey by regional staff, and by the lack of permission from owners or managers to survey certain sites (permission was refused for about 10% of sites).

There was a general presumption against the survey of Sites of Special Scientific Interest (SSSI) and other reserves as these were likely to be well documented. However, pressure from regional staff to have 'their' SSSI's classified using the NVC lead to the inclusion of a few from each region. Further constraints on the selection procedure were logistical considerations (the need to minimise travelling between sites in any one day), the desirability of reducing lone field working, and time considerations. For example, it might be better to spend two days surveying a large wood rather than two separate, smaller sites. Each case was treated on its own merits, but the overriding consideration was to survey as many different types of woodland as possible.

Survey method

The method of survey closely followed that described in Kirby (1988a) pp 29-33, commonly known as the 'walkabout method'. An irregular path is walked throughout the wood, covering all likely sources of variation, including vegetation, physical habitats (stream sides, rock outcrops etc), any differences in management regimes and geological differences. The structure of the tree and shrub layers and the vascular plants were recorded on standard recording forms using the DAFOR scale. Other information was noted as required.

All sites were classified using the NVC. Classification of stands in the field was aided by a key to communities and sub-communities (Rodwell 1991, but using the drafts available in 1986). As the surveyors became more experienced it was possible to recognise most communities without reference to the key. Nevertheless, quadrats were recorded, both from stands which were difficult to classify in the field, and also as a periodic check that the classifications were correct (see page 40).

Results

A total of 603 woods were surveyed covering 12,911 ha, in which 2146 separate stands were fully classified. This averages at 10.7% of the ancient semi-natural woodland (asnw) in those areas surveyed.

Table 1 Area and percentage asnw surveyed in each region

Region	Area surveyed (ha)	Area asnw (ha)	% asnw surveyed
South West	2142	23731	9
South East	2600	52223	5
West Mids	1554	31658	5
North East	2089	16388	13
Dyfed-Powys*	2677	17295	15
South Wales*	1170	6981	17
North Wales	679	6382	11

(* old NCC Wales Regional boundary)
(There are minor discrepancies between the results published in the South East Region report (Oakes & Whitbread 1990) and those used for South East Region here due to the inclusion of extra sites not included in that report.)

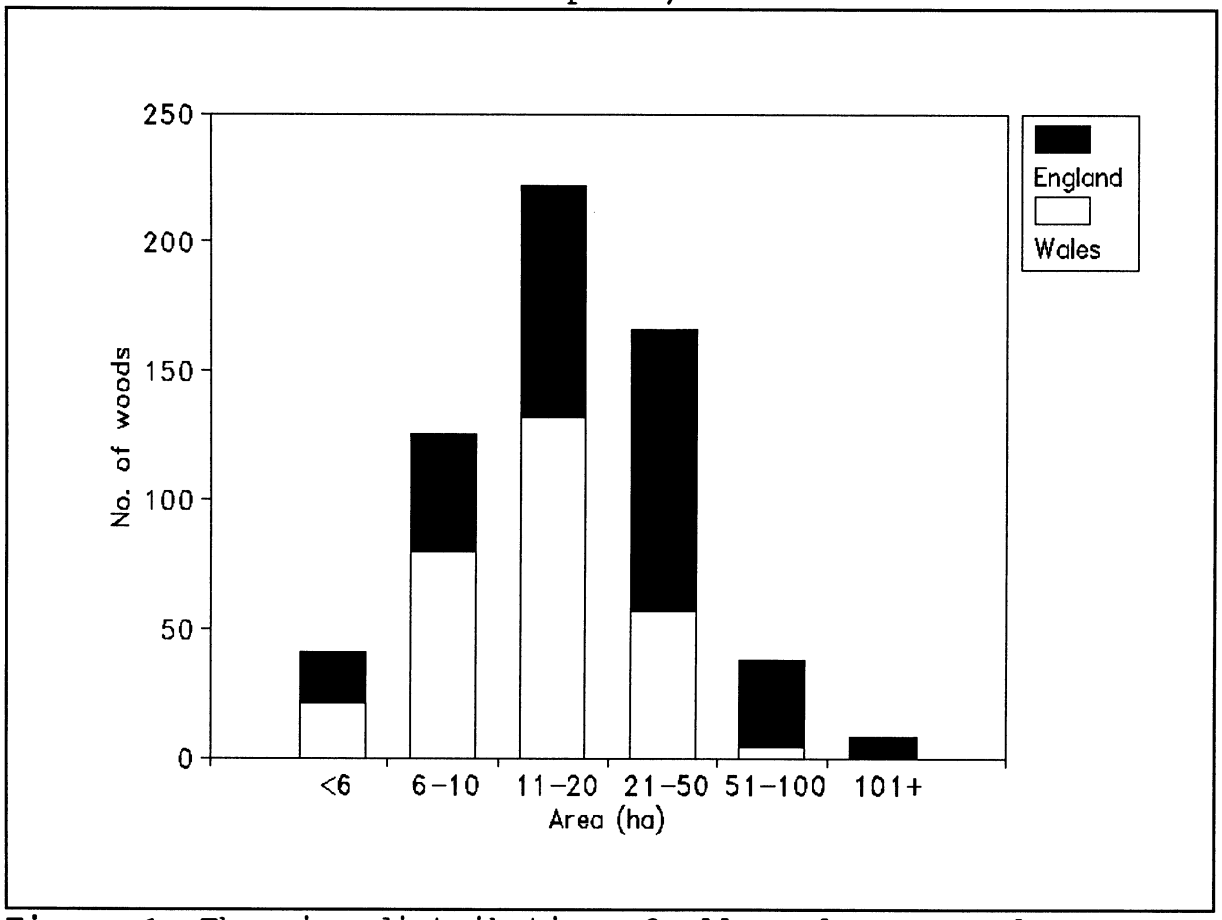
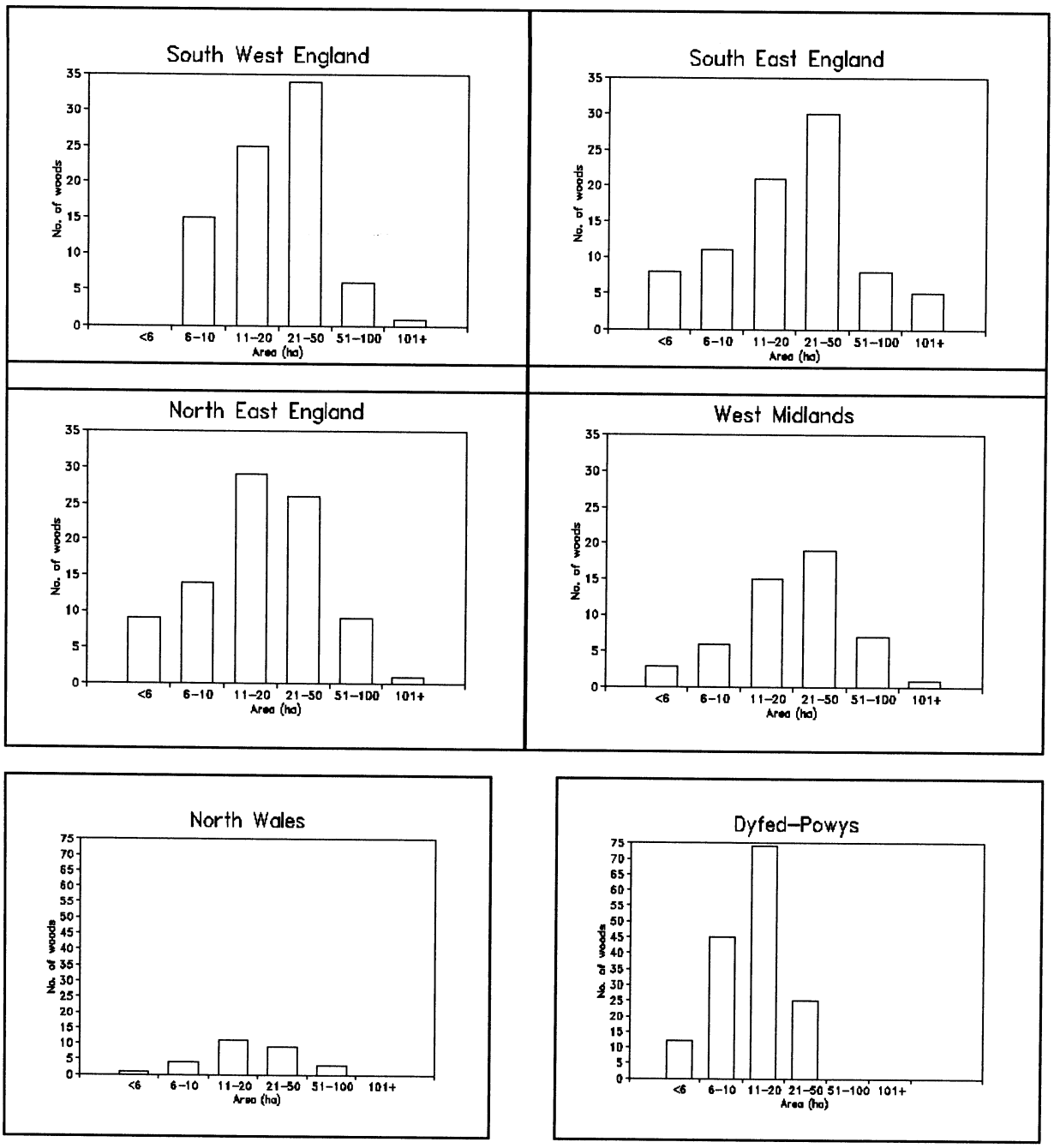


Figure 1 The size distribution of all woods surveyed



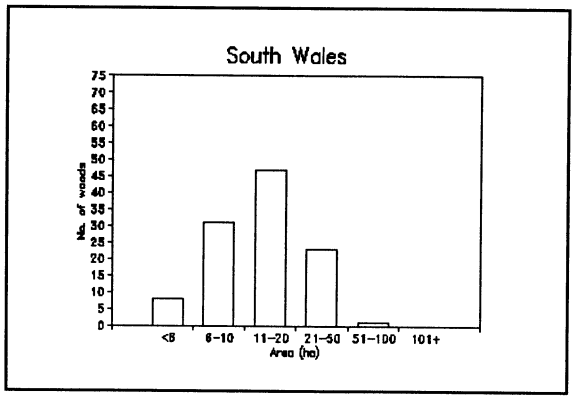


Figure 2 The size distribution of woods surveyed in each region

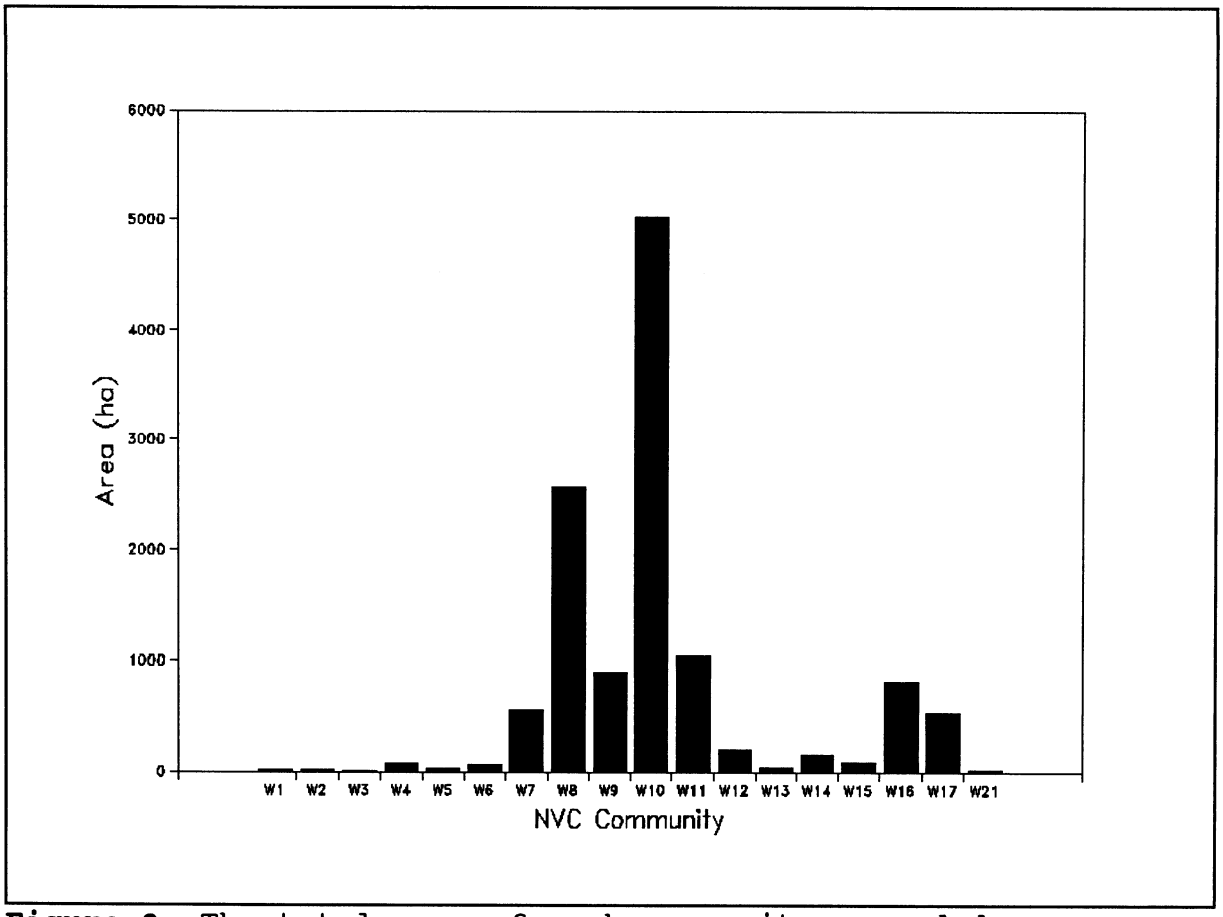


Figure 3 The total area of each community recorded

Regional variation in woodland communities

Natural variation in woodland communities occurs as a result of interactions between soil, geology and climate. Along western and northern coasts an Oceanic climate prevails, giving rise to cool humid summers and mild winters (Page 1982). The southern and eastern coasts experience a more Continental climate where both warmer summers and harsher winters occur. The response of species to these climatic effects in conjunction with the edaphic conditions on which they occur is the primary cause of natural variation in woodland throughout Great Britain. The current vegetation of a wood is also a reflection of the present management and past history of the site (Mitchell & Kirby 1989), and may be influenced by local factors such as tree litter (Sydes & Grime 1981a).

The management of woods has modified many woodland types either directly, for example through the conversion to conifer plantations (Rackham 1980), or indirectly such as increasing the proportion of oaks in some lowland mixed deciduous woods (Kirby & Patterson 1992). Changes to woods which have resulted in plantations of exotic species where semi-natural stands once existed, although partially covered by the NVC, are outside the scope of this project, as only semi-natural woods were considered for survey.

Table 2	The area of each community in each region (ha)							
	N Wales	Dyfed-Powys	NE England	West Midlands	S Wales	SW England	SE England	Total
W1	0.5	0.5				10.5		11.5
W2a		10.0	1.5	0.3	0.3			12.0
W2b								0.0
W3			6.0					6.0
W4a	1.3			6.0	6.3	3.0		16.5
W4b		29.3		1.8	13.8			44.8
W4c					8.8			8.8
W5a		2.5	0.8		1.3		0.3	4.8
W5b		1.3			13.0			14.3
W5c					3.0		0.8	3.8
W6a		1.8	1.3	1.8		0.5	3.8	9.0
W6b				6.0			1.5	7.5
W6c								0.0
W6d		1.8	6.0	8.8	13.3	6.5	0.3	36.5
W6e		5.0			0.3	6.0	0.3	11.5
W7a	17.0	26.8	39.5	18.5	29.0	33.3	15.0	179.0
W7b	7.3	34.8	15.8	10.8	68.3	27.0	17.0	180.8
W7c	13.5	24.3	29.8	38.0	78.0	9.0	4.8	197.3
W8a		14.5	20.5	99.3	35.5	185.1	465.0	819.9
W8b		1.3	1.3		30.3	42.5	65.8	141.0
W8c	6.3	7.3	21.0	46.5	89.5	16.8	32.5	219.8
W8d		15.0		35.5	36.0	180.5	41.8	308.8
W8e	72.3	63.3	42.8	171.0	243.3	140.3	44.3	777.0
W8f		6.8	64.3	7.5	18.5	32.3	20.3	149.5
W8g		87.0	15.3	0.5	43.8		1.3	147.8
W9a	66.0	176.0	377.3	41.3	54.8	2.5	1.3	719.0
W9b	6.5	6.3	161.3					174.0
W10a	42.0	308.8	197.8	530.0	118.8	302.8	1253.0	2753.0
W10b			7.5		2.5	58.3	226.5	294.8
W10c	34.5	10.3		12.0	68.8	214.5	28.5	368.5
W10d	0.5		95.0	76.0	8.5	12.5	23.3	215.8
W10e	98.8	22.8	472.3	255.3	223.3	308.5	10.0	1390.8
W11a	76.5	443.0	72.3	22.8	311.3	6.3		932.0
W11b	32.3		42.8	1.3				76.3
W11c	6.0							6.0
W11d		21.5	13.3		2.5			37.3
W12a	3.8		6.0	15.0	7.3	44.8	55.0	131.8
W12b				16.3				16.3
W12c							48.0	48.0
W13a						1.3	7.3	8.5
W13b			7.3		3.0	1.3	9.8	21.3
W14	7.3	9.0	1.5	53.0	43.0	16.0	16.0	145.8
W15a		1.3			12.3	7.3	13.8	34.5
W15b	1.3	1.5		6.3	21.3	12.0	1.3	43.5
W15c	0.3				2.5	0.5		3.3
W15d						1.3		1.3
W16a	0.3	1.3	22.3	18.0	1.5	65.0	35.3	143.5
W16b	3.8	177.8	66.8	43.8	146.3	222.5	7.3	668.0
W17a	12.0	96.0	7.3					115.3
W17b	153.0	85.0				7.3		245.3
W17d	21.8	147.5		0.3	6.5	6.0		182.0
W21a				1.3			1.3	2.5
W21b							7.3	7.3
W21d				1.3				1.3

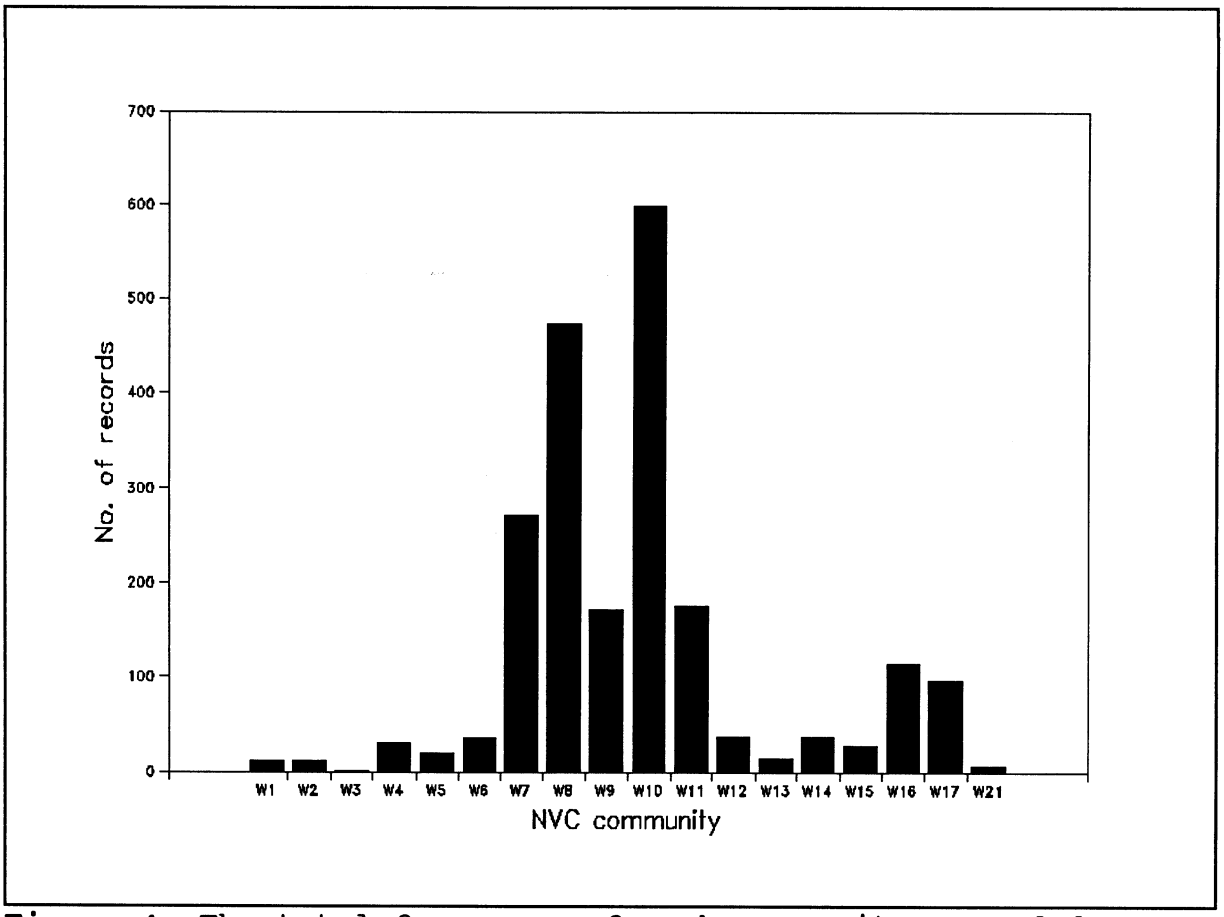


Figure 4 The total frequency of each community recorded

Some NVC communities represent seral stages in woodland development, particularly in the development of wet woodland communities on fens and mires. These communities are not, therefore, particularly characteristic of ancient woods and are under represented in surveys such as this, where the selection of sites is based on ancient woods.

Differences in the regional distribution of NVC communities is most apparent in the six mixed deciduous communities (W8, W9, W10, W11, W16 and W17). These six types are roughly split into north-west and south-east examples of base rich, mesotrophic and acidic types. In general pteridophytes and bryophytes are more abundant in the north-western communities (W9, W11 and W17), as might be expected given the prevailing Oceanic climate.

Community descriptions included in the following sections have drawn extensively on those in Rodwell (1991) and summaries in Whitbread & Kirby (1992). Nomenclature follows Clapham, Tutin & Moore (1987) for vascular plants, and Smith (1978, 1990) for bryophytes.

Table 3 The frequency of each community in each region

	N.Wal.	D-P	NE	WMs	S.Wal.	SW	SE	Total
W1	2	2				7		11
W2a		5	2	1	1			9
W2b		2						2
W3			1					1
W4a	1			1	2	3		7
W4b		11		3	5			19
W4c					4			4
W5a		2	3		1		1	7
W5b		1			5			6
W5c					4		3	7
W6a		2	1	3		2	3	11
W6b			1	1			2	4
W6c								0
W6d		2		4	3	3	1	13
W6e		4			1	1	1	7
W7a	5	25	12	12	19	13	20	81
W7b	8	19	6	7	27	15	14	74
W7c	4	12	6	13	23	5	7	59
W8a		4	5	10	11	33	63	63
W8b		1	1		9	12	26	49
W8c	2	2	2	8	16	9	13	52
W8d		1		6	8	20	16	51
W8e	6	18	16	15	35	19	10	103
W8f		7	12	3	12	8	8	50
W8g		12	2	2	10		1	27
W9a	20	60	36	12	15	2	1	125
W9b	3	2	21					26
W10a	4	57	18	26	24	38	84	163
W10b			3		2	9	38	52
W10c	5	6		2	17	28	17	53
W10d	2		4	3	3	7	8	27
W10e	14	59	37	19	43	17	5	175
W11a	8	87	9	5	41	2		144
W11b	5		8	1				14
W11c	1							1
W11d		3	3		2			8
W12a	3		1	1	2	7	15	29
W12b				2				2
W12c							5	5
W13a						1	2	3
W13b			2		4	1	4	11
W14	2	5	2	1	9	6	13	23
W15a		1			3	2	5	11
W15b	1	2		2	3	2	1	11
W15c	1				2	2		5
W15d						1		1
W16a	1	1	3	3	2	2	12	24
W16b	3	28	14	6	18	19	2	85
W17a	2	26	2					30
W17b	7	20				2		29
W17c	2	30		1	3	1		37
W21a				1			1	2
W21b							2	2
W21d				1				1

Ash-elm Woodland

NVC W9 Fraxinus excelsior - Sorbus aucuparia - Mercurialis perennis woodland.

This is a community of base rich soils and receiving slopes in the north and west. The shrub layer contains few of those species typical of the more southern sub-communities of W8, and is usually dominated by mixtures of hazel Corylus avellana, hawthorn Crataegus monogyna, rowan Sorbus aucuparia and sometimes bird cherry Prunus padus. Sycamore Acer pseudoplatanus can often be frequent in the canopy layer, especially where the elm has succumbed to Dutch elm disease. The field layer forms a complex mosaic of calcicolous forbs and grasses, without ever being dominated by two or three species, as is often the case with W8 woodland. The presence of Oxalis acetosella, as well as abundant ferns and bryophytes, is usually a good indicator of W9 as opposed to W8.

During this survey W9 woodland was the most common calcareous woodland community in North Wales, Dyfed-Powys and North East England, which is consistent with the distribution trends given in Rodwell (1991). It was recorded from all survey areas but uncommon elsewhere and rare in South West and South East England. Both of these areas are outside the main range of the community; in the South West the two records were from sites on Dartmoor, an area where Rodwell (1991) also records it. However, the record from South East England is, at first sight, anomalous. The climate in this area would appear to be completely unsuitable for the species characteristic of W9 woodland, especially the typical ferns and bryophytes. This record (for the Typical sub-community, W9a) was from a gill woodland in south-west Surrey. These sites are known for their isolated populations of strongly Oceanic species such as the liverwort Bazzania trilobata (Hill, Preston & Smith 1991) and the fern Dryopteris aemula (Jermy, Arnold & Farrell 1978). Although these species are not confined to W9 woodland they are more typical of northern and western woods than their presence here would suggest. Therefore this record of W9 is not as unlikely as would first appear.

Most W9 records were for the Typical sub-community, W9a. The Crepis paludosa sub-community, W9b, was only frequent in North East England. This sub-community has more of a northern distribution (as opposed to W9a which has a north-western distribution) as it contains both Continental Northern species such as Prunus padus and Rubus saxatilis and Northern Montane species such as Crepis paludosa and Cirsium helenoides (Rodwell 1991).

NVC W8 Fraxinus excelsior - Acer campestre - Mercurialis perennis woodland.

Mixed woodland communities on calcareous soils in the south and east fall into this community. It is the most complex of the NVC woodland communities with seven sub-communities recognised. These can be split into two major groups, separated mainly by floristic

differences arising as a result of differing edaphic conditions. The first group, W8a, b, c and d are the dominant W8 sub-communities in the south and east of Britain where heavy calcareous clays predominate in rolling countryside. To the north and west base rich soils are usually freely draining brown earths, often accumulating in valley bottoms, and here the sub-communities W8e, f and g are commonest. As these communities can be found towards the limits of the W8 range there is often considerable overlap between these and W9, and in some cases, particularly in the Yorkshire Dales, woods with both W8 and W9 sub-communities are not uncommon.

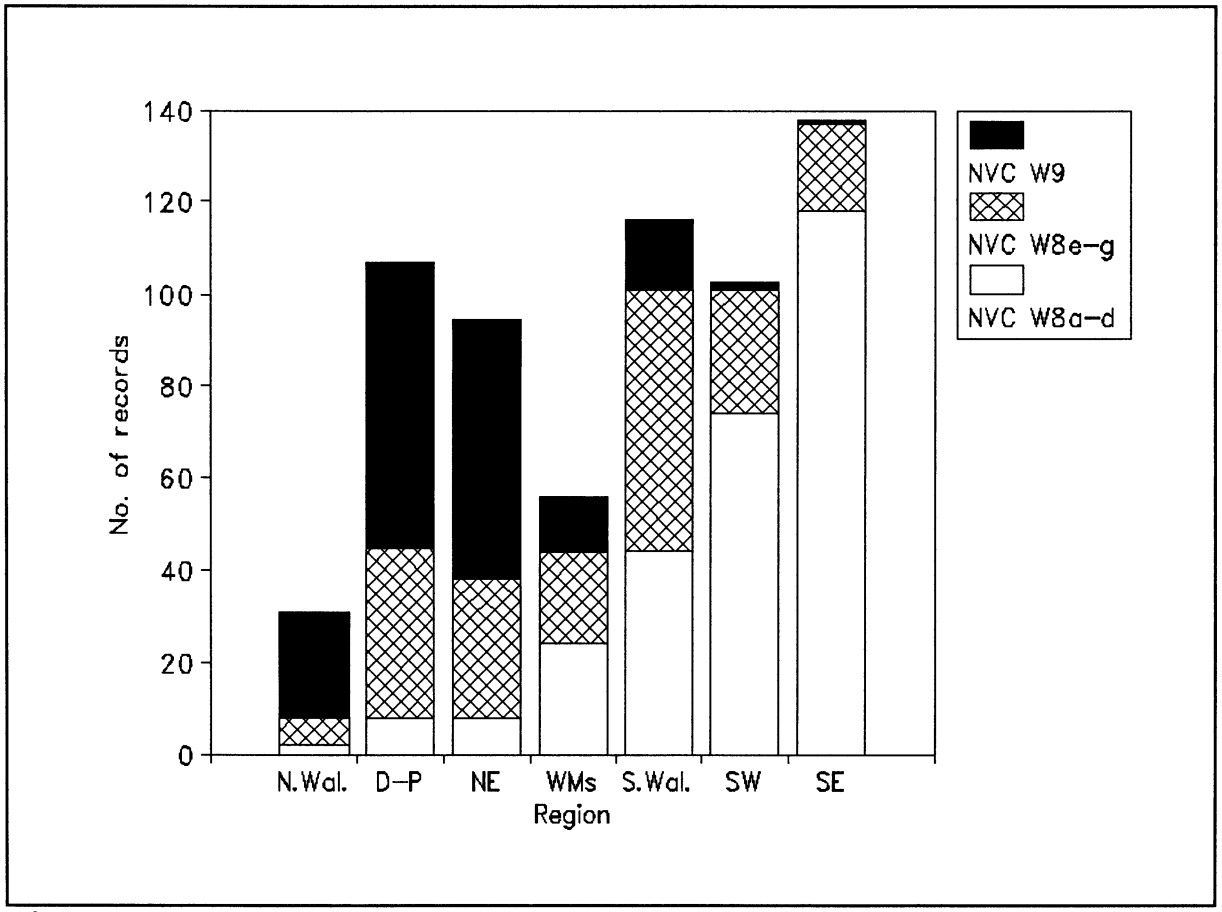


Figure 5 The frequency of as-elm communities in each region

In general W8 woodland is characterised by the presence of Acer campestre in the shrub layer. Other southern shrubs such as Cornus sanguinea, Crataegus laevigata, Euonymus europaeus, Rhamnus catharticus and Viburnum lantana are often also present, especially in sub-communities W8a, b, c and d. These shrubs are confined to the southern half of Britain where the climate is warm and dry enough for successful sexual reproduction (Rodwell 1991). Other Continental and Southern Continental elements of the flora strongly associated with this group of sub-communities include Arum maculatum, Euphorbia amygdaloides, Lamiastrum galeobdolon and Viola reichenbachiana. The north-western group of sub-communities (W8e, f and g) have a less diverse shrub layer (which may, however, include Taxus baccata) and richer fern and bryophyte communities, although not as prolific as those found

in W9 woodland. The canopy layer of W8 can be very varied, and may include stands of Carpinus betulus and Tilia cordata on base rich soils. (As these species may also dominate mesotrophic woodland they are not recognised as specific sub-communities.)

The recorded distribution of these communities largely reflects national trends (Rodwell 1991), and is shown in Map 3 and Figure 5. The south-east group of sub-communities shows a strong bias towards those areas, although the second group of sub-communities is not infrequent in those areas either. However, this group is dominant in North Wales, Dyfed-Powys and North East England.

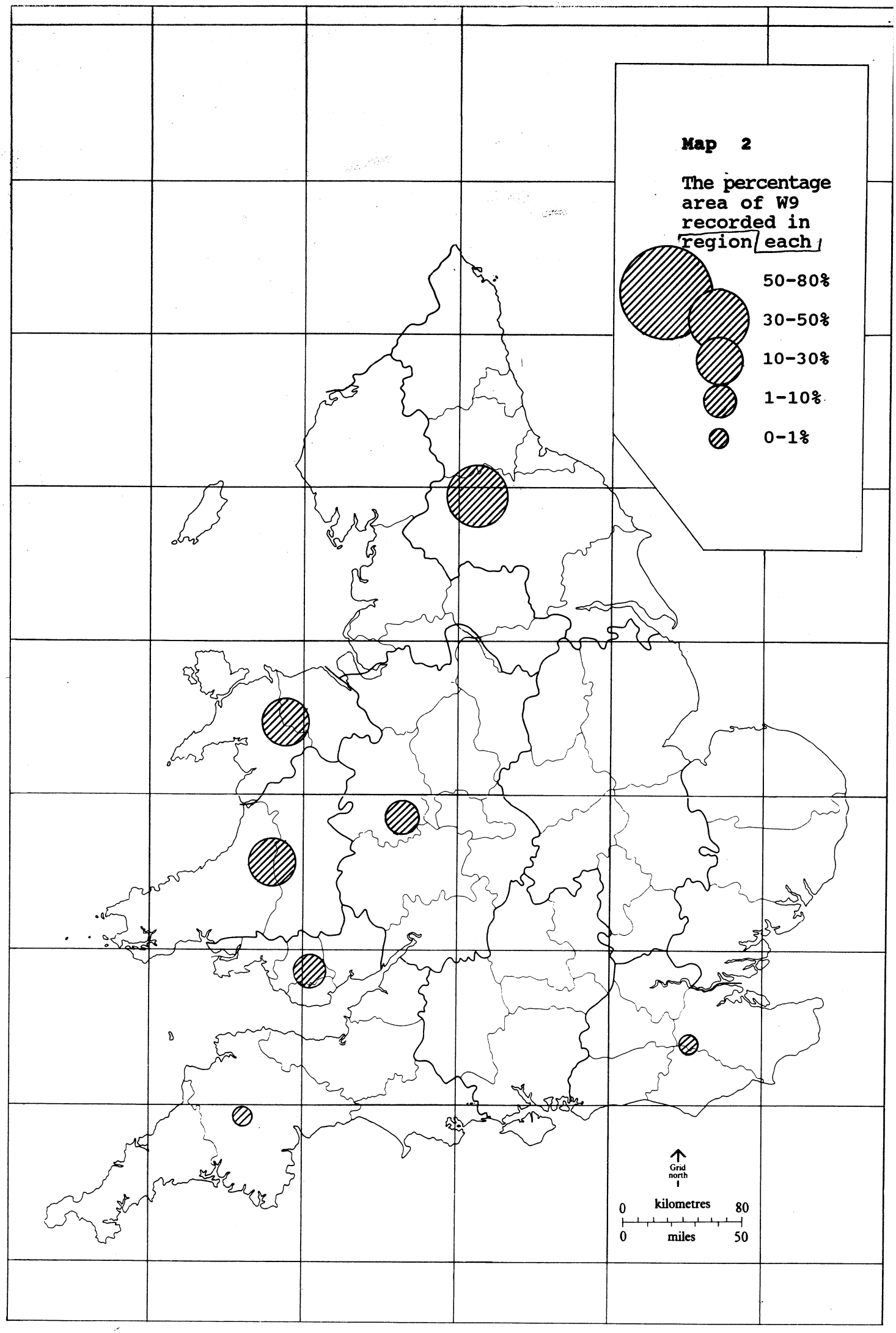
The scarcest sub-community is W8g, the Teucrium scorodonia sub-community, a community of thin rendzina soils, often over limestone. This community was only recorded by Rodwell (1991) from the Derbyshire Dales, and a solitary record from the Wye Valley. During this survey it was recorded occasionally from Dyfed-Powys and South Wales, with rare records from Derbyshire, North East and South East England. The majority of the records come from areas of limestone, usually Carboniferous Limestone and appear to be faithful to this substrate. For example, records of W8g occur all around the dome of the South Wales coalfield where Carboniferous Limestone outcrops. The single record of this sub-community from the south-east is from West Sussex on the scarp slope of the Southern Downs, where it occurs with calcareous beech and yew woodland.

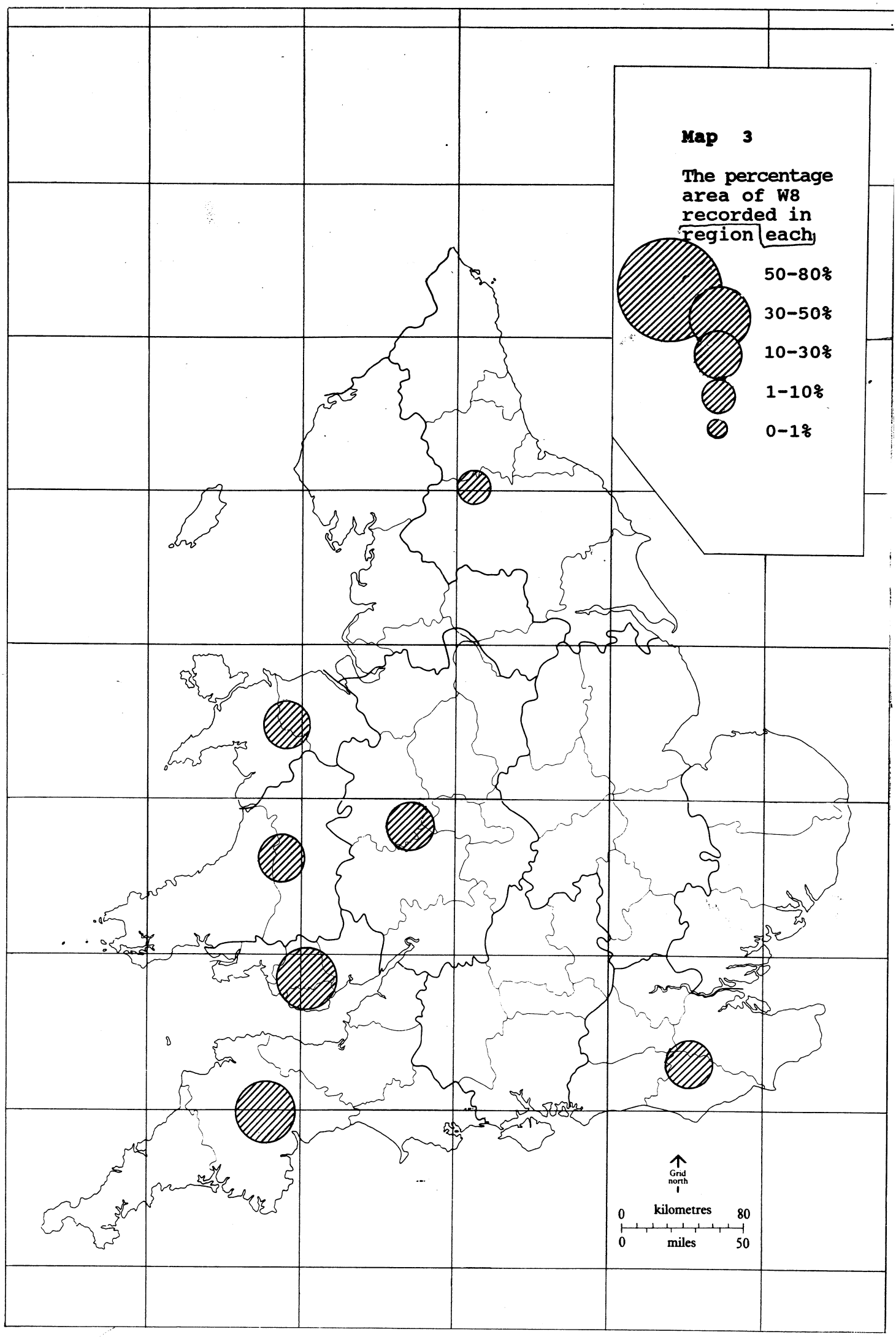
The W8b sub-community is probably under recorded. This type is characterised by dense carpets of vernal species, especially Anemone nemorosa and Ranunculus ficaria and surveys in late summer and autumn will fail to pick up these species (Kirby et al 1986). In these cases the community may well be classified as W8a, which tends to act as a default sub-community in the key to W8 sub-communities.

Mixed oak woodland

Woodland on mesotrophic soils with a mixture of tree species present in the canopy, but usually dominated by oak is either W10 or W11. The distribution of these two communities is given in Maps 4 and 5 and their relative frequency in each survey area in Figure 6. In general W11 is the community of the north and west, with W10 occurring in the south and east. However, this pattern of distribution is affected by the occurrence of W10e, an Oceanic sub-community which overlaps with, and is transitional to W11.

The results from this survey programme reflect this pattern with W11 not recorded in South East England, and only sparingly present in South West England (one record from each of Devon and Cornwall, the largest stand coming from a site on Dartmoor, where this type of woodland is not out of place in the Oceanic climate of that area). The community was also scarce in North East England, West Midlands and, surprisingly, North Wales. However, North Wales region includes Clwyd, which has a more Continental climate, thereby explaining the scarcity of W11 in Clwyd where it was recorded only three times. In contrast it was recorded 11


Map 2
The percentage area of W9 recorded in region each
50-80%
30-50%
10-30%
1-10%
0-1%
Grid north
0 kilometres 80
0 miles 50


Map 3
The percentage area of W8 recorded in region each
50-80%
30-50%
10-30%
1-10%
0-1%
Grid north
0
kilometres
80
0
miles
50

times from Gwynedd. (W10 was recorded 13 times from Gwynedd and 12 times from Clwyd.)

NVC W10 Quercus robur - Pteridium aquilinum - Rubus fruticosus woodland.

This is one of the major types of woodland community in lowland Britain. The dominant tree is usually pedunculate oak Quercus robur, although Q. petraea can attain prominence in the Acer pseudoplatanus - Oxalis acetosella sub-community, W10e, and to a lesser extent in the Typical sub-community, W10a. Both Tilia cordata and Carpinus betulus may be locally dominant (as in W8), but unlike W8 Castanea sativa may be abundant in some stands. This last is a species with a sub-Mediterranean distribution in Europe which does very well as an introduction in south-east England where it has been extensively planted (Rackham 1980). Betula, almost always B. pendula is occasional but may be prominent in disturbed stands or recent woodland. In the damper climate of the north and west ash, sycamore and wych elm Ulmus glabra may be frequent, especially in W10e. The shrub layer is invariably dominated by hazel, with scattered Crataegus monogyna. Other species are infrequent. The community is quite complex with five sub-communities recognised, although compared with W8 the field layer is less varied. The effects of management may mask floristic differences resulting from climatic and edaphic variation (Pigott 1990; Rodwell 1991). There are only three constants in the field layer (each occurring in 61% or more of stands, but not necessarily all present in the same stand), these are Lonicera periclymenum, Pteridium aquilinum and Rubus fruticosus agg. and are abundant throughout all sub-communities, except NVC W10e where they are less common (but still frequent).

As it is a more Oceanic sub-community W10e tends to be commoner in the north and west. In contrast W10b, the Anemone nemorosa sub-community, often with Castanea sativa present as coppice, is most frequently found in South East England on the heavy clays of the Weald, and in Kent. The Hedera helix sub-community W10c, is commonest in areas where H. helix is more luxuriant such as for example in the south-west of Britain where harsh winter temperatures, to which it is sensitive (Godwin 1975), are infrequent. Ivy can also attain prominence in recent woodland (Rackham 1980; Peterken 1981) and is reported to increase in stands of neglected coppice in the south-west. The Holcus lanatus sub-community, W10d is a very uniform sub-community, of a grassy appearance. It is most common in secondary woods which have developed on grassland (cf W16a, secondary woodland developing on heathland). This sub-community also includes many softwood plantations which have become floristically impoverished (Mitchell & Kirby 1989). The final sub-community W10a, the Typical sub-community, is rather undistinguished and is almost a default type.

The community was recorded abundantly from all survey areas, and the distributions of the sub-communities (see Figure 7) closely match the described distributions (Rodwell 1991) outlined above. The most abundant sub-community in Wales, the West Midlands and

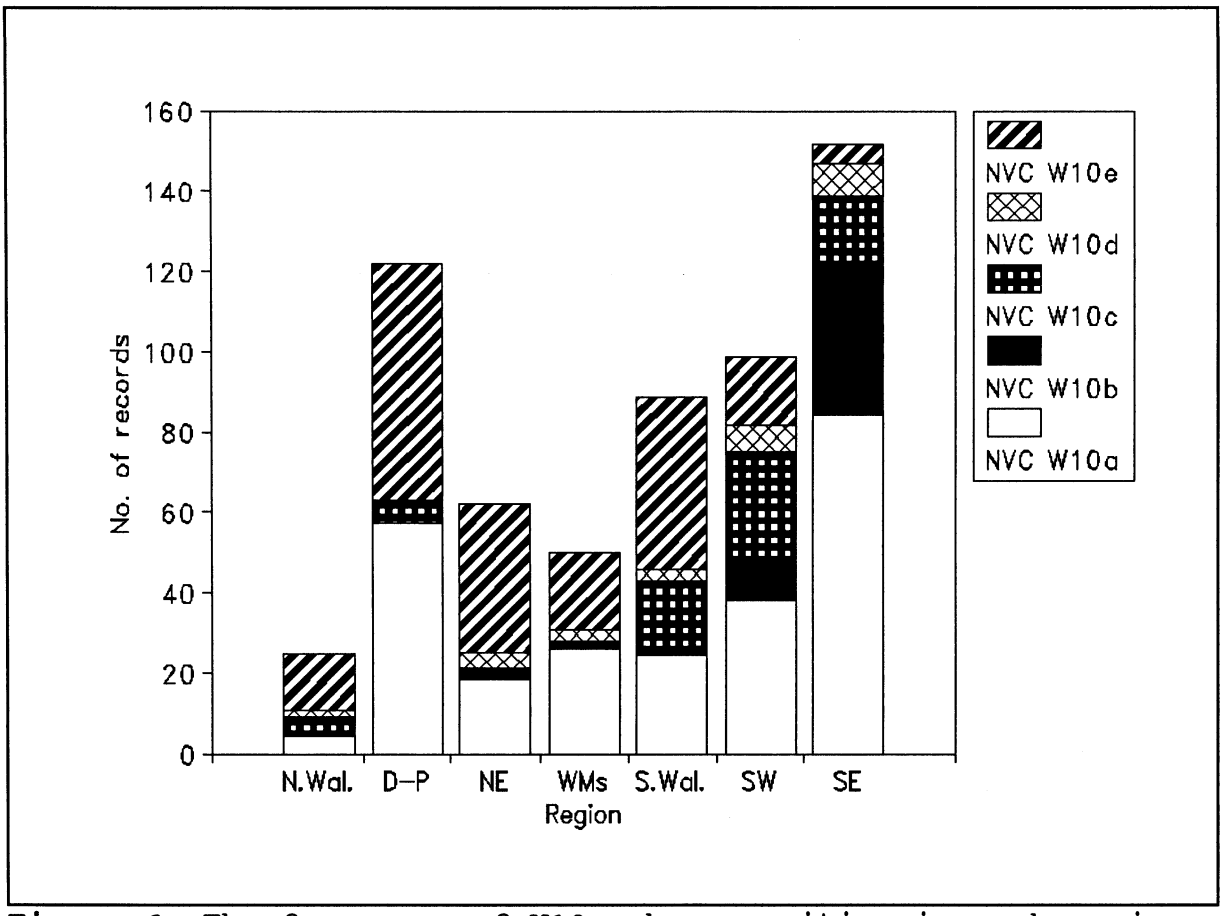
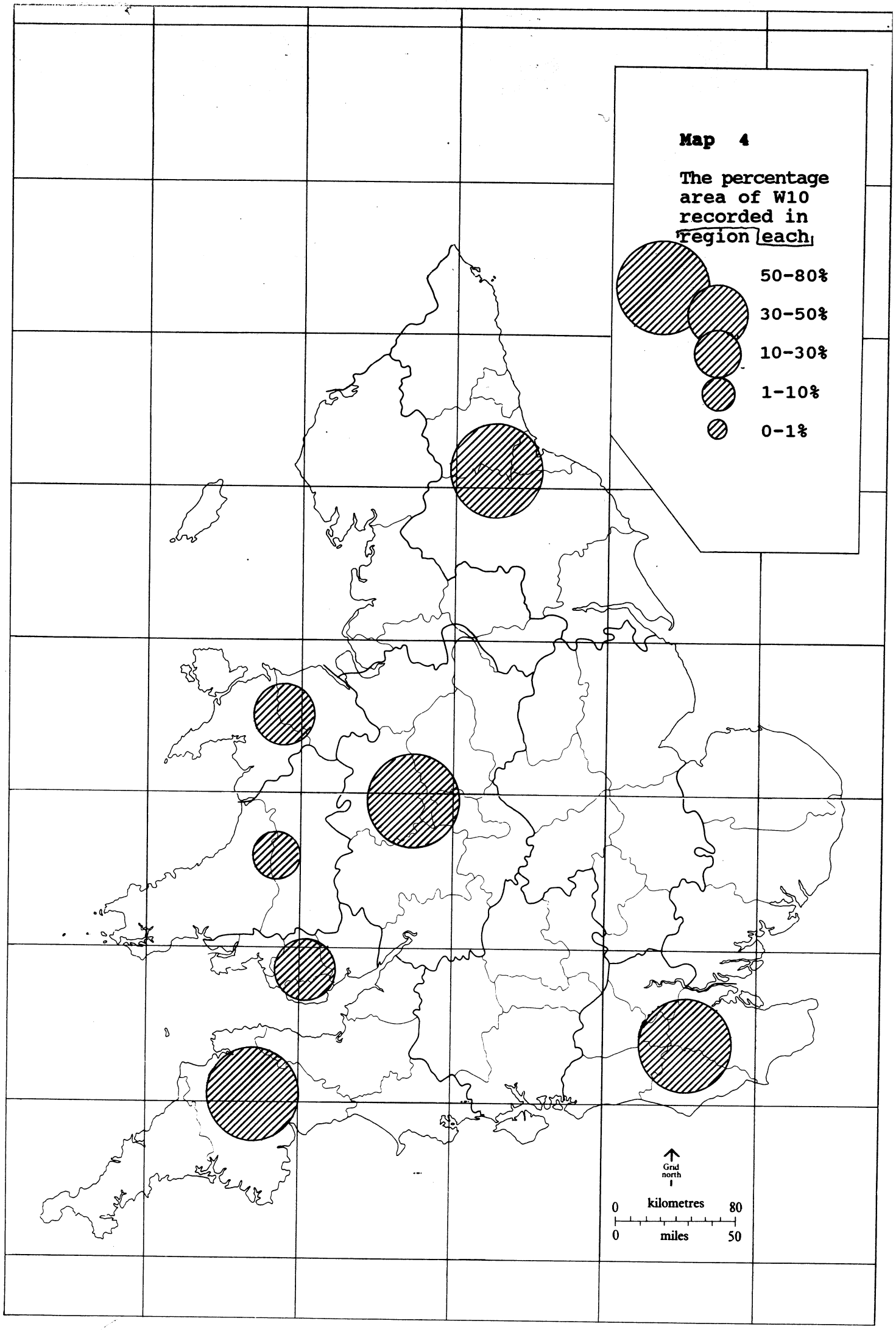


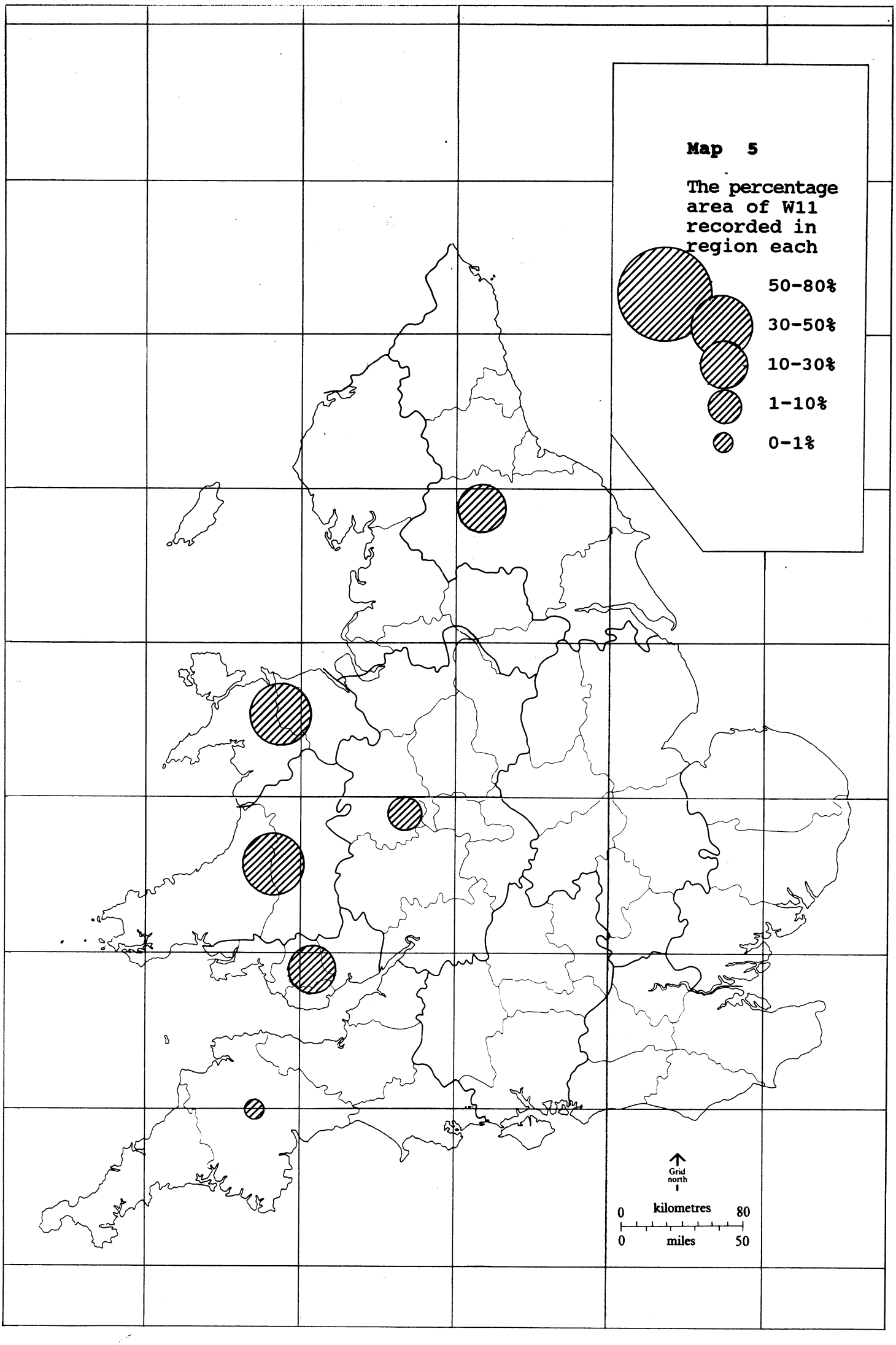
Figure 6 The frequency of W10 sub-communities in each region

North East England is W10e, occurring where the climate is more Oceanic. This sub-community is rare in South East England. No obvious pattern is apparent in the distribution of W10a, which is most frequent in South East England and Dyfed-Powys, but rare in North Wales. Similarly W10c shows no trends; it is rare throughout all the survey areas, partly due to its preference for secondary stands, which were not surveyed. A similar situation exists with W10d. However, W10b is rare in all areas except South East England, again mirroring the described distribution.

NVC W11 Quercus petraea - Betula pubescens - Oxalis acetosella woodland.

This community, usually on moderately base poor brown earths, is commonly heavily influenced by grazing, both by deer and sheep, as it often occurs on unenclosed hillside woods. Quercus petraea and Betula pubescens are the commonest tree species (cf W10), although both Q. robur and B. pendula can be locally frequent in the north-east. Other tree species are rare. The often poorly developed shrub layer is usually dominated by hazel. Rowan can be occasional, although grazing is a limiting factor. Grasses are a significant and characteristic feature of the community, their prevalence also due to herbivorous grazing (Mitchell & Kirby 1990). Herbs are more varied than in W10 with species characteristic of moist soils eg Oxalis acetosella and Viola


Map 4
The percentage area of W10 recorded in region each
50-80%
30-50%
10-30%
1-10%
0-1%
Grid north
0 kilometres 80
0 miles 50


Map 5
The percentage area of W11 recorded in region each
50-80%
30-50%
10-30%
1-10%
0-1%
Grid north
0
kilometres
80
0
miles
50

riviniana occurring with those preferring a degree of surface leaching such as Galium saxatile and Potentilla erecta (Rodwell 1991). In ungrazed stands Lonicera periclymenum, Pteridium aquilinum and Rubus fruticosus may attain prominence in the summer months. Ferns are conspicuous, especially in ungrazed stands and mosses are notably more abundant here than in W10, but leafy liverworts remain scarce.

Four sub-communities are recognized which can be split into two groups, W11a, the Dryopteris dilatata sub-community, and W11b, the Blechnum spicant sub-community which both have an Oceanic distribution, and W11c, the Anemone nemorosa sub-community and W11d, the Stellaria holostea - Hypericum pulchrum sub-community which have a more Northern Continental distribution.

The results from this survey show the dominance of W11a amongst the sub-communities; it was the most common sub-community in all regions, most notably in Dyfed-Powys and South Wales where 128 records were for W11a out of a total of 132 W11 records. This is probably due to a combination of poor, leached soils resulting in a general impoverishment of the flora and the high intensity of sheep grazing in most of these sites, causing a gradual shift to the more grazing tolerant grasses. In North Wales and North East England W11b was almost as frequent as W11a. This is probably explained by the wetter and colder climates of these areas. Records for W11d are infrequent; this sub-community was usually recorded from the edge of woods were they grade into pasture, or under very open canopies. These were not very good examples. A solitary stand of W11c was recorded from Gwynedd in North Wales. This is recognised as being well outside its normal range; the stronghold of this community is in the north-east of Scotland where the climate is wet but the winter temperatures low.

Oak birch communities

Two woodland types have been recognised from base poor or heavily leached soils, dominated by oak and birch, and with strongly calcifugous plant communities. As with the mesotrophic and calcicolous pairs of woodland communities, these show strong regional distribution patterns, largely dictated by climate (see Maps 6 and 7 and Figure 8).

NVC W16 Quercus spp. - Betula spp. - Deschampsia flexuosa Woodland.

Two sub-communities are recognised. W16a (the Quercus robur sub-community) is more often dominated by Q. robur and Betula pendula. It occurs mainly in the lowlands, often, but not exclusively, as secondary woodland on former heathland. The field and shrub layers tend to be species poor, and bryophytes rare. By contrast W16b (the Vaccinium myrtillus - Dryopteris dilatata sub-community) is characterised by a predominance of Quercus petraea, with any birch present more likely to be B. pubescens. This sub-community is more common in the upland fringes of Britain where the higher rainfall and humidity give rise to a

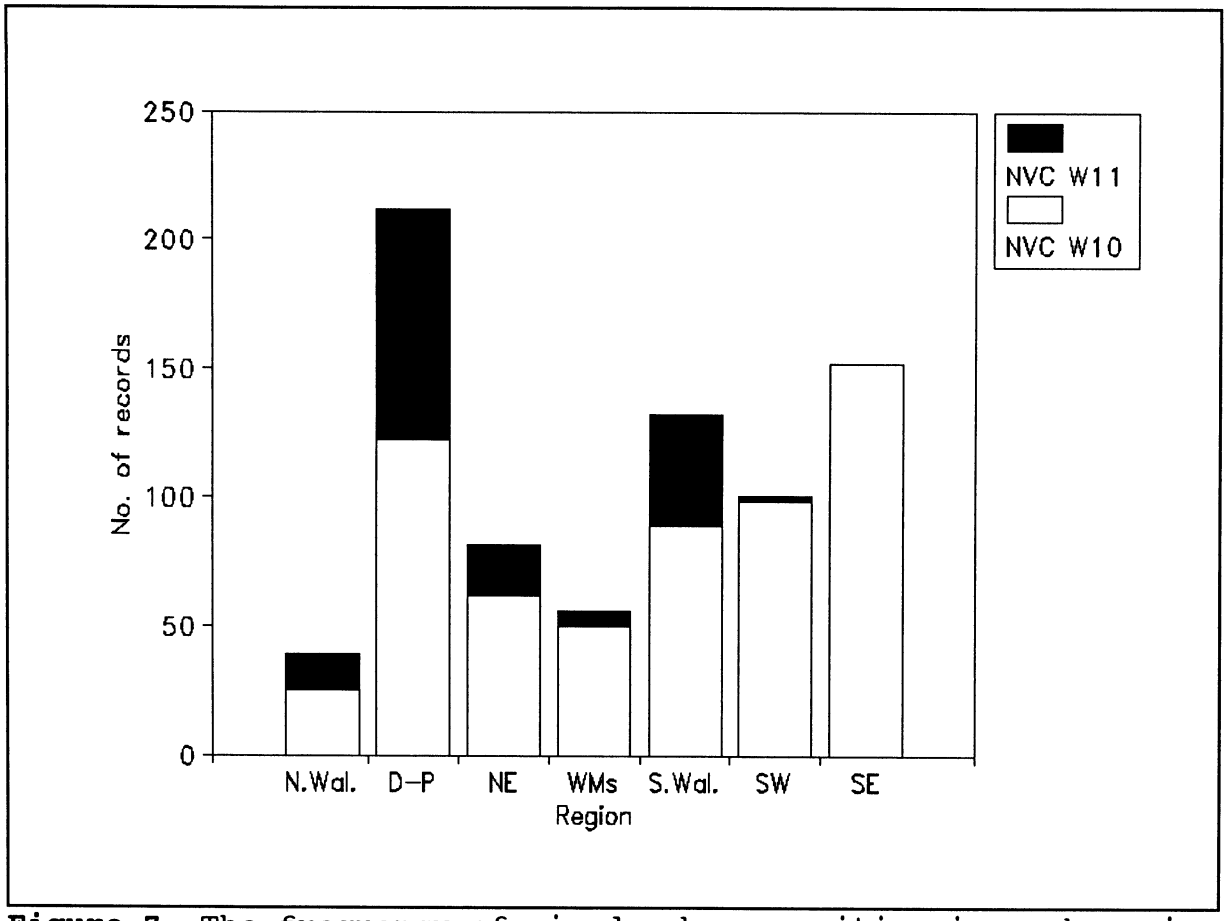


Figure 7 The frequency of mixed oak communities in each region

more varied bryophyte flora. Towards the west this sub-community becomes transitional with the bryophyte rich community, W17.

In all regions except South East England W16b was the most frequently recorded sub-community. All other survey areas could be considered as part of the 'upland fringe', thus W16b is the commoner of the two sub-communities in these areas (this also explains the scarcity of W16b in South East England - an entirely lowland area), and the sites selected were mainly ancient woods, so that secondary W16a stands are likely to have been missed. In South East England W16b was recorded from two woods in stands where Quercus petraea was present - itself unusual in this area - and came from the same general area, the Greensand Ridge, as the W9a record (see above), thus further demonstrating the distinctness of some woods in this area of South East England.

This community (W16) was frequently recorded from Wales during these surveys. However the community distribution map given in Rodwell (1991) does not indicate the presence of W16 in Wales. In mid Wales in particular the W16b stands recorded were more bryophyte rich than described in Rodwell (1991). However their bryophyte communities were not rich enough to warrant classification as W17, and several other species typical of W11 or W17 were absent, notably the grasses such as Anthoxanthum odoratum and Agrostis capillaris. These stands were exhibiting

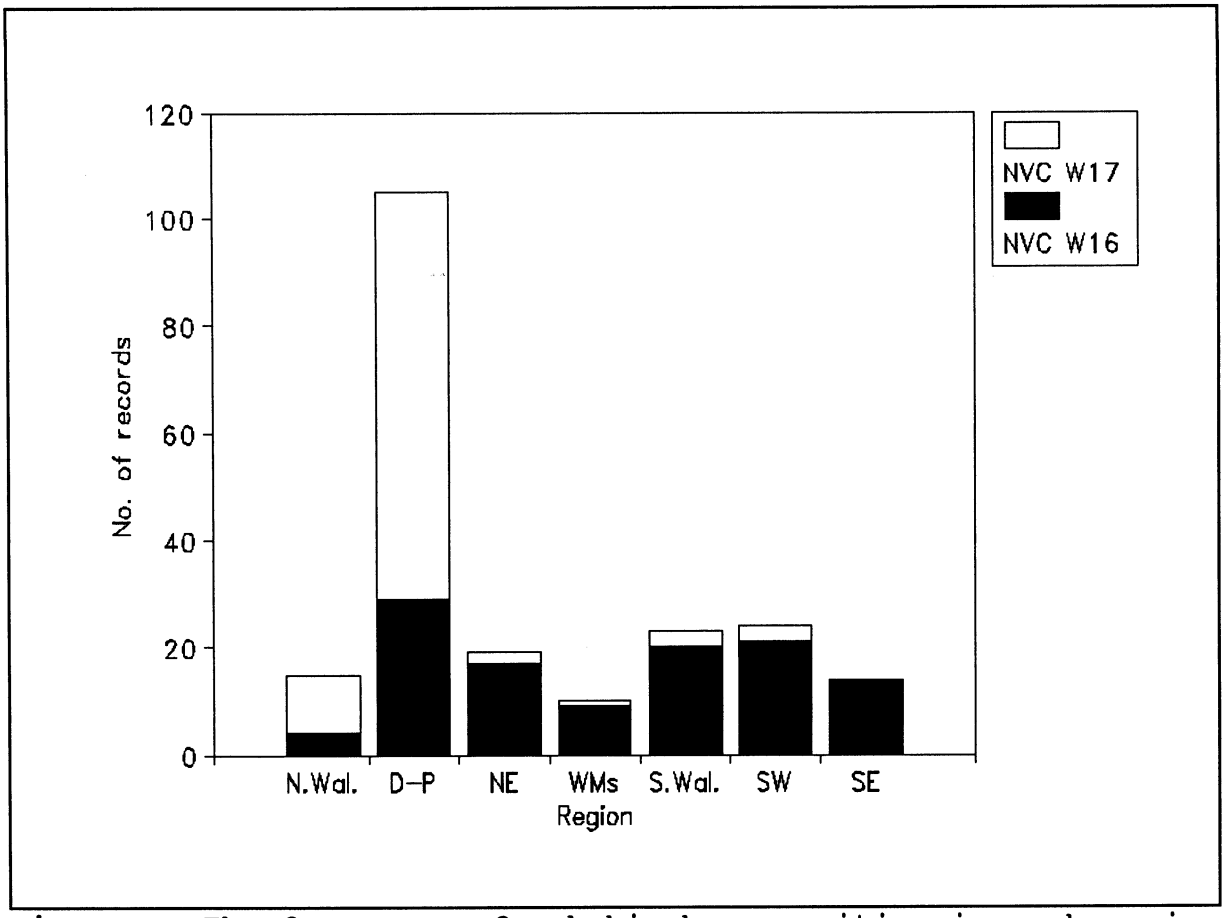


Figure 8 The frequency of oak-birch communities in each region

the transition to W17 reported in Rodwell (1991).

NVC W17 Quercus petraea - Betula pubescens - Dicranum majus Woodland.

This community is characteristic of the north and west of Britain where the climate is strongly Oceanic. Four sub-communities are recognized but only three were recorded. The fourth - W17d, Rhytidiadelphus triquetrus sub-community - is almost a sub-boreal community centred around the Scottish Highlands. All sub-communities are typified by the luxuriance of their bryophyte carpets, but this feature really attains prominence in W17a, the Isothecium myosuroides - Diplophyllum albicans sub-community. The Anthoxanthum odoratum - Agrostis capillaris sub-community, W17c, is the poorest in terms of its bryophyte community but here they still form a prominent feature with at least six of the common large woodland bryophytes present. The distinctive feature of this sub-community is, in association with the bryophytes, the field layer. This is dominated by acidophilous grasses, usually encouraged by the grazing of large herbivores on base poor soils. Where grazing is reduced or excluded then the proportion of ericoid sub shrubs (Calluna vulgaris, Vaccinium myrtillus) increases and the sub-community may become W17b, the Typical sub-community.

This bryophyte dominated community was the most common acidic oak-birch community recorded in the North Wales and Dyfed-Powys survey areas. Of the survey areas these two have the most Oceanic climate, and North Wales in particular is renowned for its sessile oak woods containing rich assemblages of Atlantic bryophytes (Ratcliffe 1968, 1977). The community was not recorded from South East England and was only recorded sparingly from the other survey areas. However the most demanding of the sub-communities, W17a, was not recorded outside North Wales and Dyfed-Powys. In the West Midlands the single record of W17c was from Derbyshire and considered to be a poor example; in the South West of England W17b was recorded from two sites, one on Bodmin Moor and the other from a high altitude oak wood on Dartmoor; in North East England the two records of W17b come from west facing slopes high in the Hambleton Hills, and in the South Wales survey area the four records of W17c all come from Brecknock.

The W17a sub-community frequently occurs as a mosaic with mixtures of W17b; it is often present on rocky ledges, boulders and around tree bases whilst the W17b occurs on the slightly deeper soils. If the site is grazed then W17b may be confined to less accessible areas.

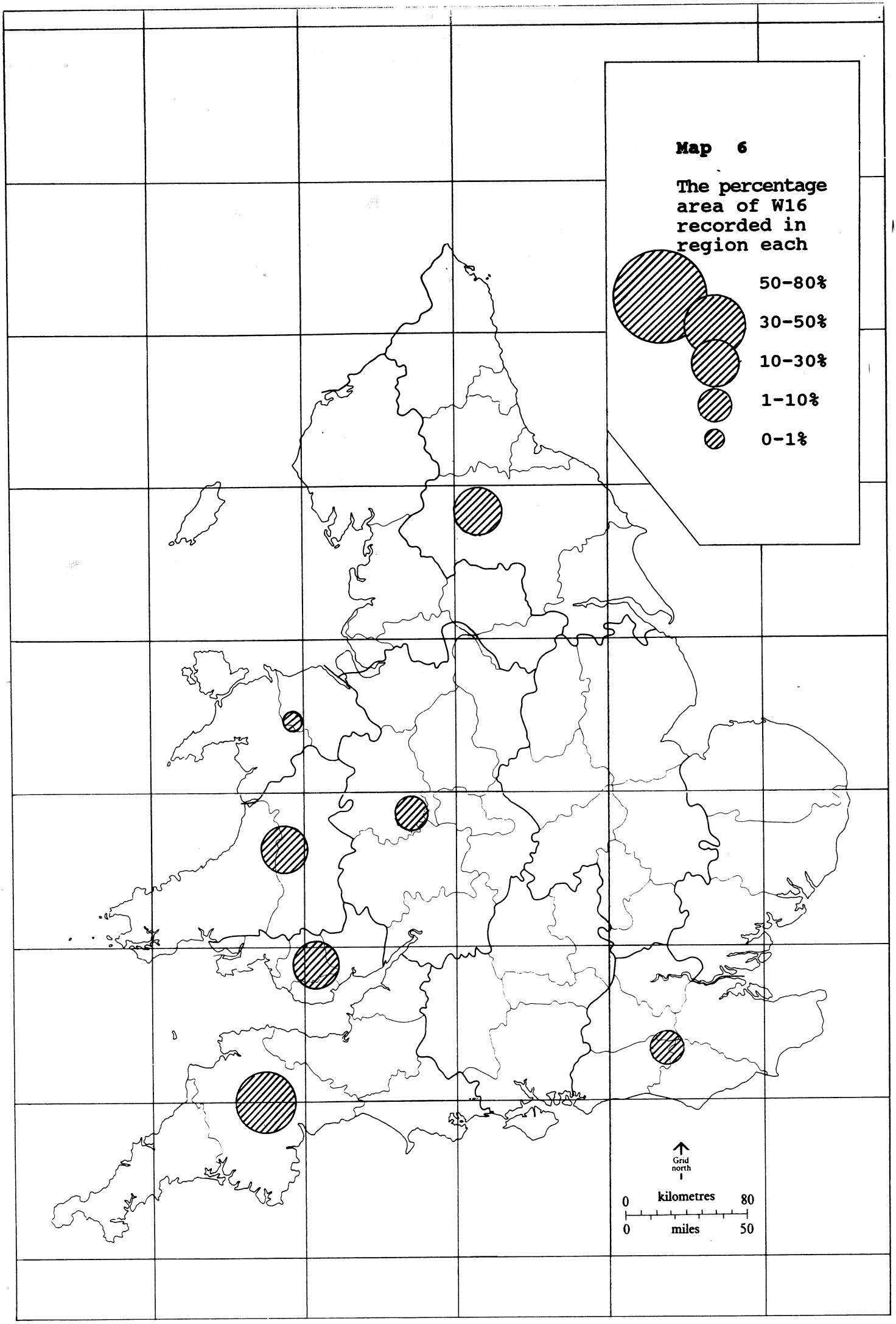
Beech dominated communities.

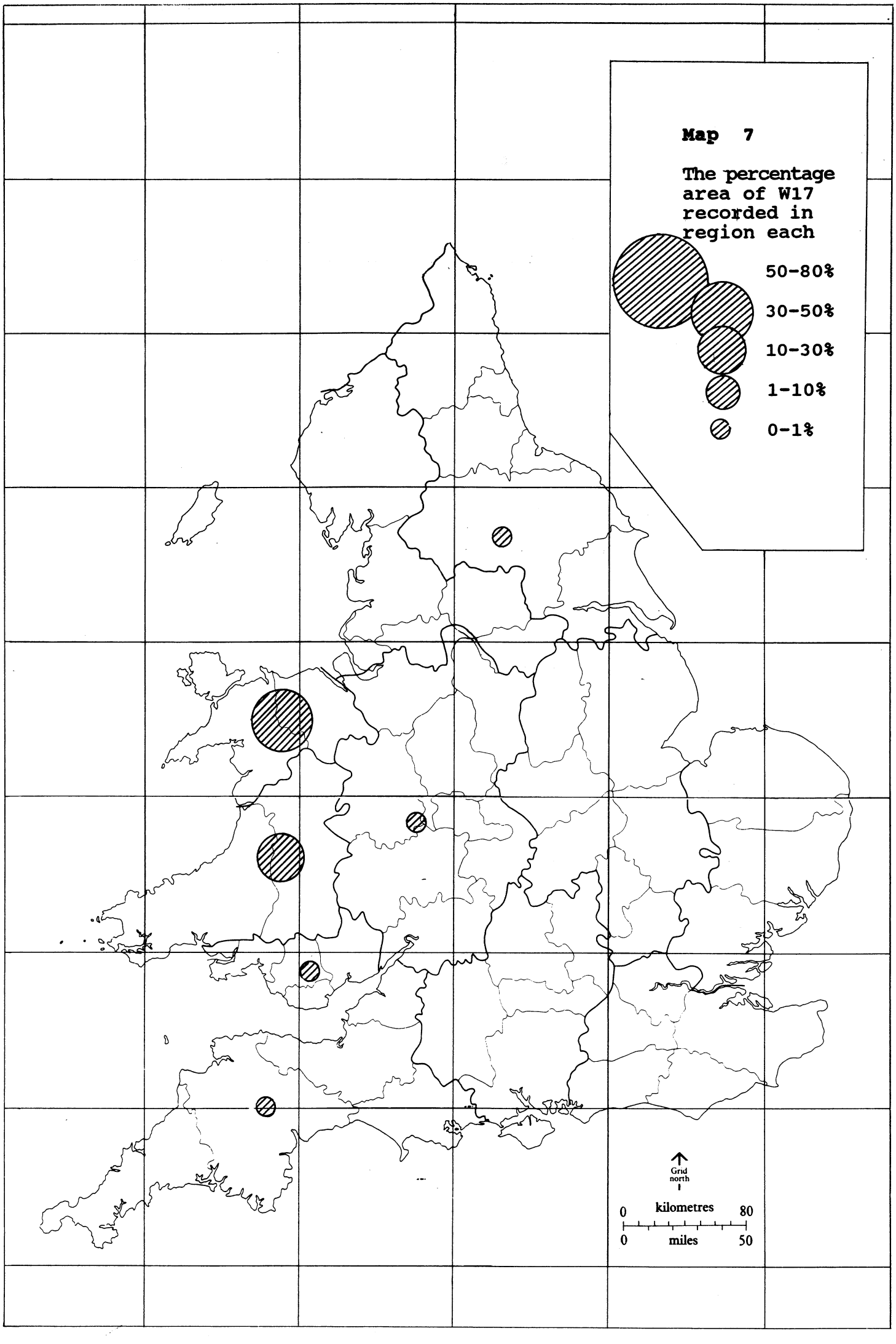
Beech is remarkably catholic in its preference for soil types (Evans 1984) and may be present on most soils except excessively damp ones. Woodland communities characterised by a pre-eminence of beech are represented by three NVC communities; W12 on base rich soils, usually chalk; W14 on mesotrophic soils, and W15 on base poor sites.

NVC W12 Fagus sylvatica - Mercurialis perennis woodland.

This community is split into three sub-communities, based largely on differences in available soil moisture, slope and soil depth (Rodwell 1991). Beech woodland has a poorly developed shrub and field layer, due mainly to the effects of canopy shade (Rackham 1980), but it is also negatively influenced by persistent beech litter (Sydes & Grime 1981a). In W12 both the shrub and field layers are qualitatively very similar to the analogous ash-elm community of base rich soils, W8, but the abundance of these shrub and field layer species is very much reduced.

Most of the records from this survey were for the Mercurialis perennis sub-community, W12a. This is the sub-community most likely to be encountered in non-native stands of beech as it is the least specialised, and is the closest to W8, which is presumably what these stands would be had beech not been introduced. The Sanicula europaea sub-community, W12b, was only recorded twice, both times from the West Midlands; one was a small stand resulting from amenity planting around an old quarry and the other a much larger native stand from Gloustershire over Jurassic limestones with a long history of high forest management. In places this sub-community is intermediate with W8a in this wood. The only records for W12c, the Taxus baccata sub-


Map 6
The percentage area of W16 recorded in region each
50-80%
30-50%
10-30%
1-10%
0-1%
Grid north
0
kilometres
80
0
miles
50


Map 7
The percentage area of W17 recorded in region each
50-80%
30-50%
10-30%
1-10%
0-1%
Grid north
0
kilometres
80
0
miles
50

community come from South East England. Here this sub-community represented 30% of all the beech stands classified. The records were all from sites on either the North or South Downs on thin soils. In some respects this is the most specialised of the sub-communities with southern shrubs such as Taxus, Buxus sempervirens and Sorbus aria present. This sub-community may grade into yew woodland, W13.

NVC W14 Fagus sylvatica - Rubus fruticosus agg. woodland.

This community was the most abundant beech community, recorded from all survey areas. Again the shrub and especially the field layers are qualitatively similar to the mesotrophic mixed deciduous woodland community, W10, but are again much reduced by shade cast by the beech canopy. The community was most abundant from South East England, where beech is native throughout. No sub-communities are recognised.

NVC W15 Fagus sylvatica - Deschampsia flexuosa woodland.

It is in this community that the beech canopy is generally the densest, and combined with the inherent floristic impoverishment of acidic soils, results in an extremely sparse and species poor field and shrub layer, and other tree species are usually confined to canopy gaps. Under the shade the bryophyte community is often distinctive, with typical calcifuges such as Dicranum scoparium, Leucobryum glaucum, and Polytrichum formosum present. Four sub-communities are present, differences between which are mainly related to the local light climate (Rodwell 1991).

This community was recorded from all survey areas except North East England (where it exists as plantations - but these were not sampled), but was most abundant in South Wales, South East and South West England. In South Wales this community was recorded from the base poor Pennant sandstones of the coal field. Here the woods were very dense and, unusually for beech, many had been managed as coppice, where it was used for charcoal production, needed for iron smelting (Marren 1992). In the South West of England the community was recorded from base poor brown earths and podzols with free to excessive drainage on older Devonian rocks. All records here were from non-native stands. The records from South East England are from areas of sandstone on the Weald. Most records from all areas were of the Fagus sylvatica sub-community, W15a, where the field layer is virtually absent due to shade.

Although beech communities were recorded from all survey areas beech itself is not native in many areas including the entire North-East England, North Wales and Dyfed-Powys survey areas. Its recorded presence in these areas is due to the recognition of NVC communities in beech plantations, where long established beech plantations develop the characteristic species poor communities of beech communities. Nevertheless, beech communities were recorded most frequently in South East England - the only area surveyed in which beech is native throughout.

The point at which an oak dominated stand with beech (eg W10 or W11) becomes a beech dominated stand with oak (eg W14 or W15) is not easy to define. In many cases the distribution of beech and oak in mixed woods in the south-east is complex and dependant on factors not yet fully understood (Rackham 1980). However, as a guide the other constituents of the community should be considered, ie the shrub, field and ground layers as these may be give better indication of the community than the canopy layer in difficult stands.

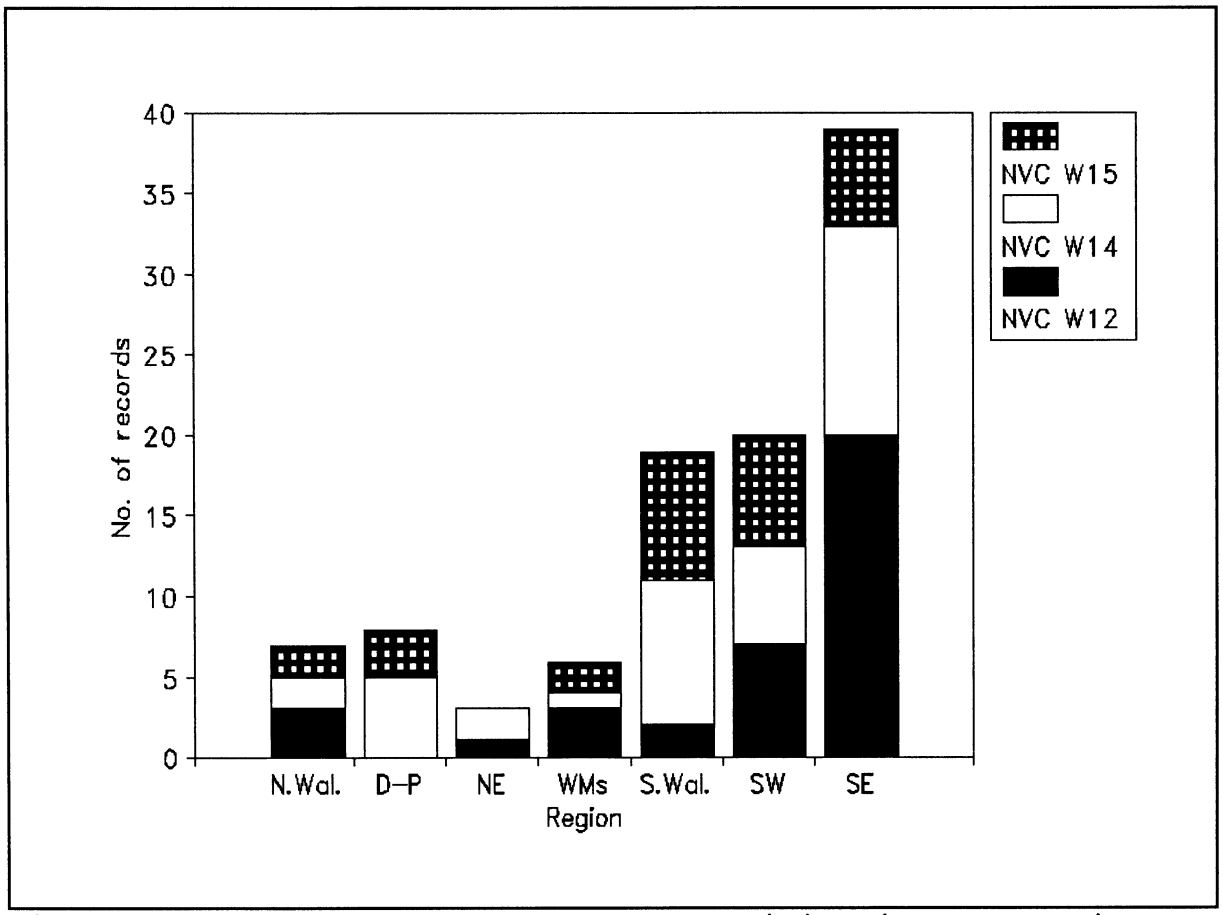


Figure 9 The frequency of beech communities in each region

Yew woodland, NVC W13 Taxus baccata woodland.

This community is dominated by yew with few other trees present. Due to the deep shade cast by the yew (Rodwell 1991), exacerbated by the often low canopy height, the community is notably species poor, with even the bryophytes poorly represented. Two sub-communities are recognised; W13a, the Sorbus aria sub-community where the field layer is virtually absent and W13b, the Mercurialis perennis sub-community with a slightly more open canopy allowing some development of field and ground layers. The latter sub-community was only recorded from South East and South West England, although in the South West it was a planted stand.

According to Rodwell (1991) this community is confined to the

Chalk of southern England, and yew dominated stands occurring elsewhere, for example on Carboniferous Limestone in Lancashire, are "best considered as variants of the north western types of W8". However the yew at Castle Eden Dene on Magnesian Limestone is included as W13 by Rodwell. Where yew dominated stands were encountered during this survey project they were classified according to their vegetation, irrespective of geology. Consequently W13 was recorded from North East England (yew stands on Carboniferous Limestone in the Yorkshire Dales), South Wales (Carboniferous Limestone in Gwent) and South West England (Carboniferous Limestone in Avon and Dorset), as well as from its more typical habitats on Chalk in South East England. Most of these records from Carboniferous Limestone were, however, very small stands (all below 2 ha except for one site in the Yorkshire Dales which was about 6 ha in extent), and the community remains very scarce.

Wet Woodland Communities.

Within this rather broad heading are seven NVC communities. With the exception of W7 they were all infrequently recorded, largely because W1 to W6 are more frequent in recent woodland, and these have been under sampled (see Site selection). However, woodland on fertile flood plains and along flat river valleys is also genuinely scarce due to the high agricultural value of such land.

The three Salix dominated communities; NVC W1 Salix cinerea - Galium palustre woodland, NVC W2 Salix cinerea - Betula pubescens - Phragmites australis woodland, and NVC W3 Salix pentandra - Carex rostrata woodland are usually recent woodland communities which have developed on a variety of formerly wet habitats. Rodwell (1991) gives the typical habitats of W1 as roadside ditches, dune slacks and the laggs of raised mires, W2 as either primary or secondary woodland developing on topogenous fen peats, and W3 as occurring in similar situations to W1, but as the northern counterpart of that community.

All of these communities were only rarely encountered so that little can be inferred from their sporadic occurrence in the results.

NVC W4 Betula pubescens - Molinia caerulea woodland.

This community is found on moist acidic peaty soils throughout Britain, and was frequently recorded from the Dyfed-Powys and South Wales survey areas. The canopy is dominated by Betula pubescens, sometimes with scattered Alnus glutinosa. The shrub layer is often indistinct, merging with the low canopy, with Salix cinerea the most common constituent. The most obvious feature of the ground flora is the dominance of Molinia caerulea, usually over a ground layer dominated by Sphagnum spp.

In Dyfed-Powys all records are for the Juncus effusus sub-community, W4b. This sub-community contains a greater proportion of grasses and sheep grazing may cause the increase in grazing tolerant grasses at the expense of other herbs. All sub-

communities were recorded from South Wales.

NVC W5 Alnus glutinosa - Carex paniculata woodland.

This community was most common in South Wales, being more frequently recorded here than all the other survey areas combined. In South Wales it occurs as small stands at the bottom of wooded slopes or valleys. Records come mostly from around the edge of the coalfield. The community is found on waterlogged organic soils which are base rich and moderately eutrophic, so it is unlikely to be found on non-calcareous strata. Alnus glutinosa is the most abundant canopy species, again with Salix cinerea in the shrub layer. Fraxinus excelsior may occur in drier areas, together with a range of other calcicole shrubs. The field layer is dominated by large sedge species such as Carex paniculata and C. acutiformis. Other species associated with fens are often present, including Eupatorium cannabinum, Iris pseudacorus, Phragmites australis and Valeriana spp. Ferns are usually conspicuous and mosses are common around sedge tussocks, but Sphagnum spp. tend to be rare, except along base poor seepages.

NVC W6 Alnus glutinosa - Urtica dioica woodland.

Another infrequently recorded wet woodland community, scattered throughout all the survey areas. This is a community of eutrophic moist mineral soils. The tree layer is most commonly dominated by Alnus, but Salices may be prominent. The field layer is dominated by Urtica dioica, and typical tall herb fen species are absent. This community is a acknowledged to be rather ill-defined. Five sub-communities are currently recognised, but Rodwell (1991) suspects that further sampling may warrant extra divisions. The community may be primary or secondary in origin, but is almost always recent woodland.

NVC W7 Alnus glutinosa - Fraxinus excelsior - Lysimachia nemorum woodland.

This was the most abundantly recorded of the wet woodland types in all survey areas (see Figure 10 and Map 8). It is found on moist to wet base rich mineral soils rather than on acidic peats. Alder is the usual canopy dominant, often with Fraxinus excelsior, Salix capraea, S. cinerea and, on drier soils, Acer pseudoplatanus. Again on drier soils Corylus avellana and Crataegus monogyna can form a distinct shrub layer, showing the strong affinities drier stands of this community have with W8 and W9. The field layer is generally composed of species preferring nutrient rich wet conditions such as Athyrium filix-femina, Lysimachia nemorum, and Ranunculus repens. On drier soils Mercurialis perennis and other calcicoles may occur. The ground layer is variable, and only Eurhynchium praelongum and Plagiomnium undulatum are frequent. Three sub-communities are present, and differences between them are largely related to variations in the extent of waterlogging and the nature of the water supply.

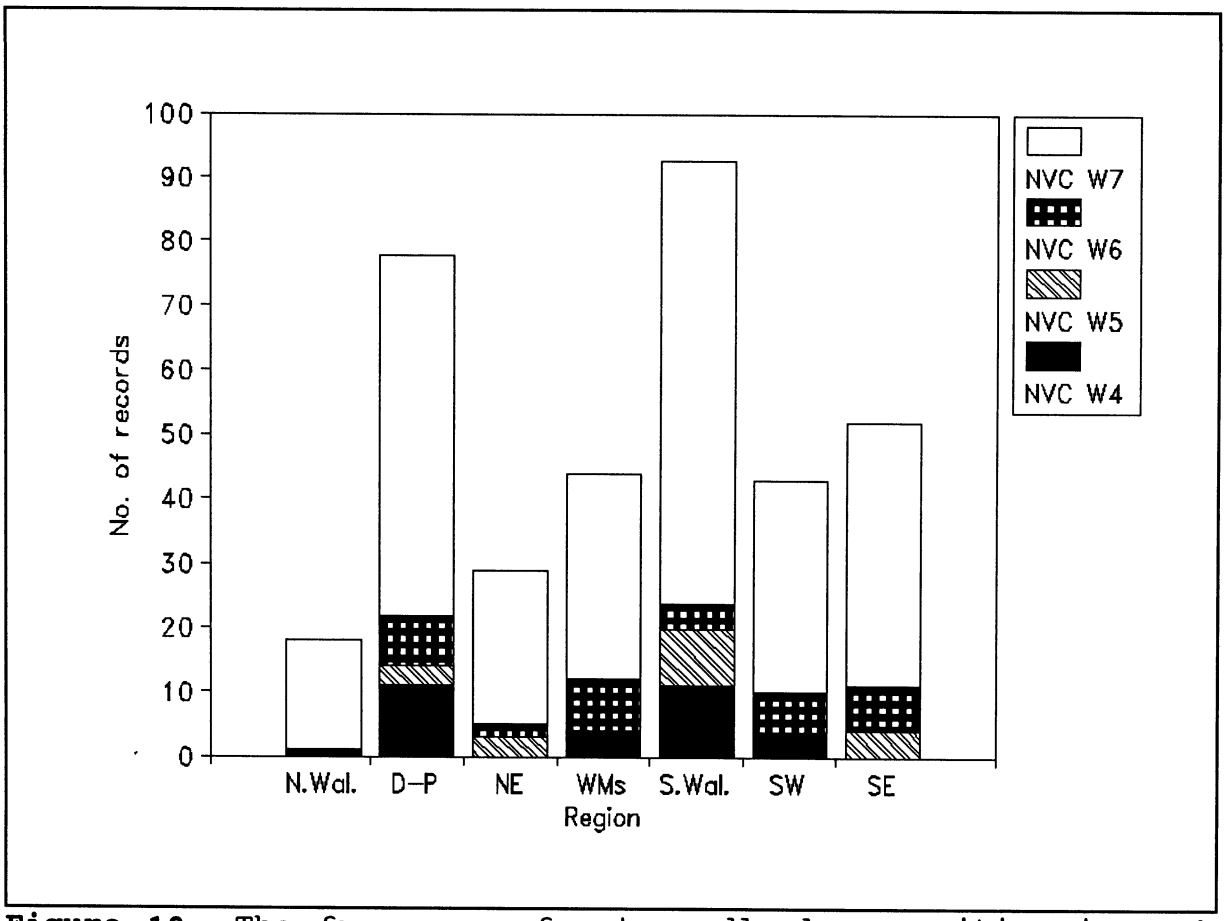
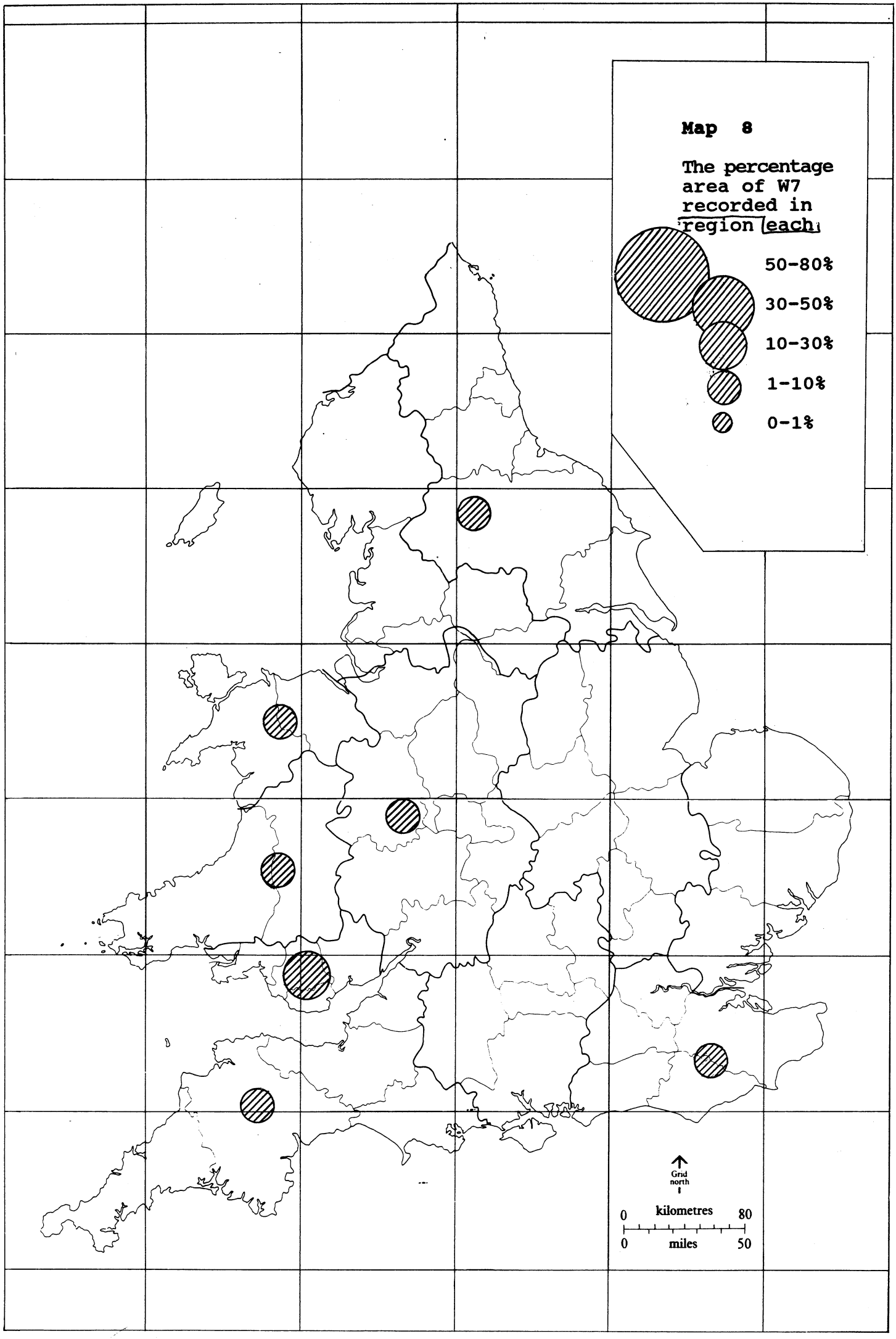


Figure 10 The frequency of wet woodland communities in each region

This community was found in two main situations, either along water courses in valley woodlands, or as alder dominated stands on level ground (plateau alder woods). The former were more frequent, occurring in many upland sites. Plateau alder woods are considered to be a scarce woodland type (Peterken 1981) because of the high agricultural value of the land, and those which survive often show signs of attempted drainage. Many such sites have been managed as coppice, alder having been a great favourite for clog soles (Linnard 1982).

Where the community occurs along valley bottoms it often represents the final stage of the continuum from acidic W17 or W16 at the top of the slope, through more mesotrophic W11 or W10 to flushed W9 or north western W8 types on receiving slopes and finally W7 at the foot of the slope, especially if there is some level ground. The boundary between any of these communities is often indistinct, and local conditions may result in a truncation of this series at either end, or indeed a mixing up of the order. Often in these situations W7 occurs in narrow linear patches, and as flat valley bottoms have usually been cultivated, most stands are now small (see page 41).


Map 8
The percentage area of W7 recorded in region each
50-80%
30-50%
10-30%
1-10%
0-1%
Grid north
0 kilometres 80
0 miles 50

Although more common in the north-west this community was frequently recorded from South East England (43 records), mostly from the Weald, where Rodwell (1991) also notes its presence. However, the records from South East England were generally very small areas and often poorly developed.

Discussion

Use of the NVC

This survey programme was the first comprehensive woodland survey project undertaken in England and Wales to exclusively use the NVC for classification purposes. The NVC has also been used in Scotland (Mackintosh 1988, 1990; Tidswell 1988, 1990).

This project was undertaken by surveyors who prior to the survey had limited experience of the NVC. Until 1988 pocket sized drafts of the woodland chapter had been unavailable, and the earlier bulky drafts were unsuitable for field use. (The woodland chapter of the NVC was published in 1991 (Rodwell 1991).) Before the surveys began the original surveyors received one week's intensive training in the field application of the woodland NVC chapter, whilst surveyors who joined the project later were largely trained on the job.

Early difficulties associated with the use of the NVC in normal phase 2 survey work, such as the recognition and appreciation of homogeneous stands, mapping and local variations to NVC communities are discussed in Cooke & Saunders (1989); references to local variations encountered in other survey areas can be found in the relevant survey reports (Barber & Cooke 1991; Cooke & Saunders 1990; Heath & Bevan 1991; Heath & Oakes 1991; Oakes & Whitbread 1990).

The overall ease with which the NVC was learnt and subsequently applied over large parts of England and Wales, using existing phase 2 survey methods (Kirby 1988a), suggests both the adaptability and robustness of the classification. Out of 2177 stands surveyed only 31 were not fully classified; these were mainly considered to be intermediate or mixed stands. However, no matter how experienced the surveyor or whatever the classification system used, some mis-classifications will inevitably occur (Kirby 1984a).

Genuine difficulties do exist with the survey of some woodland types late in the season. The identification of sub-communities W8b and W10b rely heavily on vernal species so that surveys late in the season will fail to pick these up (Kirby et al 1986), and their classification will be difficult. Inexperienced surveyors may put these stands into the 'default' communities (W8a, W10a).

Despite the inclusion of a few wet woods of recent origin the communities W1 to W6 are certainly under represented. This is especially true of W1, W2, W3 and W5 which tend to occur around mires and lake margins, rather than being associated with existing woods as W4 and W6 can be, and were therefore very

Table 4 Combined constancy table for W10 and W11 sub-communities

Field and ground layers only

Boxed species are those which are indicative of that sub-community

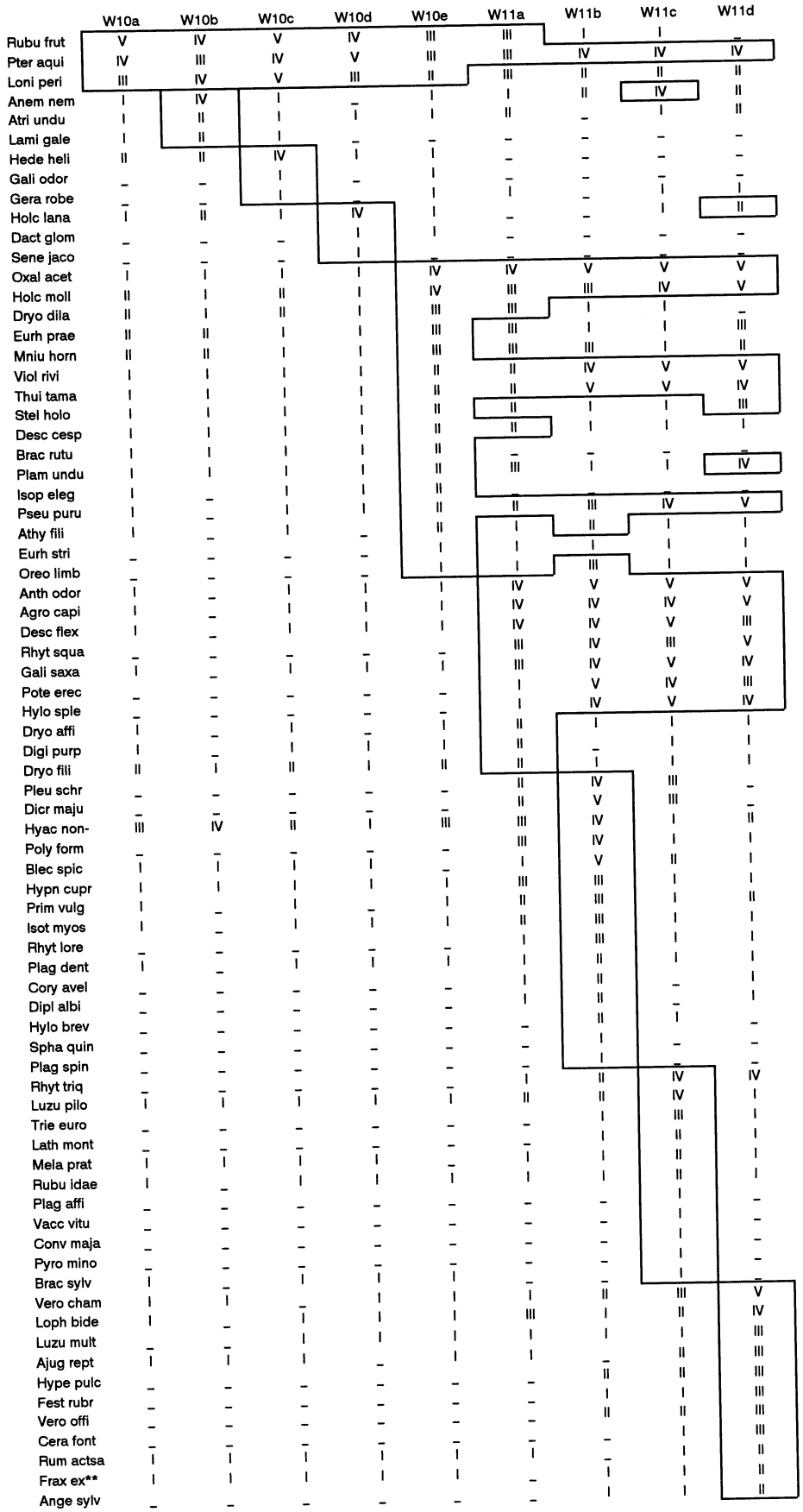


Table 5 Combined constancy table for W8 and W10 sub-communities

Field and ground layers only

Boxed species are those which are indicative of that sub-community

	W8a	W8b	W8c	W8d	W8e	W8f	W8g	W10a	W10b	W10c	W10d	W10e
Merc pere	IV	III	II	V	IV	V	V	I	-	I	-	I
Eurh prae	IV	IV	III	II	IV	V	V	II	II	I	I	III
Rubu frut	IV	III	V	IV	III	III	II	V	IV	V	IV	III
Poa triv	III	II	II	I	I	-	I	I	I	I	I	I
Glec hede	III	II	I	I	I	-	I	-	-	-	-	-
Prim vulg	III	II	I	I	I	I	I	I	-	I	-	I
Viol ri/re	II	II	II	II	I	-	II	I	I	I	I	II
Ajug rept	II	II	II	I	I	-	-	I	I	I	-	I
Prim elat	I	I	I	I	-	-	-	-	-	-	-	-
Prim v X e	I	I	-	-	-	-	-	-	-	-	-	-
Anem nemo	I	IV	I	I	I	II	I	I	IV	I	-	I
Ranu fica	I	IV	-	I	I	II	-	I	I	-	-	I
Lami gale	I	II	I	I	I	I	I	I	II	I	-	-
Rume sang	I	II	-	I	I	-	-	I	I	I	I	-
Desc cesp	I	I	V	I	I	I	II	I	I	I	I	II
Fili ulma	I	I	II	I	I	I	II	-	-	-	-	-
Pote ster	I	I	II	I	I	-	I	-	I	I	-	I
Lysi nemo	I	I	II	-	-	-	-	I	I	-	I	I
Junc effu			II	-	-	-	-	I	-	I	I	I
Hede heli	II	II	II	IV	III	III	II	II	II	IV	I	I
Urti dioi	II	II	-	I	III	III	III	I	I	I	I	I
Gali apar	I	II	I	I	III	III	II	-	-	-	-	-
Gera robe	I	I	-	I	III	II	II	-	-	I	-	I
Eurh stri	I	I	-	I	III	II	II	-	-	-	-	I
Tham alop	I	I	I	I	II	II	I	-	-	-	-	-
Aspl scol	-	-	-	I	II	II	I	-	-	-	-	-
Cten moll	-	-	-	-	I	I	I	-	-	-	-	-
Alli ursi	I	I	I	I	II	V	I	-	-	-	-	-
Brac sylv	II	I	II	III	II	I	IV	I	-	I	I	I
Teuc scor	-	I	-	I	I	-	IV	I	I	I	I	I
Meli unif	I	I	I	I	I	-	III	I	I	I	I	I
Arrh elat	-	-	-	-	I	I	III	-	-	-	-	-
Camp lati	-	I	-	-	I	-	II	-	-	-	-	-
Poly acul	I	-	-	-	I	-	II	-	-	-	-	-
Myos sylv	-	-	-	-	I	-	II	-	-	-	-	-
Plag dent	-	-	-	-	I	-	II	I	I	I	I	II
Conv maja	-	-	-	-	I	-	II	-	-	-	-	-
Meli nuta	-	-	-	-	-	-	II	-	-	-	-	-
Rubu saxa	-	-	-	-	-	-	II	-	-	-	-	-
Rosa vill	-	-	-	-	-	-	I	-	-	-	-	-
Pter aqui	I	I	I	I	I	-	-	IV	III	IV	V	III
Loni peri	II	II	II	I	I	I	-	III	IV	V	III	II
Atri undu	II	I	II	I	I	I	II	I	II	I	I	I
Gali odor	I	I	-	I	I	-	I	-	-	I	-	I
Holc lana	I	I	I	I	-	-	I	I	II	I	IV	I
Dact glom	I	I	-	I	I	-	I	-	-	-	I	I
Sene jaco	-	-	-	-	-	-	-	-	-	-	I	-
Oxal acet	I	I	I	-	I	I	-	I	I	I	I	IV
Holc moll	I	I	-	-	I	-	I	II	I	II	I	IV
Dryo dila	I	I	-	I	I	I	-	II	I	II	I	III
Mniu horn	II	II	I	I	I	-	II	II	II	I	I	III
Thui tama	II	I	II	I	I	I	I	I	I	I	I	II
Stel holo	I	I	-	I	I	I	-	I	I	I	I	II
Brac rutu	III	II	III	II	III	V	I	I	I	I	I	II
Plam undu	III	III	II	I	III	II	III	I	I	I	I	II
Isop eleg	-	-	-	-	-	-	-	I	-	I	I	II
Pseu puru	-	-	-	-	-	-	-	I	-	I	I	II
Athy fili	I	I	-	I	I	-	I	I	-	I	-	II
Oreo limb	-	-	-	-	-	-	-	-	-	-	-	I

ENGLISH NATURE

Phase 2 woodland NVC surveys 1988-1991 in England and Wales

No. 8 - English Nature Research Reports

working today
for nature tomorrow

Contents

Summary

Over 600 selected woods were surveyed in different regions of England and Wales. A total of 2146 separate stands occupying 12911 ha were classified using the National Vegetation Classification (NVC). This report gives the results of these surveys and provides updated NVC distribution maps for W9, W16, W8g, W10e and W11b, which were found to have a wider distribution than previously thought. Estimates of the total area of each NVC community based upon these results are given, and a comparison between the NVC and Stand Type classification method is provided.

Acknowledgements

Surveys were also carried out by Geoff Barber, Jamie Bevan, Mel Heath, Helen Oakes, Gavin Saunders and Tony Whitbread to whom thanks are due. Throughout the project we were based in NCC regional offices and are grateful for the help and encouragement received from staff there. Finally, this project could not have been undertaken without the cooperation of the many hundreds of landowners who granted us permission to work in their woods. Various members of staff from both English Nature and the Countryside Council for Wales made helpful comments on an early draft of this report.

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Introduction

In 1981 the Nature Conservancy Council (NCC) began a project, using existing information sources, which has resulted in a national inventory of ancient woods (Spencer & Kirby in press; Roberts et al in press). Provisional reports have been produced for each county in England and Wales, and for each district in Scotland. These list all ancient semi-natural woods and all plantations on ancient sites (Kirby et al 1984; Walker & Kirby 1989).

The inventory is used by the Forestry Commission to help identify woods requiring special treatment under the Woodland Grant Scheme (Forestry Commission 1988). It provides a factual base upon which planning decisions, nature conservation advice and countryside management can be based and is a base line against which changes in the woodland area can be measured (eg Peterken & Allison 1989; Spencer 1989).

As was recognised from the outset, some of the information upon which the inventory is based was out of date or incomplete and required checking by field survey. Such field survey of sites was a normal part of NCC's work, (and is now a part of its successor bodies work), but additional checks were carried out in response to enquiries from woodland owners or managers.

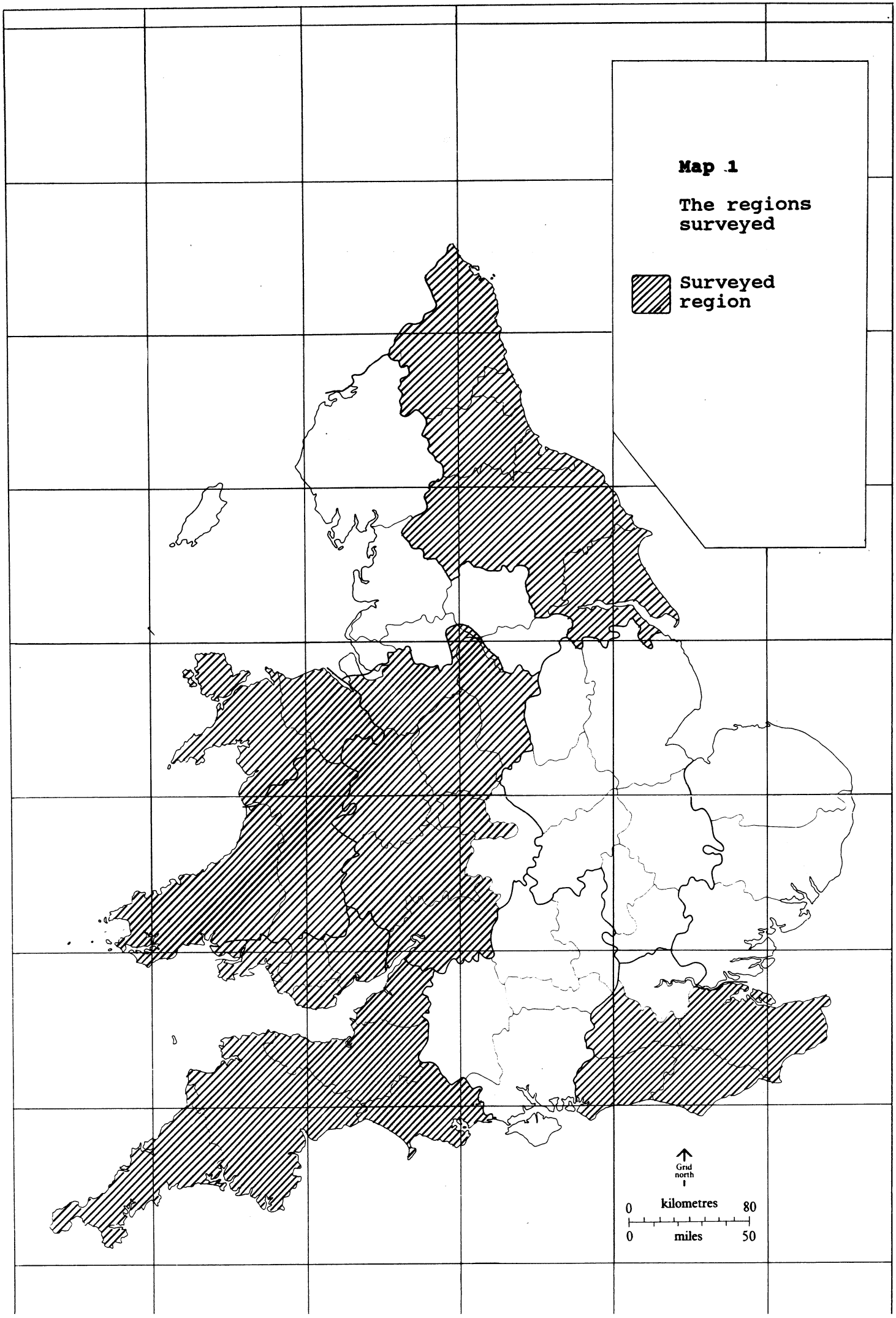
As work on the draft inventories came to an end, a five year survey programme was initiated in 1988 in England and Wales to carry out a more systematic survey of woods. (A similar programme was already in operation in Scotland eg MacKintosh 1988, 1990.) During the five years the intention was that two teams of two surveyors would each spend a year in each of the three Welsh and eight English regions of the NCC.

The Government's decision to reorganise the NCC (HMSO 1990) truncated this programme. At the time of reorganisation about two thirds of the programme had been completed, with the three Welsh Regions and the North East, South East, South West and West Midlands Regions of England covered (see Map 1). (In fact the Regions of North Wales and West Midlands were surveyed in a single year by a single team for logistic reasons.) The English Regions which were not surveyed during this project were South, North West, East Midlands and East Anglia. The latter two are now combined into the East Region of English Nature (EN), the successor body to the NCC in England.

This report brings together the results of these field surveys in Wales and the four English Regions, previously reported on individually as Chief Scientist Directorate Research Reports (Barber & Cooke 1990; Cooke & Saunders 1989, 1990; Heath & Bevan 1991; Heath & Oakes 1990; Oakes & Whitbread 1990).

Aims of the project

The aims of the project were threefold: to introduce the National Vegetation Classification (NVC) (Rodwell 1991) and help establish


Map 1
The regions surveyed
Surveyed region
Grid north
0 kilometres 80
0 miles 50

it as the main method of woodland classification, and to increase our knowledge of the extent and distribution of communities; to survey some of the larger ancient semi-natural woods for which there was little or no botanical survey information; and within the constraints of the above, to revise and amend the draft ancient woodland inventories.

Site selection

Sites were selected subjectively; no attempt was made to choose a random, statistically valid sample. This was primarily because of the multiple aims of the survey. In general the woods selected for survey were the largest ancient semi-natural woods for which only limited botanical information was available, covering the range of geological and edaphic variation within the region, and occurring in as many different aspects as possible. In practice the selected list was modified by sites considered to be in urgent need of survey by regional staff, and by the lack of permission from owners or managers to survey certain sites (permission was refused for about 10% of sites).

There was a general presumption against the survey of Sites of Special Scientific Interest (SSSI) and other reserves as these were likely to be well documented. However, pressure from regional staff to have 'their' SSSI's classified using the NVC lead to the inclusion of a few from each region. Further constraints on the selection procedure were logistical considerations (the need to minimise travelling between sites in any one day), the desirability of reducing lone field working, and time considerations. For example, it might be better to spend two days surveying a large wood rather than two separate, smaller sites. Each case was treated on its own merits, but the overriding consideration was to survey as many different types of woodland as possible.

Survey method

The method of survey closely followed that described in Kirby (1988a) pp 29-33, commonly known as the 'walkabout method'. An irregular path is walked throughout the wood, covering all likely sources of variation, including vegetation, physical habitats (stream sides, rock outcrops etc), any differences in management regimes and geological differences. The structure of the tree and shrub layers and the vascular plants were recorded on standard recording forms using the DAFOR scale. Other information was noted as required.

All sites were classified using the NVC. Classification of stands in the field was aided by a key to communities and sub-communities (Rodwell 1991, but using the drafts available in 1986). As the surveyors became more experienced it was possible to recognise most communities without reference to the key. Nevertheless, quadrats were recorded, both from stands which were difficult to classify in the field, and also as a periodic check that the classifications were correct (see page 40).

Results

A total of 603 woods were surveyed covering 12,911 ha, in which 2146 separate stands were fully classified. This averages at 10.7% of the ancient semi-natural woodland (asnw) in those areas surveyed.

Table 1 Area and percentage asnw surveyed in each region

Region	Area surveyed (ha)	Area asnw (ha)	% asnw surveyed
South West	2142	23731	9
South East	2600	52223	5
West Mids	1554	31658	5
North East	2089	16388	13
Dyfed-Powys*	2677	17295	15
South Wales*	1170	6981	17
North Wales	679	6382	11

(* old NCC Wales Regional boundary)
(There are minor discrepancies between the results published in the South East Region report (Oakes & Whitbread 1990) and those used for South East Region here due to the inclusion of extra sites not included in that report.)

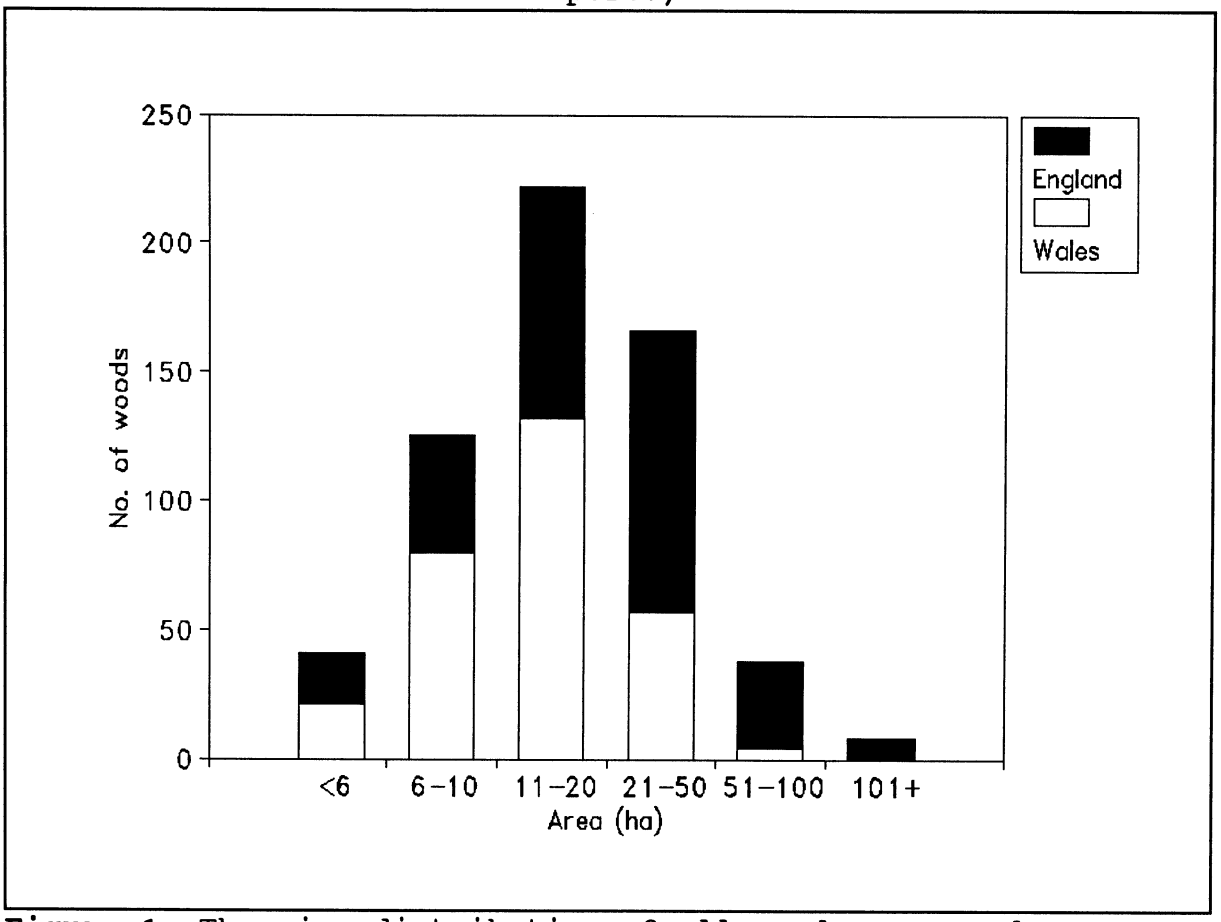


Figure 1 The size distribution of all woods surveyed

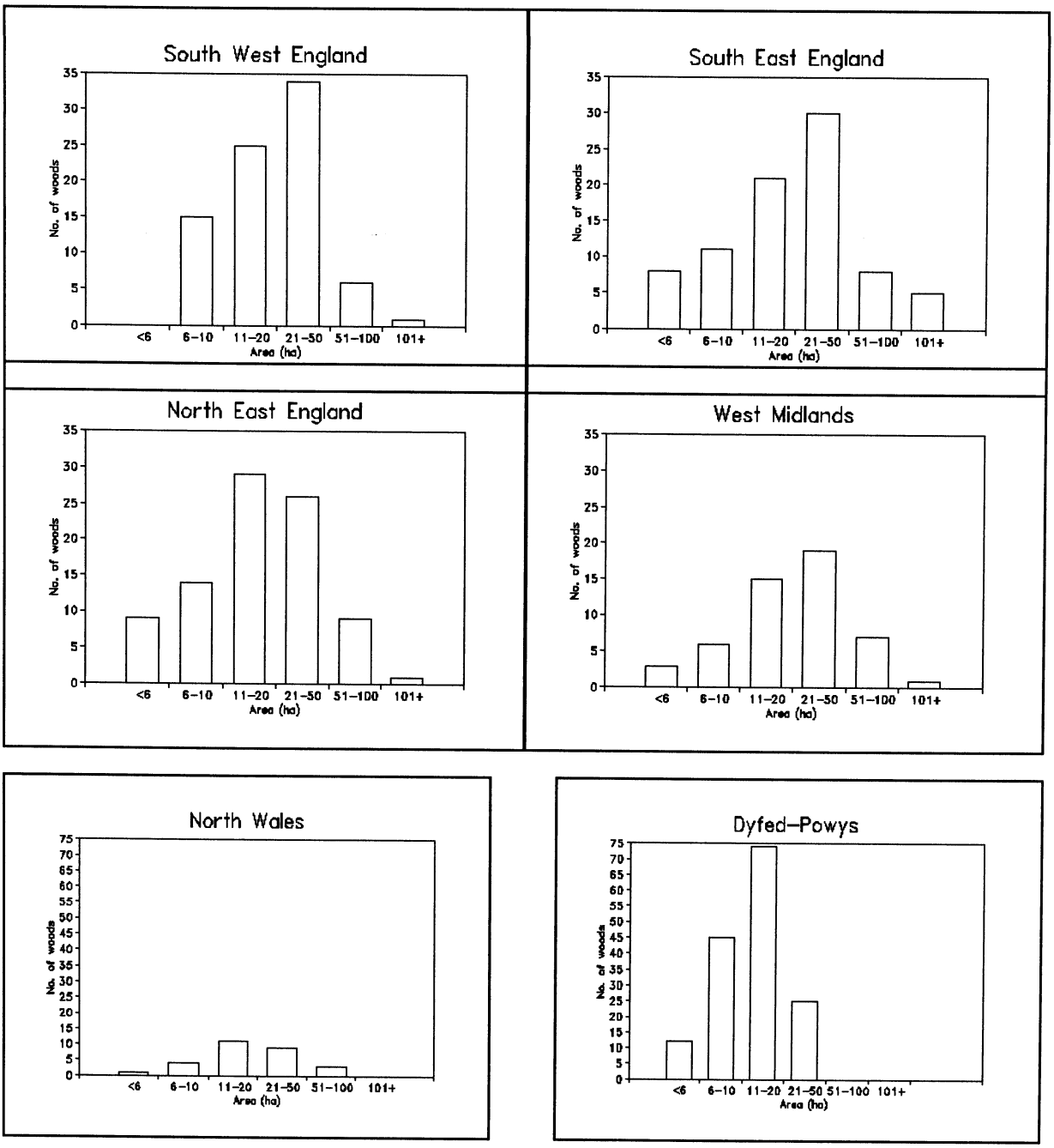


Figure 2 The size distribution of woods surveyed in each region

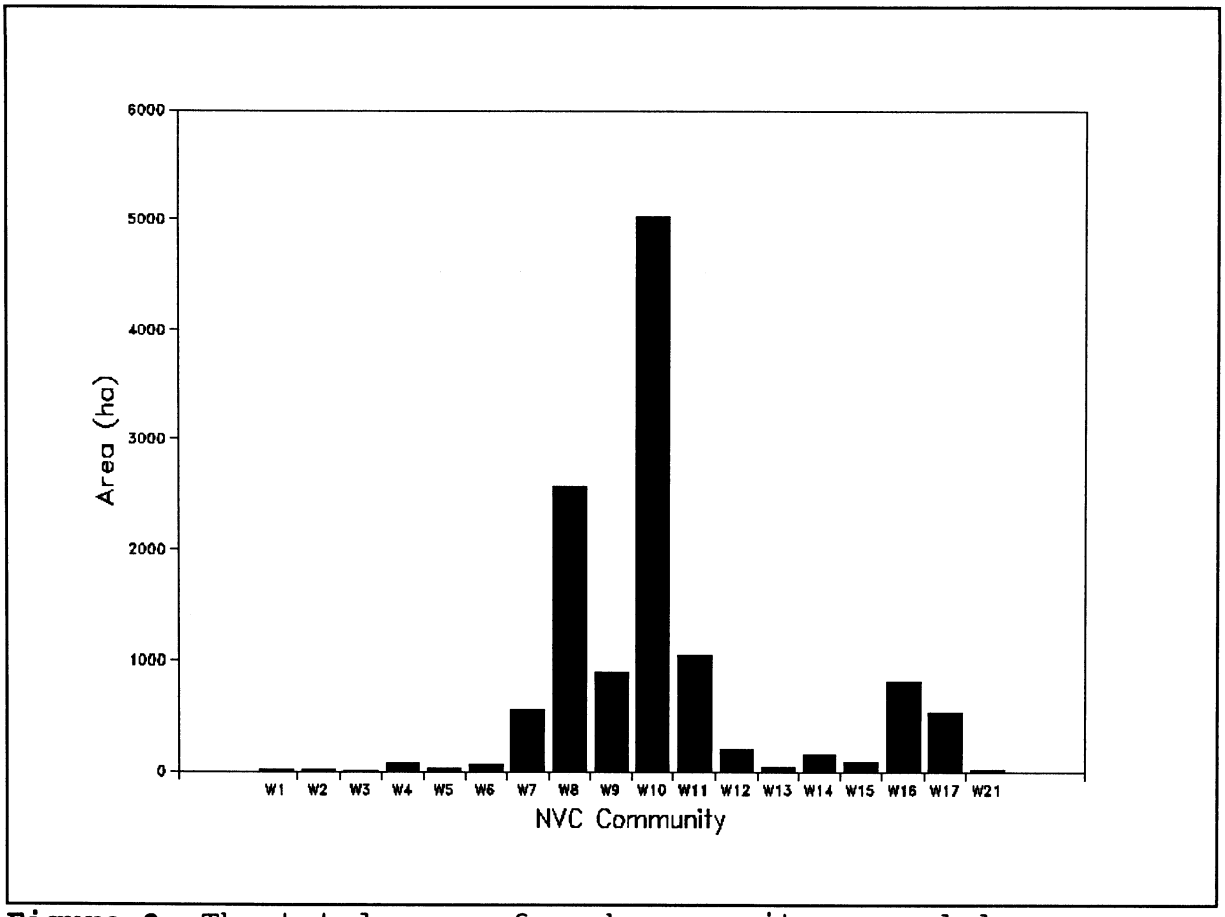


Figure 3 The total area of each community recorded

Regional variation in woodland communities

Natural variation in woodland communities occurs as a result of interactions between soil, geology and climate. Along western and northern coasts an Oceanic climate prevails, giving rise to cool humid summers and mild winters (Page 1982). The southern and eastern coasts experience a more Continental climate where both warmer summers and harsher winters occur. The response of species to these climatic effects in conjunction with the edaphic conditions on which they occur is the primary cause of natural variation in woodland throughout Great Britain. The current vegetation of a wood is also a reflection of the present management and past history of the site (Mitchell & Kirby 1989), and may be influenced by local factors such as tree litter (Sydes & Grime 1981a).

The management of woods has modified many woodland types either directly, for example through the conversion to conifer plantations (Rackham 1980), or indirectly such as increasing the proportion of oaks in some lowland mixed deciduous woods (Kirby & Patterson 1992). Changes to woods which have resulted in plantations of exotic species where semi-natural stands once existed, although partially covered by the NVC, are outside the scope of this project, as only semi-natural woods were considered for survey.

Table 2	The area of each community in each region (ha)							
	N Wales	Dyfed-Powys	NE England	West Midlands	S Wales	SW England	SE England	Total
W1	0.5	0.5				10.5		11.5
W2a		10.0	1.5	0.3	0.3			12.0
W2b								0.0
W3			6.0					6.0
W4a	1.3			6.0	6.3	3.0		16.5
W4b		29.3		1.8	13.8			44.8
W4c					8.8			8.8
W5a		2.5	0.8		1.3		0.3	4.8
W5b		1.3			13.0			14.3
W5c					3.0		0.8	3.8
W6a		1.8	1.3	1.8		0.5	3.8	9.0
W6b				6.0			1.5	7.5
W6c								0.0
W6d		1.8	6.0	8.8	13.3	6.5	0.3	36.5
W6e		5.0			0.3	6.0	0.3	11.5
W7a	17.0	26.8	39.5	18.5	29.0	33.3	15.0	179.0
W7b	7.3	34.8	15.8	10.8	68.3	27.0	17.0	180.8
W7c	13.5	24.3	29.8	38.0	78.0	9.0	4.8	197.3
W8a		14.5	20.5	99.3	35.5	185.1	465.0	819.9
W8b		1.3	1.3		30.3	42.5	65.8	141.0
W8c	6.3	7.3	21.0	46.5	89.5	16.8	32.5	219.8
W8d		15.0		35.5	36.0	180.5	41.8	308.8
W8e	72.3	63.3	42.8	171.0	243.3	140.3	44.3	777.0
W8f		6.8	64.3	7.5	18.5	32.3	20.3	149.5
W8g		87.0	15.3	0.5	43.8		1.3	147.8
W9a	66.0	176.0	377.3	41.3	54.8	2.5	1.3	719.0
W9b	6.5	6.3	161.3					174.0
W10a	42.0	308.8	197.8	530.0	118.8	302.8	1253.0	2753.0
W10b			7.5		2.5	58.3	226.5	294.8
W10c	34.5	10.3		12.0	68.8	214.5	28.5	368.5
W10d	0.5		95.0	76.0	8.5	12.5	23.3	215.8
W10e	98.8	22.8	472.3	255.3	223.3	308.5	10.0	1390.8
W11a	76.5	443.0	72.3	22.8	311.3	6.3		932.0
W11b	32.3		42.8	1.3				76.3
W11c	6.0							6.0
W11d		21.5	13.3		2.5			37.3
W12a	3.8		6.0	15.0	7.3	44.8	55.0	131.8
W12b				16.3				16.3
W12c							48.0	48.0
W13a						1.3	7.3	8.5
W13b			7.3		3.0	1.3	9.8	21.3
W14	7.3	9.0	1.5	53.0	43.0	16.0	16.0	145.8
W15a		1.3			12.3	7.3	13.8	34.5
W15b	1.3	1.5		6.3	21.3	12.0	1.3	43.5
W15c	0.3				2.5	0.5		3.3
W15d						1.3		1.3
W16a	0.3	1.3	22.3	18.0	1.5	65.0	35.3	143.5
W16b	3.8	177.8	66.8	43.8	146.3	222.5	7.3	668.0
W17a	12.0	96.0	7.3					115.3
W17b	153.0	85.0				7.3		245.3
W17d	21.8	147.5		0.3	6.5	6.0		182.0
W21a				1.3			1.3	2.5
W21b							7.3	7.3
W21d				1.3				1.3

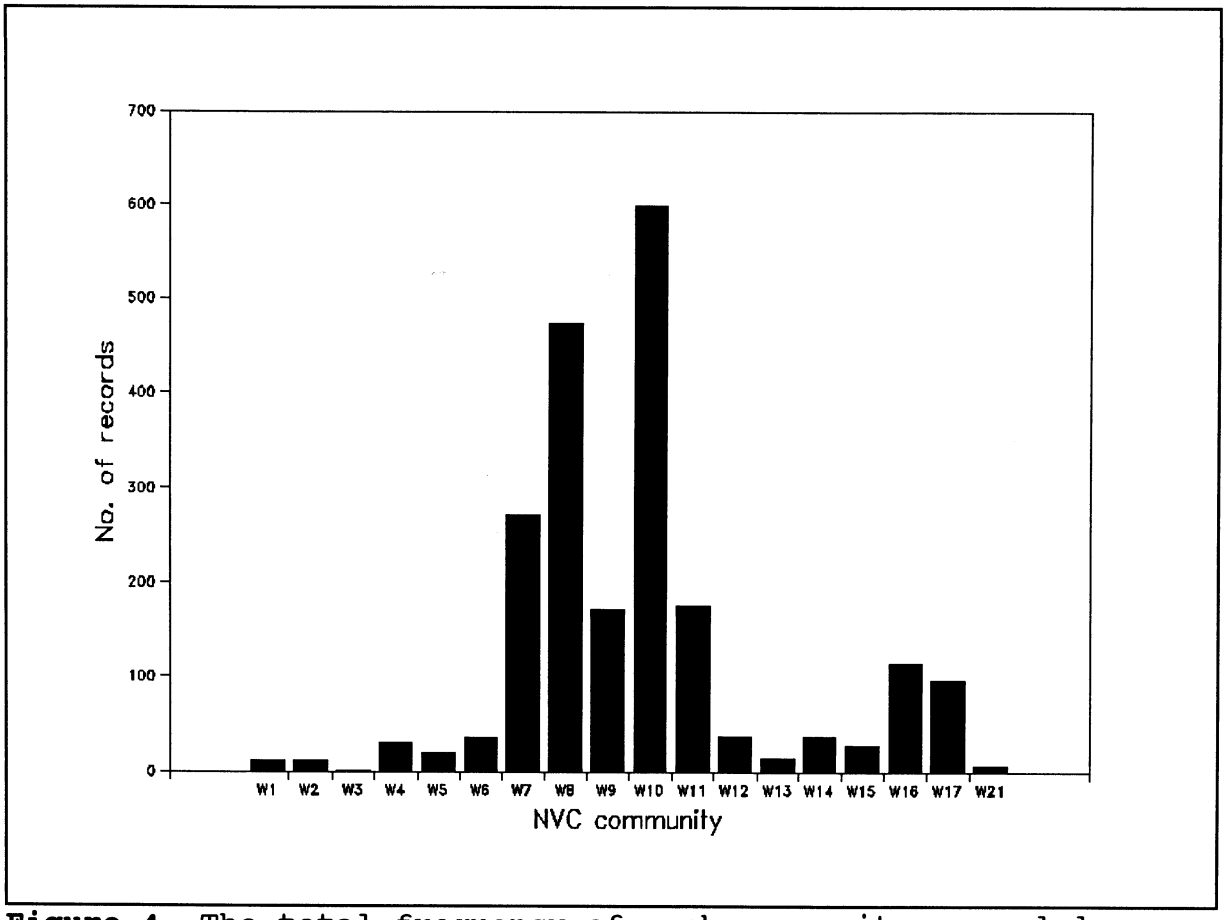


Figure 4 The total frequency of each community recorded

Some NVC communities represent seral stages in woodland development, particularly in the development of wet woodland communities on fens and mires. These communities are not, therefore, particularly characteristic of ancient woods and are under represented in surveys such as this, where the selection of sites is based on ancient woods.

Differences in the regional distribution of NVC communities is most apparent in the six mixed deciduous communities (W8, W9, W10, W11, W16 and W17). These six types are roughly split into north-west and south-east examples of base rich, mesotrophic and acidic types. In general pteridophytes and bryophytes are more abundant in the north-western communities (W9, W11 and W17), as might be expected given the prevailing Oceanic climate.

Community descriptions included in the following sections have drawn extensively on those in Rodwell (1991) and summaries in Whitbread & Kirby (1992). Nomenclature follows Clapham, Tutin & Moore (1987) for vascular plants, and Smith (1978, 1990) for bryophytes.

Table 3 The frequency of each community in each region

	N.Wal.	D-P	NE	WMs	S.Wal.	SW	SE	Total
W1	2	2				7		11
W2a		5	2	1	1			9
W2b		2						2
W3			1					1
W4a	1			1	2	3		7
W4b		11		3	5			19
W4c					4			4
W5a		2	3		1		1	7
W5b		1			5			6
W5c					4		3	7
W6a		2	1	3		2	3	11
W6b			1	1			2	4
W6c								0
W6d		2		4	3	3	1	13
W6e		4			1	1	1	7
W7a	5	25	12	12	19	13	20	81
W7b	8	19	6	7	27	15	14	74
W7c	4	12	6	13	23	5	7	59
W8a		4	5	10	11	33	63	63
W8b		1	1		9	12	26	49
W8c	2	2	2	8	16	9	13	52
W8d		1		6	8	20	16	51
W8e	6	18	16	15	35	19	10	103
W8f		7	12	3	12	8	8	50
W8g		12	2	2	10		1	27
W9a	20	60	36	12	15	2	1	125
W9b	3	2	21					26
W10a	4	57	18	26	24	38	84	163
W10b			3		2	9	38	52
W10c	5	6		2	17	28	17	53
W10d	2		4	3	3	7	8	27
W10e	14	59	37	19	43	17	5	175
W11a	8	87	9	5	41	2		144
W11b	5		8	1				14
W11c	1							1
W11d		3	3		2			8
W12a	3		1	1	2	7	15	29
W12b				2				2
W12c							5	5
W13a						1	2	3
W13b			2		4	1	4	11
W14	2	5	2	1	9	6	13	23
W15a		1			3	2	5	11
W15b	1	2		2	3	2	1	11
W15c	1				2	2		5
W15d						1		1
W16a	1	1	3	3	2	2	12	24
W16b	3	28	14	6	18	19	2	85
W17a	2	26	2					30
W17b	7	20				2		29
W17c	2	30		1	3	1		37
W21a				1			1	2
W21b							2	2
W21d				1				1

Ash-elm Woodland

NVC W9 Fraxinus excelsior - Sorbus aucuparia - Mercurialis perennis woodland.

This is a community of base rich soils and receiving slopes in the north and west. The shrub layer contains few of those species typical of the more southern sub-communities of W8, and is usually dominated by mixtures of hazel Corylus avellana, hawthorn Crataegus monogyna, rowan Sorbus aucuparia and sometimes bird cherry Prunus padus. Sycamore Acer pseudoplatanus can often be frequent in the canopy layer, especially where the elm has succumbed to Dutch elm disease. The field layer forms a complex mosaic of calcicolous forbs and grasses, without ever being dominated by two or three species, as is often the case with W8 woodland. The presence of Oxalis acetosella, as well as abundant ferns and bryophytes, is usually a good indicator of W9 as opposed to W8.

During this survey W9 woodland was the most common calcareous woodland community in North Wales, Dyfed-Powys and North East England, which is consistent with the distribution trends given in Rodwell (1991). It was recorded from all survey areas but uncommon elsewhere and rare in South West and South East England. Both of these areas are outside the main range of the community; in the South West the two records were from sites on Dartmoor, an area where Rodwell (1991) also records it. However, the record from South East England is, at first sight, anomalous. The climate in this area would appear to be completely unsuitable for the species characteristic of W9 woodland, especially the typical ferns and bryophytes. This record (for the Typical sub-community, W9a) was from a gill woodland in south-west Surrey. These sites are known for their isolated populations of strongly Oceanic species such as the liverwort Bazzania trilobata (Hill, Preston & Smith 1991) and the fern Dryopteris aemula (Jermy, Arnold & Farrell 1978). Although these species are not confined to W9 woodland they are more typical of northern and western woods than their presence here would suggest. Therefore this record of W9 is not as unlikely as would first appear.

Most W9 records were for the Typical sub-community, W9a. The Crepis paludosa sub-community, W9b, was only frequent in North East England. This sub-community has more of a northern distribution (as opposed to W9a which has a north-western distribution) as it contains both Continental Northern species such as Prunus padus and Rubus saxatilis and Northern Montane species such as Crepis paludosa and Cirsium helenoides (Rodwell 1991).

NVC W8 Fraxinus excelsior - Acer campestre - Mercurialis perennis woodland.

Mixed woodland communities on calcareous soils in the south and east fall into this community. It is the most complex of the NVC woodland communities with seven sub-communities recognised. These can be split into two major groups, separated mainly by floristic

differences arising as a result of differing edaphic conditions. The first group, W8a, b, c and d are the dominant W8 sub-communities in the south and east of Britain where heavy calcareous clays predominate in rolling countryside. To the north and west base rich soils are usually freely draining brown earths, often accumulating in valley bottoms, and here the sub-communities W8e, f and g are commonest. As these communities can be found towards the limits of the W8 range there is often considerable overlap between these and W9, and in some cases, particularly in the Yorkshire Dales, woods with both W8 and W9 sub-communities are not uncommon.

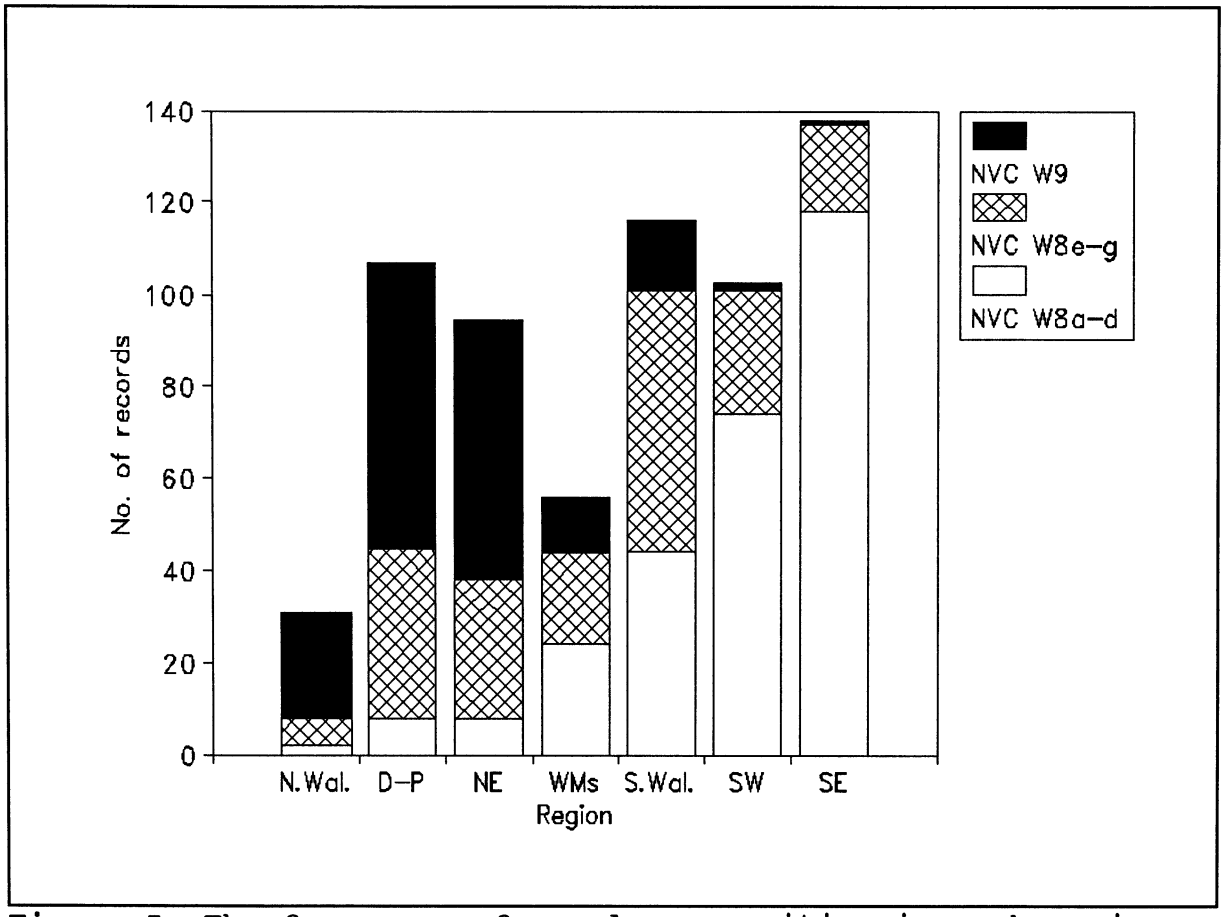


Figure 5 The frequency of as-elm communities in each region

In general W8 woodland is characterised by the presence of Acer campestre in the shrub layer. Other southern shrubs such as Cornus sanguinea, Crataegus laevigata, Euonymus europaeus, Rhamnus catharticus and Viburnum lantana are often also present, especially in sub-communities W8a, b, c and d. These shrubs are confined to the southern half of Britain where the climate is warm and dry enough for successful sexual reproduction (Rodwell 1991). Other Continental and Southern Continental elements of the flora strongly associated with this group of sub-communities include Arum maculatum, Euphorbia amygdaloides, Lamiastrum galeobdolon and Viola reichenbachiana. The north-western group of sub-communities (W8e, f and g) have a less diverse shrub layer (which may, however, include Taxus baccata) and richer fern and bryophyte communities, although not as prolific as those found

in W9 woodland. The canopy layer of W8 can be very varied, and may include stands of Carpinus betulus and Tilia cordata on base rich soils. (As these species may also dominate mesotrophic woodland they are not recognised as specific sub-communities.)

The recorded distribution of these communities largely reflects national trends (Rodwell 1991), and is shown in Map 3 and Figure 5. The south-east group of sub-communities shows a strong bias towards those areas, although the second group of sub-communities is not infrequent in those areas either. However, this group is dominant in North Wales, Dyfed-Powys and North East England.

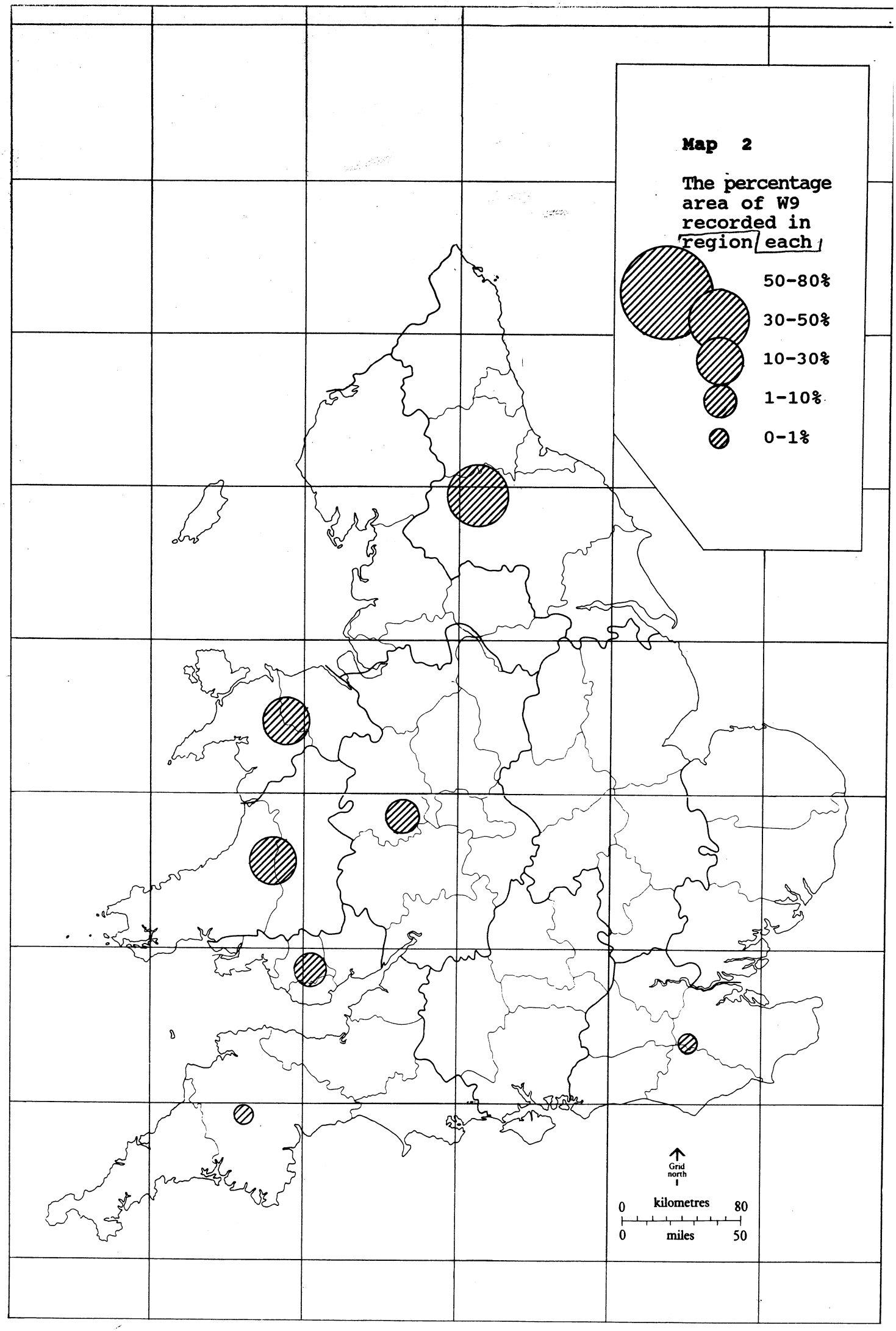
The scarcest sub-community is W8g, the Teucrium scorodonia sub-community, a community of thin rendzina soils, often over limestone. This community was only recorded by Rodwell (1991) from the Derbyshire Dales, and a solitary record from the Wye Valley. During this survey it was recorded occasionally from Dyfed-Powys and South Wales, with rare records from Derbyshire, North East and South East England. The majority of the records come from areas of limestone, usually Carboniferous Limestone and appear to be faithful to this substrate. For example, records of W8g occur all around the dome of the South Wales coalfield where Carboniferous Limestone outcrops. The single record of this sub-community from the south-east is from West Sussex on the scarp slope of the Southern Downs, where it occurs with calcareous beech and yew woodland.

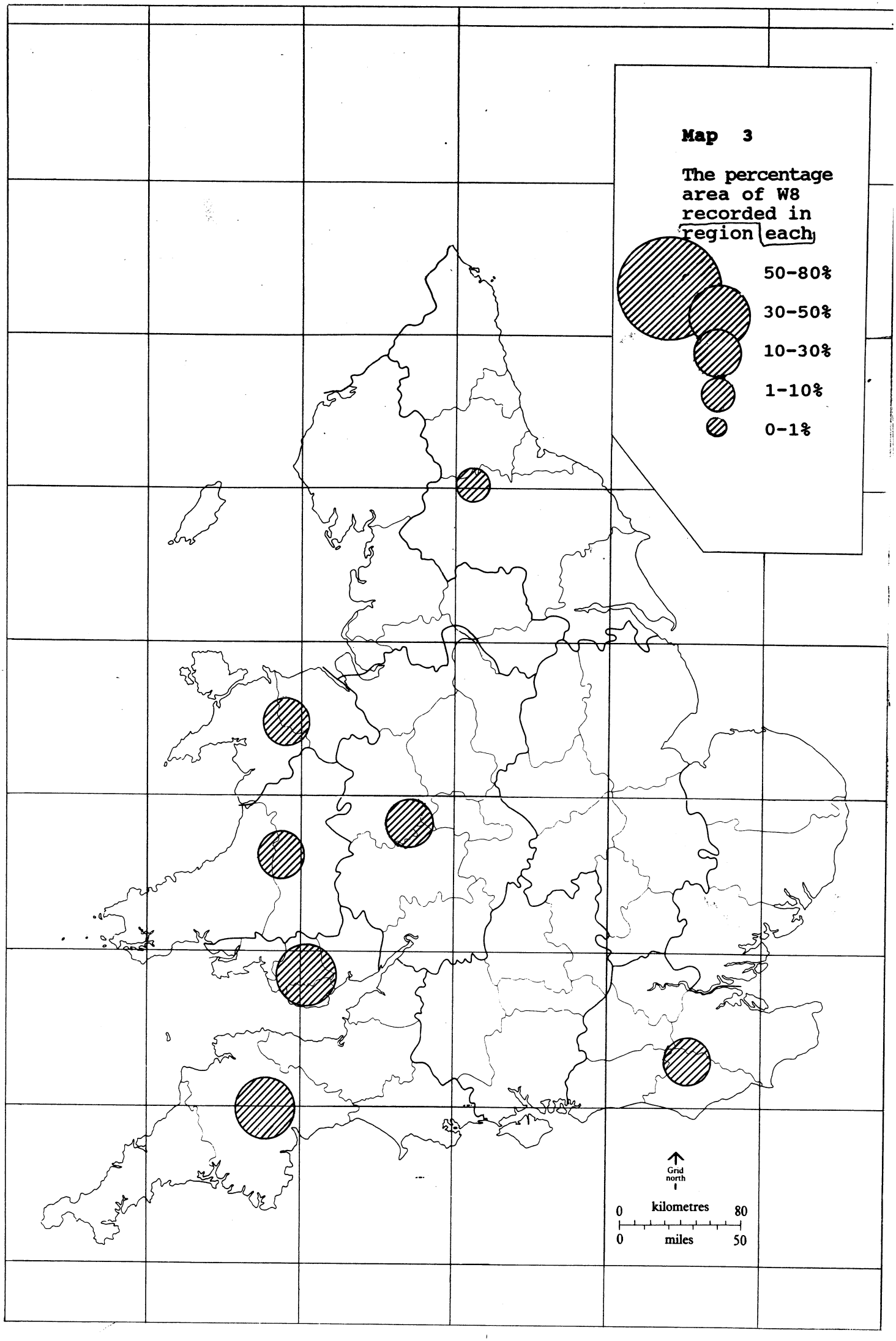
The W8b sub-community is probably under recorded. This type is characterised by dense carpets of vernal species, especially Anemone nemorosa and Ranunculus ficaria and surveys in late summer and autumn will fail to pick up these species (Kirby et al 1986). In these cases the community may well be classified as W8a, which tends to act as a default sub-community in the key to W8 sub-communities.

Mixed oak woodland

Woodland on mesotrophic soils with a mixture of tree species present in the canopy, but usually dominated by oak is either W10 or W11. The distribution of these two communities is given in Maps 4 and 5 and their relative frequency in each survey area in Figure 6. In general W11 is the community of the north and west, with W10 occurring in the south and east. However, this pattern of distribution is affected by the occurrence of W10e, an Oceanic sub-community which overlaps with, and is transitional to W11.

The results from this survey programme reflect this pattern with W11 not recorded in South East England, and only sparingly present in South West England (one record from each of Devon and Cornwall, the largest stand coming from a site on Dartmoor, where this type of woodland is not out of place in the Oceanic climate of that area). The community was also scarce in North East England, West Midlands and, surprisingly, North Wales. However, North Wales region includes Clwyd, which has a more Continental climate, thereby explaining the scarcity of W11 in Clwyd where it was recorded only three times. In contrast it was recorded 11


Map 2
The percentage area of W9 recorded in region each
50-80%
30-50%
10-30%
1-10%
0-1%
Grid north
0 kilometres 80
0 miles 50


Map 3
The percentage area of W8 recorded in region each
50-80%
30-50%
10-30%
1-10%
0-1%
Grid north
0
kilometres
80
0
miles
50

times from Gwynedd. (W10 was recorded 13 times from Gwynedd and 12 times from Clwyd.)

NVC W10 Quercus robur - Pteridium aquilinum - Rubus fruticosus woodland.

This is one of the major types of woodland community in lowland Britain. The dominant tree is usually pedunculate oak Quercus robur, although Q. petraea can attain prominence in the Acer pseudoplatanus - Oxalis acetosella sub-community, W10e, and to a lesser extent in the Typical sub-community, W10a. Both Tilia cordata and Carpinus betulus may be locally dominant (as in W8), but unlike W8 Castanea sativa may be abundant in some stands. This last is a species with a sub-Mediterranean distribution in Europe which does very well as an introduction in south-east England where it has been extensively planted (Rackham 1980). Betula, almost always B. pendula is occasional but may be prominent in disturbed stands or recent woodland. In the damper climate of the north and west ash, sycamore and wych elm Ulmus glabra may be frequent, especially in W10e. The shrub layer is invariably dominated by hazel, with scattered Crataegus monogyna. Other species are infrequent. The community is quite complex with five sub-communities recognised, although compared with W8 the field layer is less varied. The effects of management may mask floristic differences resulting from climatic and edaphic variation (Pigott 1990; Rodwell 1991). There are only three constants in the field layer (each occurring in 61% or more of stands, but not necessarily all present in the same stand), these are Lonicera periclymenum, Pteridium aquilinum and Rubus fruticosus agg. and are abundant throughout all sub-communities, except NVC W10e where they are less common (but still frequent).

As it is a more Oceanic sub-community W10e tends to be commoner in the north and west. In contrast W10b, the Anemone nemorosa sub-community, often with Castanea sativa present as coppice, is most frequently found in South East England on the heavy clays of the Weald, and in Kent. The Hedera helix sub-community W10c, is commonest in areas where H. helix is more luxuriant such as for example in the south-west of Britain where harsh winter temperatures, to which it is sensitive (Godwin 1975), are infrequent. Ivy can also attain prominence in recent woodland (Rackham 1980; Peterken 1981) and is reported to increase in stands of neglected coppice in the south-west. The Holcus lanatus sub-community, W10d is a very uniform sub-community, of a grassy appearance. It is most common in secondary woods which have developed on grassland (cf W16a, secondary woodland developing on heathland). This sub-community also includes many softwood plantations which have become floristically impoverished (Mitchell & Kirby 1989). The final sub-community W10a, the Typical sub-community, is rather undistinguished and is almost a default type.

The community was recorded abundantly from all survey areas, and the distributions of the sub-communities (see Figure 7) closely match the described distributions (Rodwell 1991) outlined above. The most abundant sub-community in Wales, the West Midlands and

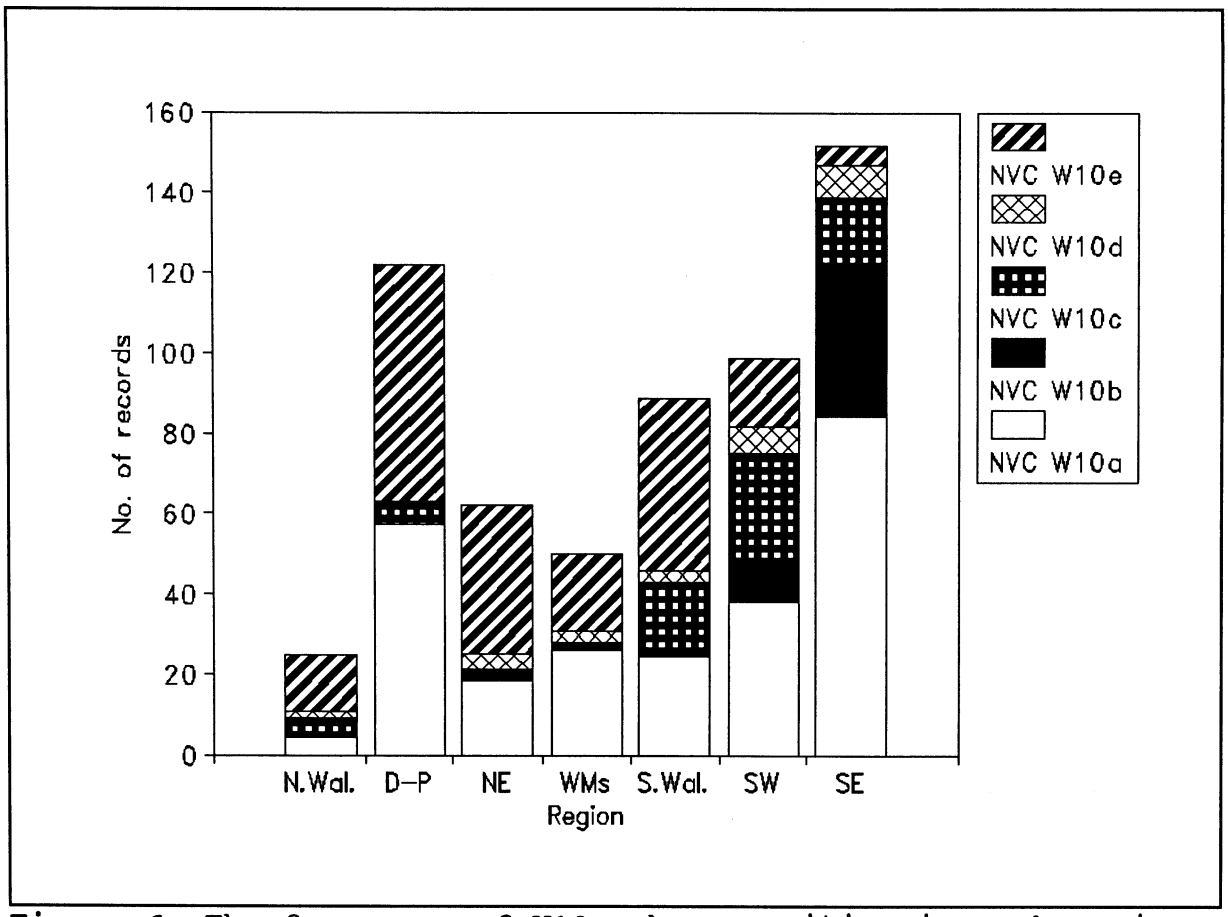
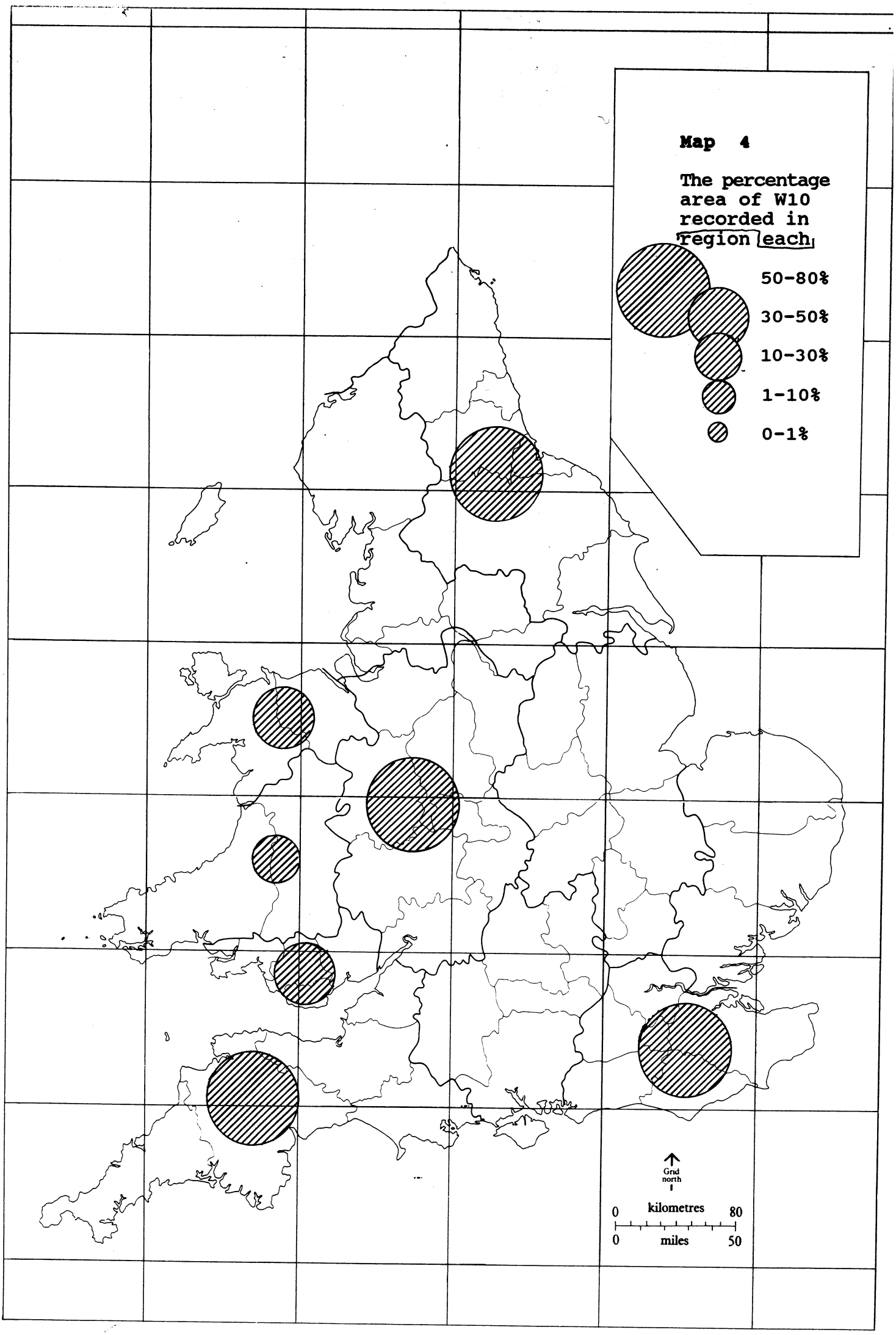


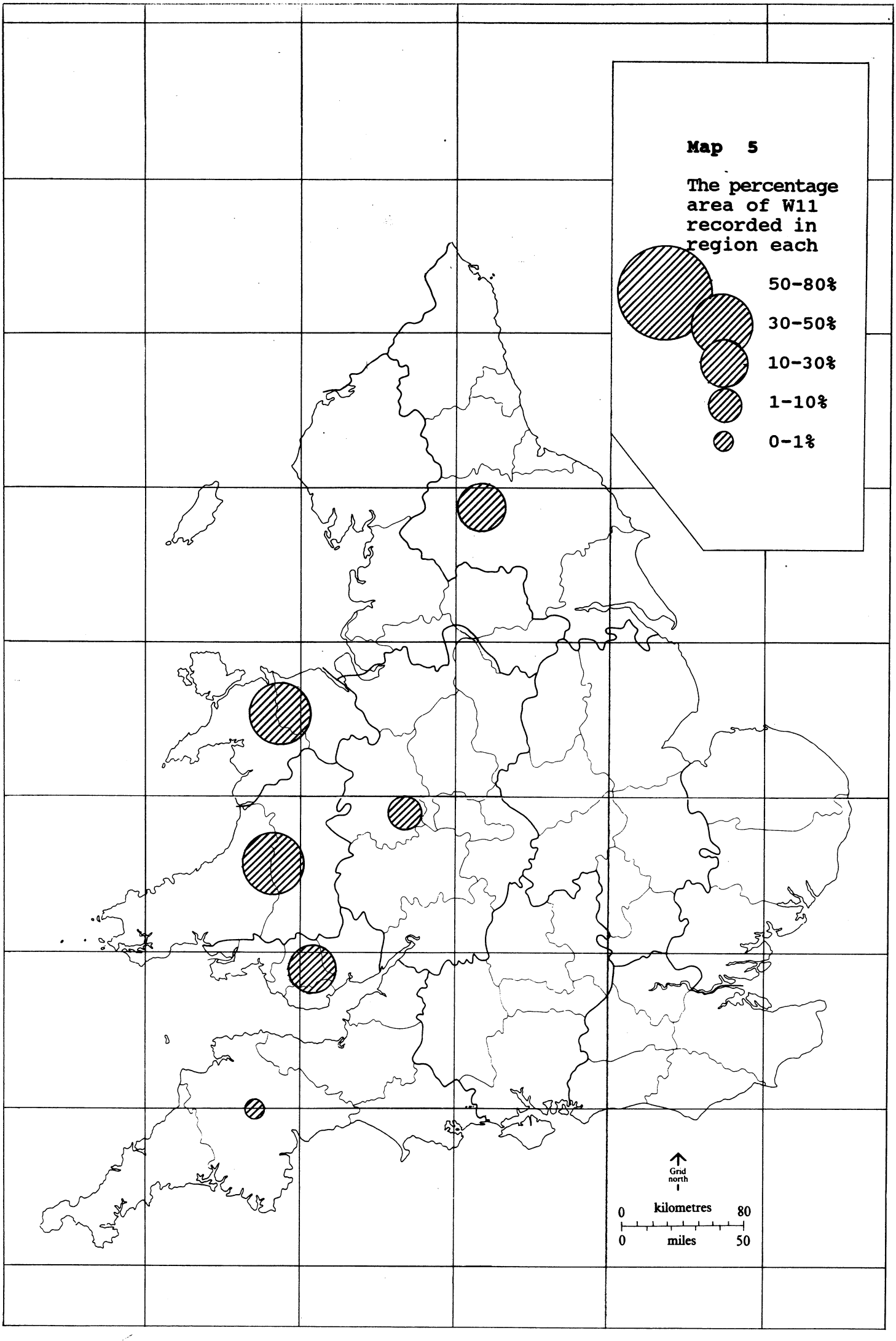
Figure 6 The frequency of W10 sub-communities in each region

North East England is W10e, occurring where the climate is more Oceanic. This sub-community is rare in South East England. No obvious pattern is apparent in the distribution of W10a, which is most frequent in South East England and Dyfed-Powys, but rare in North Wales. Similarly W10c shows no trends; it is rare throughout all the survey areas, partly due to its preference for secondary stands, which were not surveyed. A similar situation exists with W10d. However, W10b is rare in all areas except South East England, again mirroring the described distribution.

NVC W11 Quercus petraea - Betula pubescens - Oxalis acetosella woodland.

This community, usually on moderately base poor brown earths, is commonly heavily influenced by grazing, both by deer and sheep, as it often occurs on unenclosed hillside woods. Quercus petraea and Betula pubescens are the commonest tree species (cf W10), although both Q. robur and B. pendula can be locally frequent in the north-east. Other tree species are rare. The often poorly developed shrub layer is usually dominated by hazel. Rowan can be occasional, although grazing is a limiting factor. Grasses are a significant and characteristic feature of the community, their prevalence also due to herbivorous grazing (Mitchell & Kirby 1990). Herbs are more varied than in W10 with species characteristic of moist soils eg Oxalis acetosella and Viola


Map 4
The percentage area of W10 recorded in region each
50-80%
30-50%
10-30%
1-10%
0-1%
Grid north
0 kilometres 80
0 miles 50


Map 5
The percentage area of W11 recorded in region each
50-80%
30-50%
10-30%
1-10%
0-1%
Grid north
0
kilometres
80
0
miles
50

riviniana occurring with those preferring a degree of surface leaching such as Galium saxatile and Potentilla erecta (Rodwell 1991). In ungrazed stands Lonicera periclymenum, Pteridium aquilinum and Rubus fruticosus may attain prominence in the summer months. Ferns are conspicuous, especially in ungrazed stands and mosses are notably more abundant here than in W10, but leafy liverworts remain scarce.

Four sub-communities are recognized which can be split into two groups, W11a, the Dryopteris dilatata sub-community, and W11b, the Blechnum spicant sub-community which both have an Oceanic distribution, and W11c, the Anemone nemorosa sub-community and W11d, the Stellaria holostea - Hypericum pulchrum sub-community which have a more Northern Continental distribution.

The results from this survey show the dominance of W11a amongst the sub-communities; it was the most common sub-community in all regions, most notably in Dyfed-Powys and South Wales where 128 records were for W11a out of a total of 132 W11 records. This is probably due to a combination of poor, leached soils resulting in a general impoverishment of the flora and the high intensity of sheep grazing in most of these sites, causing a gradual shift to the more grazing tolerant grasses. In North Wales and North East England W11b was almost as frequent as W11a. This is probably explained by the wetter and colder climates of these areas. Records for W11d are infrequent; this sub-community was usually recorded from the edge of woods were they grade into pasture, or under very open canopies. These were not very good examples. A solitary stand of W11c was recorded from Gwynedd in North Wales. This is recognised as being well outside its normal range; the stronghold of this community is in the north-east of Scotland where the climate is wet but the winter temperatures low.

Oak birch communities

Two woodland types have been recognised from base poor or heavily leached soils, dominated by oak and birch, and with strongly calcifugous plant communities. As with the mesotrophic and calcicolous pairs of woodland communities, these show strong regional distribution patterns, largely dictated by climate (see Maps 6 and 7 and Figure 8).

NVC W16 Quercus spp. - Betula spp. - Deschampsia flexuosa Woodland.

Two sub-communities are recognised. W16a (the Quercus robur sub-community) is more often dominated by Q. robur and Betula pendula. It occurs mainly in the lowlands, often, but not exclusively, as secondary woodland on former heathland. The field and shrub layers tend to be species poor, and bryophytes rare. By contrast W16b (the Vaccinium myrtillus - Dryopteris dilatata sub-community) is characterised by a predominance of Quercus petraea, with any birch present more likely to be B. pubescens. This sub-community is more common in the upland fringes of Britain where the higher rainfall and humidity give rise to a

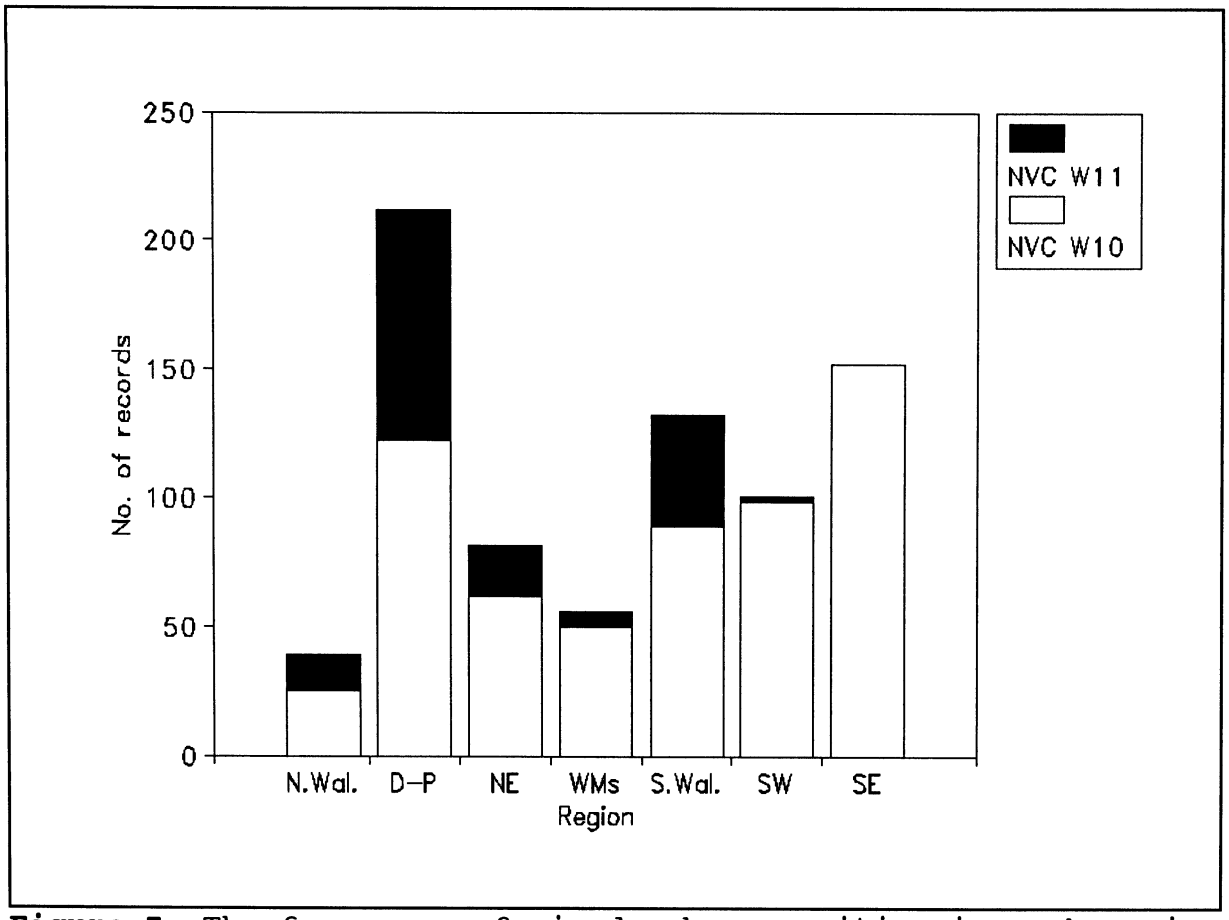


Figure 7 The frequency of mixed oak communities in each region

more varied bryophyte flora. Towards the west this sub-community becomes transitional with the bryophyte rich community, W17.

In all regions except South East England W16b was the most frequently recorded sub-community. All other survey areas could be considered as part of the 'upland fringe', thus W16b is the commoner of the two sub-communities in these areas (this also explains the scarcity of W16b in South East England - an entirely lowland area), and the sites selected were mainly ancient woods, so that secondary W16a stands are likely to have been missed. In South East England W16b was recorded from two woods in stands where Quercus petraea was present - itself unusual in this area - and came from the same general area, the Greensand Ridge, as the W9a record (see above), thus further demonstrating the distinctness of some woods in this area of South East England.

This community (W16) was frequently recorded from Wales during these surveys. However the community distribution map given in Rodwell (1991) does not indicate the presence of W16 in Wales. In mid Wales in particular the W16b stands recorded were more bryophyte rich than described in Rodwell (1991). However their bryophyte communities were not rich enough to warrant classification as W17, and several other species typical of W11 or W17 were absent, notably the grasses such as Anthoxanthum odoratum and Agrostis capillaris. These stands were exhibiting

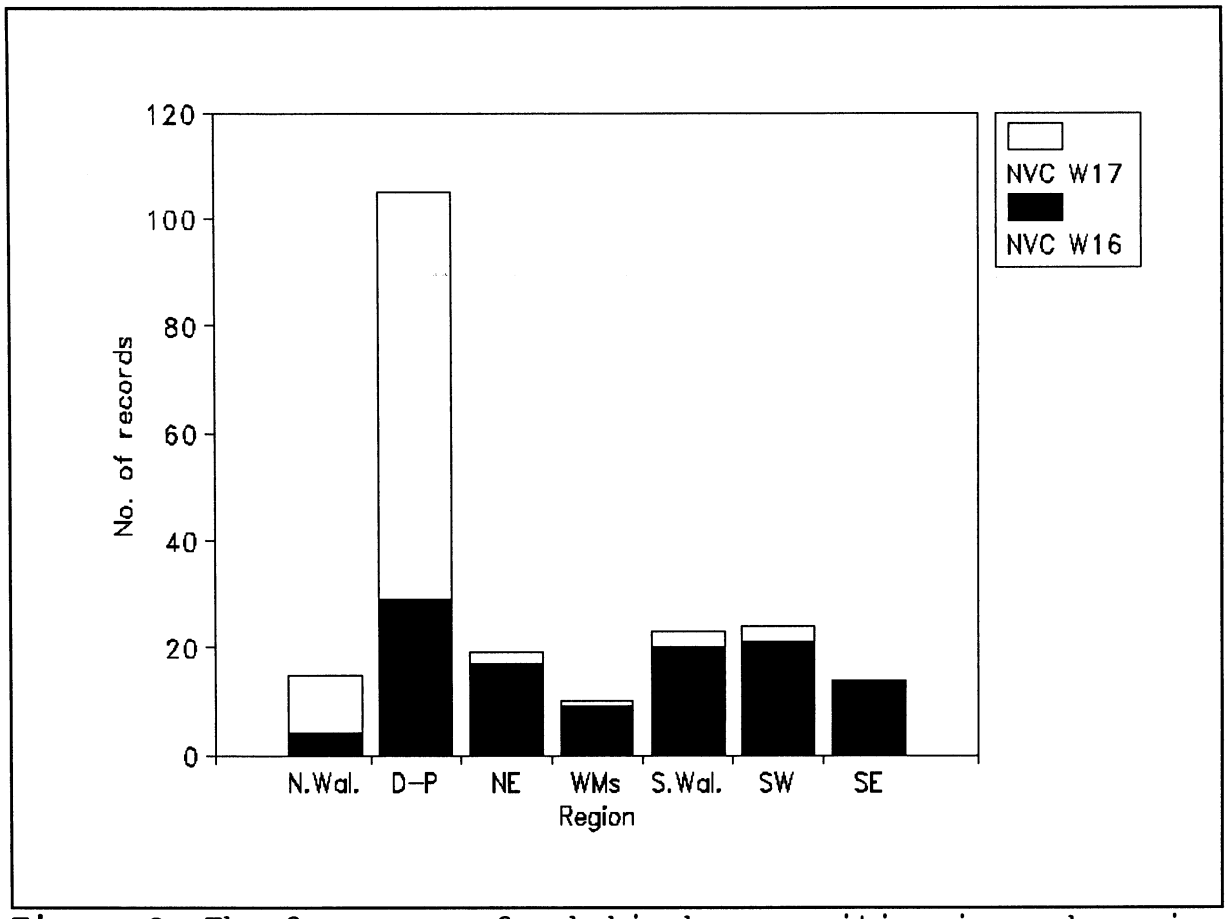


Figure 8 The frequency of oak-birch communities in each region

the transition to W17 reported in Rodwell (1991).

NVC W17 Quercus petraea - Betula pubescens - Dicranum majus Woodland.

This community is characteristic of the north and west of Britain where the climate is strongly Oceanic. Four sub-communities are recognized but only three were recorded. The fourth - W17d, Rhytidiadelphus triquetrus sub-community - is almost a sub-boreal community centred around the Scottish Highlands. All sub-communities are typified by the luxuriance of their bryophyte carpets, but this feature really attains prominence in W17a, the Isothecium myosuroides - Diplophyllum albicans sub-community. The Anthoxanthum odoratum - Agrostis capillaris sub-community, W17c, is the poorest in terms of its bryophyte community but here they still form a prominent feature with at least six of the common large woodland bryophytes present. The distinctive feature of this sub-community is, in association with the bryophytes, the field layer. This is dominated by acidophilous grasses, usually encouraged by the grazing of large herbivores on base poor soils. Where grazing is reduced or excluded then the proportion of ericoid sub shrubs (Calluna vulgaris, Vaccinium myrtillus) increases and the sub-community may become W17b, the Typical sub-community.

This bryophyte dominated community was the most common acidic oak-birch community recorded in the North Wales and Dyfed-Powys survey areas. Of the survey areas these two have the most Oceanic climate, and North Wales in particular is renowned for its sessile oak woods containing rich assemblages of Atlantic bryophytes (Ratcliffe 1968, 1977). The community was not recorded from South East England and was only recorded sparingly from the other survey areas. However the most demanding of the sub-communities, W17a, was not recorded outside North Wales and Dyfed-Powys. In the West Midlands the single record of W17c was from Derbyshire and considered to be a poor example; in the South West of England W17b was recorded from two sites, one on Bodmin Moor and the other from a high altitude oak wood on Dartmoor; in North East England the two records of W17b come from west facing slopes high in the Hambleton Hills, and in the South Wales survey area the four records of W17c all come from Brecknock.

The W17a sub-community frequently occurs as a mosaic with mixtures of W17b; it is often present on rocky ledges, boulders and around tree bases whilst the W17b occurs on the slightly deeper soils. If the site is grazed then W17b may be confined to less accessible areas.

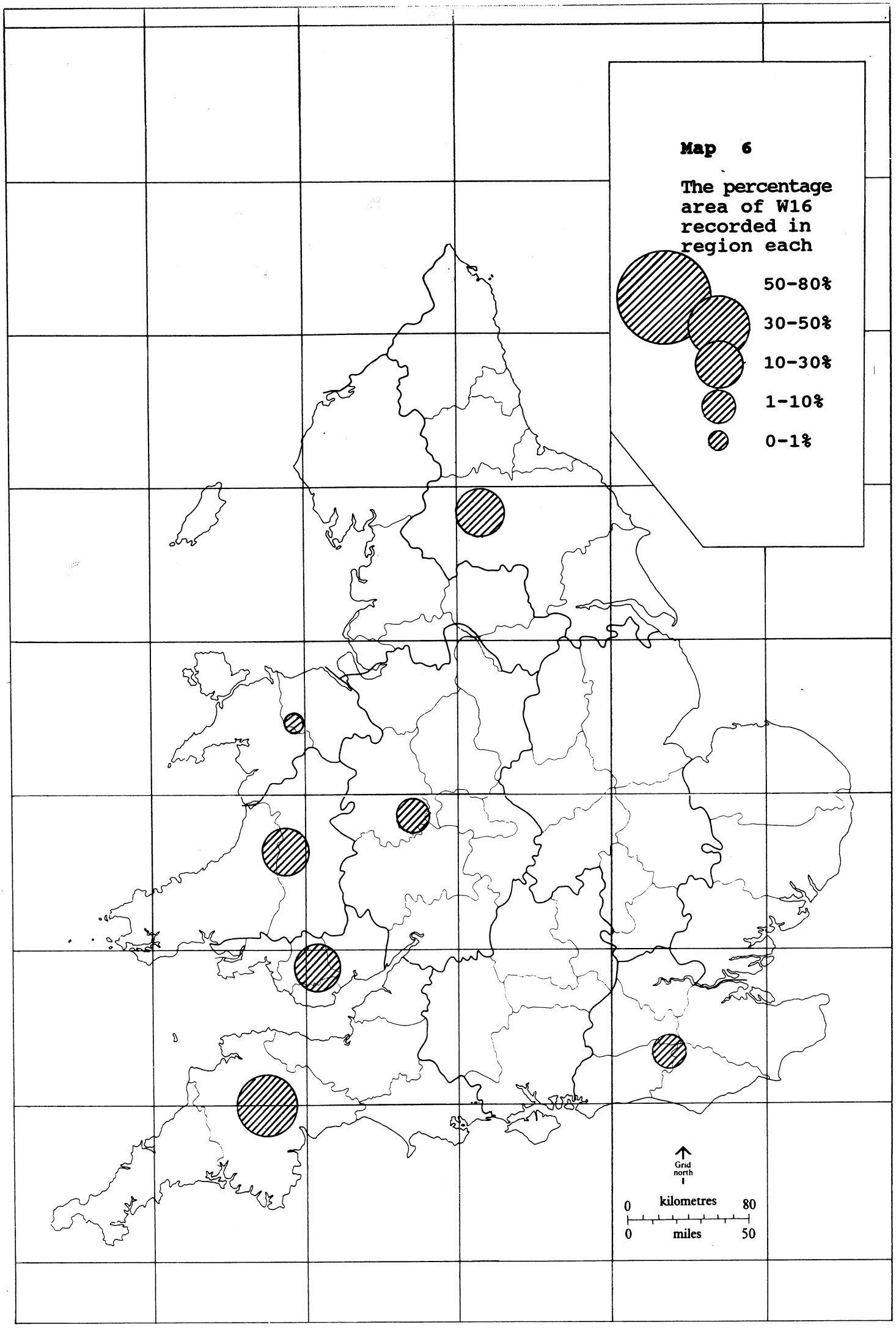
Beech dominated communities.

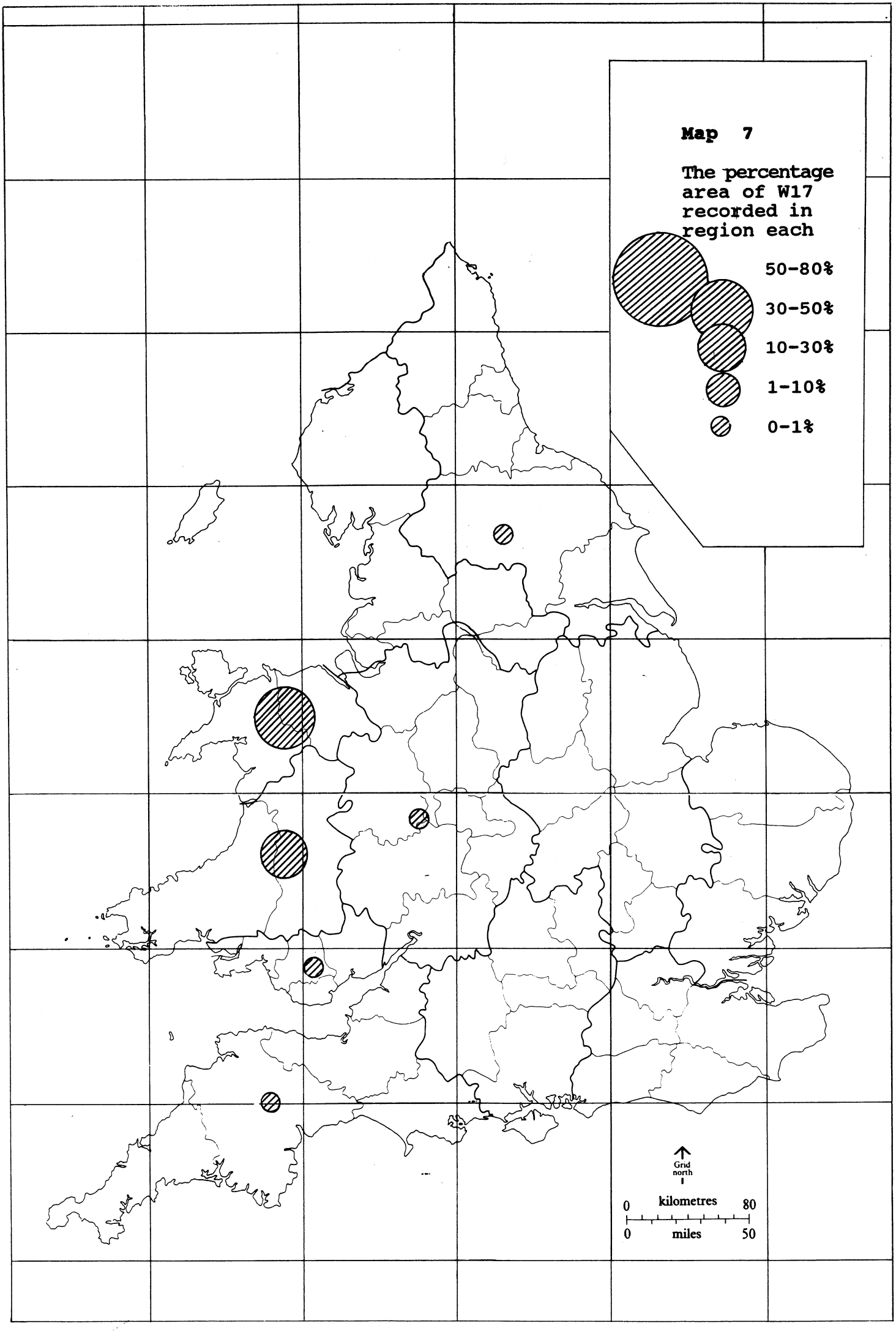
Beech is remarkably catholic in its preference for soil types (Evans 1984) and may be present on most soils except excessively damp ones. Woodland communities characterised by a pre-eminence of beech are represented by three NVC communities; W12 on base rich soils, usually chalk; W14 on mesotrophic soils, and W15 on base poor sites.

NVC W12 Fagus sylvatica - Mercurialis perennis woodland.

This community is split into three sub-communities, based largely on differences in available soil moisture, slope and soil depth (Rodwell 1991). Beech woodland has a poorly developed shrub and field layer, due mainly to the effects of canopy shade (Rackham 1980), but it is also negatively influenced by persistent beech litter (Sydes & Grime 1981a). In W12 both the shrub and field layers are qualitatively very similar to the analogous ash-elm community of base rich soils, W8, but the abundance of these shrub and field layer species is very much reduced.

Most of the records from this survey were for the Mercurialis perennis sub-community, W12a. This is the sub-community most likely to be encountered in non-native stands of beech as it is the least specialised, and is the closest to W8, which is presumably what these stands would be had beech not been introduced. The Sanicula europaea sub-community, W12b, was only recorded twice, both times from the West Midlands; one was a small stand resulting from amenity planting around an old quarry and the other a much larger native stand from Gloustershire over Jurassic limestones with a long history of high forest management. In places this sub-community is intermediate with W8a in this wood. The only records for W12c, the Taxus baccata sub-


Map 6
The percentage area of W16 recorded in region each
50-80%
30-50%
10-30%
1-10%
0-1%
Grid north
0 kilometres 80
0 miles 50


Map 7
The percentage area of W17 recorded in region each
50-80%
30-50%
10-30%
1-10%
0-1%
Grid north
0 kilometres 80
0 miles 50

community come from South East England. Here this sub-community represented 30% of all the beech stands classified. The records were all from sites on either the North or South Downs on thin soils. In some respects this is the most specialised of the sub-communities with southern shrubs such as Taxus, Buxus sempervirens and Sorbus aria present. This sub-community may grade into yew woodland, W13.

NVC W14 Fagus sylvatica - Rubus fruticosus agg. woodland.

This community was the most abundant beech community, recorded from all survey areas. Again the shrub and especially the field layers are qualitatively similar to the mesotrophic mixed deciduous woodland community, W10, but are again much reduced by shade cast by the beech canopy. The community was most abundant from South East England, where beech is native throughout. No sub-communities are recognised.

NVC W15 Fagus sylvatica - Deschampsia flexuosa woodland.

It is in this community that the beech canopy is generally the densest, and combined with the inherent floristic impoverishment of acidic soils, results in an extremely sparse and species poor field and shrub layer, and other tree species are usually confined to canopy gaps. Under the shade the bryophyte community is often distinctive, with typical calcifuges such as Dicranum scoparium, Leucobryum glaucum, and Polytrichum formosum present. Four sub-communities are present, differences between which are mainly related to the local light climate (Rodwell 1991).

This community was recorded from all survey areas except North East England (where it exists as plantations - but these were not sampled), but was most abundant in South Wales, South East and South West England. In South Wales this community was recorded from the base poor Pennant sandstones of the coal field. Here the woods were very dense and, unusually for beech, many had been managed as coppice, where it was used for charcoal production, needed for iron smelting (Marren 1992). In the South West of England the community was recorded from base poor brown earths and podzols with free to excessive drainage on older Devonian rocks. All records here were from non-native stands. The records from South East England are from areas of sandstone on the Weald. Most records from all areas were of the Fagus sylvatica sub-community, W15a, where the field layer is virtually absent due to shade.

Although beech communities were recorded from all survey areas beech itself is not native in many areas including the entire North-East England, North Wales and Dyfed-Powys survey areas. Its recorded presence in these areas is due to the recognition of NVC communities in beech plantations, where long established beech plantations develop the characteristic species poor communities of beech communities. Nevertheless, beech communities were recorded most frequently in South East England - the only area surveyed in which beech is native throughout.

The point at which an oak dominated stand with beech (eg W10 or W11) becomes a beech dominated stand with oak (eg W14 or W15) is not easy to define. In many cases the distribution of beech and oak in mixed woods in the south-east is complex and dependant on factors not yet fully understood (Rackham 1980). However, as a guide the other constituents of the community should be considered, ie the shrub, field and ground layers as these may be give better indication of the community than the canopy layer in difficult stands.

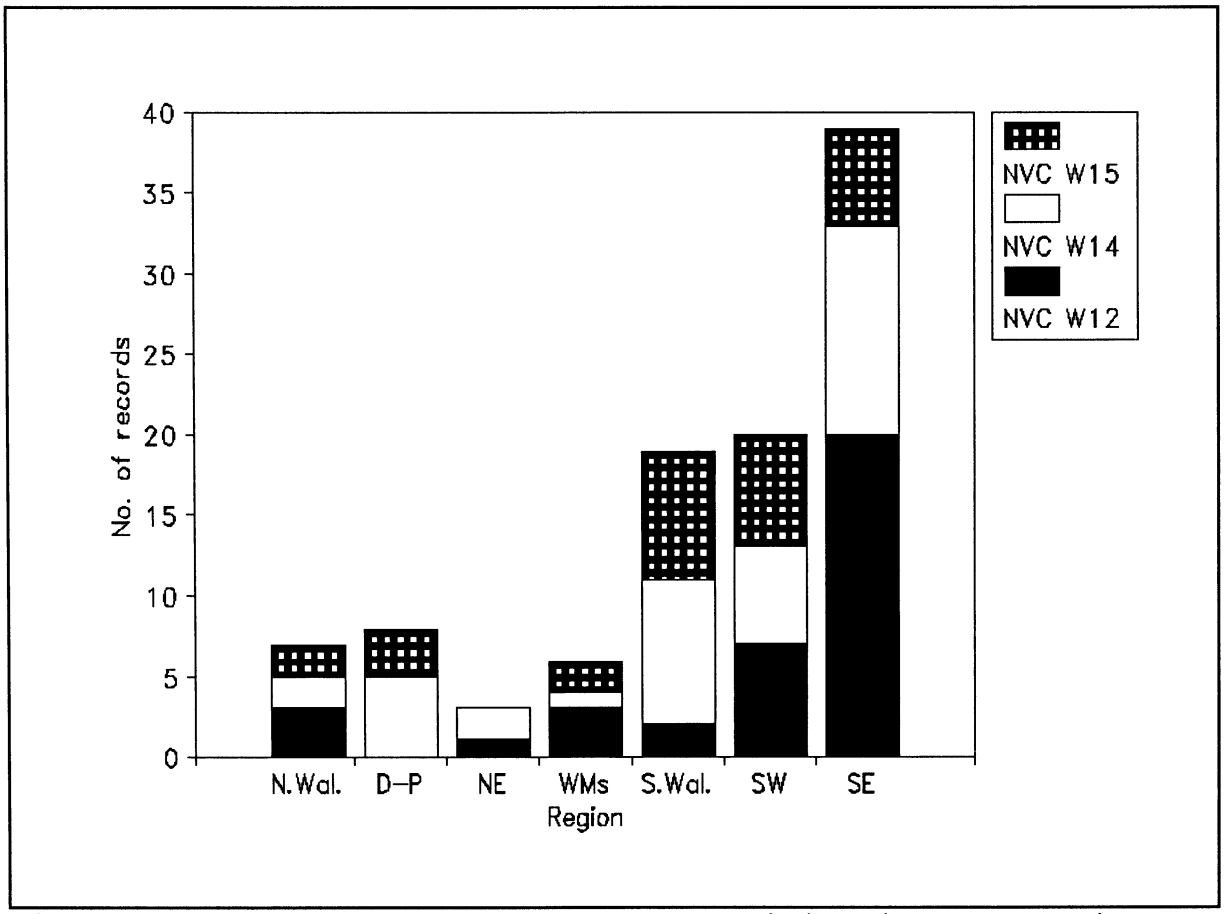


Figure 9 The frequency of beech communities in each region

Yew woodland, NVC W13 Taxus baccata woodland.

This community is dominated by yew with few other trees present. Due to the deep shade cast by the yew (Rodwell 1991), exacerbated by the often low canopy height, the community is notably species poor, with even the bryophytes poorly represented. Two sub-communities are recognised; W13a, the Sorbus aria sub-community where the field layer is virtually absent and W13b, the Mercurialis perennis sub-community with a slightly more open canopy allowing some development of field and ground layers. The latter sub-community was only recorded from South East and South West England, although in the South West it was a planted stand.

According to Rodwell (1991) this community is confined to the

Chalk of southern England, and yew dominated stands occurring elsewhere, for example on Carboniferous Limestone in Lancashire, are "best considered as variants of the north western types of W8". However the yew at Castle Eden Dene on Magnesian Limestone is included as W13 by Rodwell. Where yew dominated stands were encountered during this survey project they were classified according to their vegetation, irrespective of geology. Consequently W13 was recorded from North East England (yew stands on Carboniferous Limestone in the Yorkshire Dales), South Wales (Carboniferous Limestone in Gwent) and South West England (Carboniferous Limestone in Avon and Dorset), as well as from its more typical habitats on Chalk in South East England. Most of these records from Carboniferous Limestone were, however, very small stands (all below 2 ha except for one site in the Yorkshire Dales which was about 6 ha in extent), and the community remains very scarce.

Wet Woodland Communities.

Within this rather broad heading are seven NVC communities. With the exception of W7 they were all infrequently recorded, largely because W1 to W6 are more frequent in recent woodland, and these have been under sampled (see Site selection). However, woodland on fertile flood plains and along flat river valleys is also genuinely scarce due to the high agricultural value of such land.

The three Salix dominated communities; NVC W1 Salix cinerea - Galium palustre woodland, NVC W2 Salix cinerea - Betula pubescens - Phragmites australis woodland, and NVC W3 Salix pentandra - Carex rostrata woodland are usually recent woodland communities which have developed on a variety of formerly wet habitats. Rodwell (1991) gives the typical habitats of W1 as roadside ditches, dune slacks and the laggs of raised mires, W2 as either primary or secondary woodland developing on topogenous fen peats, and W3 as occurring in similar situations to W1, but as the northern counterpart of that community.

All of these communities were only rarely encountered so that little can be inferred from their sporadic occurrence in the results.

NVC W4 Betula pubescens - Molinia caerulea woodland.

This community is found on moist acidic peaty soils throughout Britain, and was frequently recorded from the Dyfed-Powys and South Wales survey areas. The canopy is dominated by Betula pubescens, sometimes with scattered Alnus glutinosa. The shrub layer is often indistinct, merging with the low canopy, with Salix cinerea the most common constituent. The most obvious feature of the ground flora is the dominance of Molinia caerulea, usually over a ground layer dominated by Sphagnum spp.

In Dyfed-Powys all records are for the Juncus effusus sub-community, W4b. This sub-community contains a greater proportion of grasses and sheep grazing may cause the increase in grazing tolerant grasses at the expense of other herbs. All sub-

communities were recorded from South Wales.

NVC W5 Alnus glutinosa - Carex paniculata woodland.

This community was most common in South Wales, being more frequently recorded here than all the other survey areas combined. In South Wales it occurs as small stands at the bottom of wooded slopes or valleys. Records come mostly from around the edge of the coalfield. The community is found on waterlogged organic soils which are base rich and moderately eutrophic, so it is unlikely to be found on non-calcareous strata. Alnus glutinosa is the most abundant canopy species, again with Salix cinerea in the shrub layer. Fraxinus excelsior may occur in drier areas, together with a range of other calcicole shrubs. The field layer is dominated by large sedge species such as Carex paniculata and C. acutiformis. Other species associated with fens are often present, including Eupatorium cannabinum, Iris pseudacorus, Phragmites australis and Valeriana spp. Ferns are usually conspicuous and mosses are common around sedge tussocks, but Sphagnum spp. tend to be rare, except along base poor seepages.

NVC W6 Alnus glutinosa - Urtica dioica woodland.

Another infrequently recorded wet woodland community, scattered throughout all the survey areas. This is a community of eutrophic moist mineral soils. The tree layer is most commonly dominated by Alnus, but Salices may be prominent. The field layer is dominated by Urtica dioica, and typical tall herb fen species are absent. This community is a acknowledged to be rather ill-defined. Five sub-communities are currently recognised, but Rodwell (1991) suspects that further sampling may warrant extra divisions. The community may be primary or secondary in origin, but is almost always recent woodland.

NVC W7 Alnus glutinosa - Fraxinus excelsior - Lysimachia nemorum woodland.

This was the most abundantly recorded of the wet woodland types in all survey areas (see Figure 10 and Map 8). It is found on moist to wet base rich mineral soils rather than on acidic peats. Alder is the usual canopy dominant, often with Fraxinus excelsior, Salix capraea, S. cinerea and, on drier soils, Acer pseudoplatanus. Again on drier soils Corylus avellana and Crataegus monogyna can form a distinct shrub layer, showing the strong affinities drier stands of this community have with W8 and W9. The field layer is generally composed of species preferring nutrient rich wet conditions such as Athyrium filix-femina, Lysimachia nemorum, and Ranunculus repens. On drier soils Mercurialis perennis and other calcicoles may occur. The ground layer is variable, and only Eurhynchium praelongum and Plagiomnium undulatum are frequent. Three sub-communities are present, and differences between them are largely related to variations in the extent of waterlogging and the nature of the water supply.

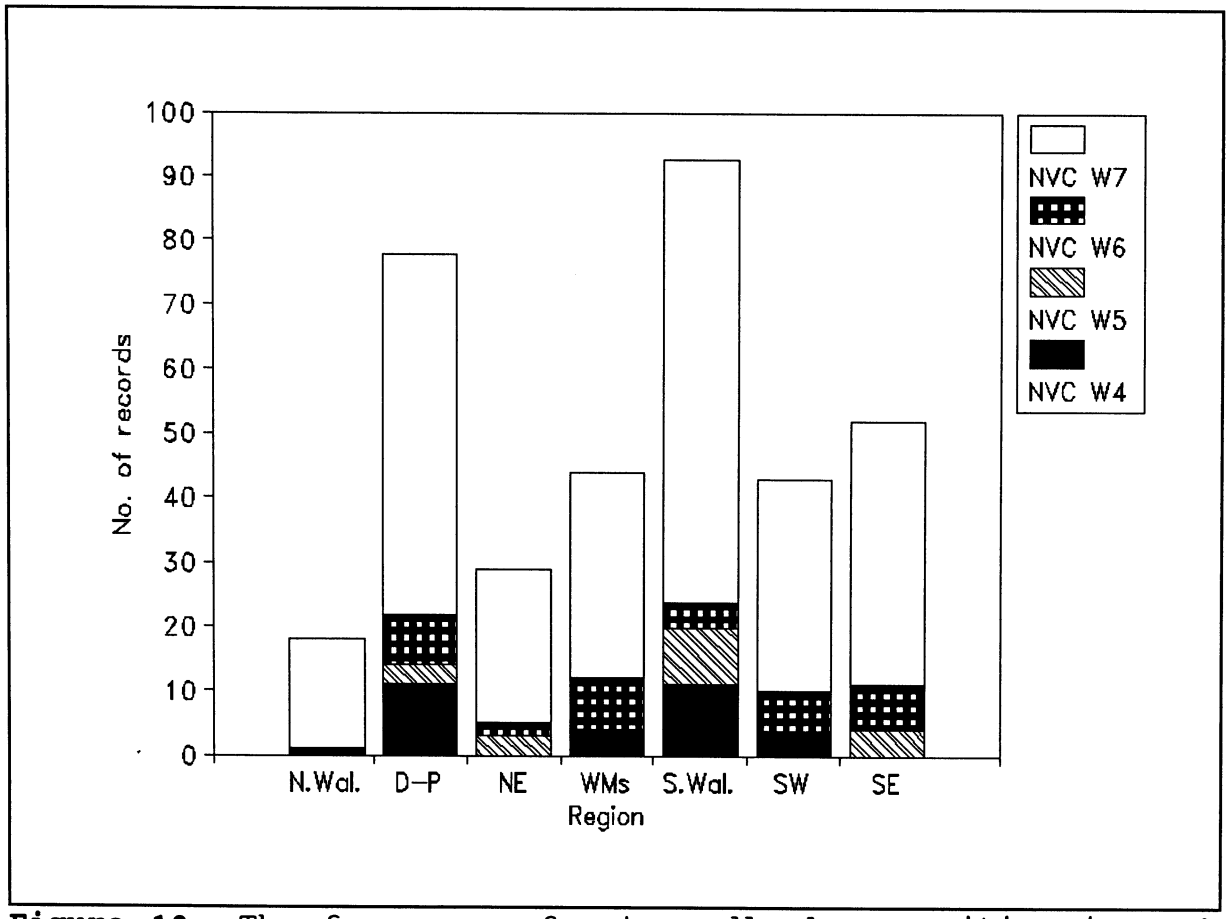
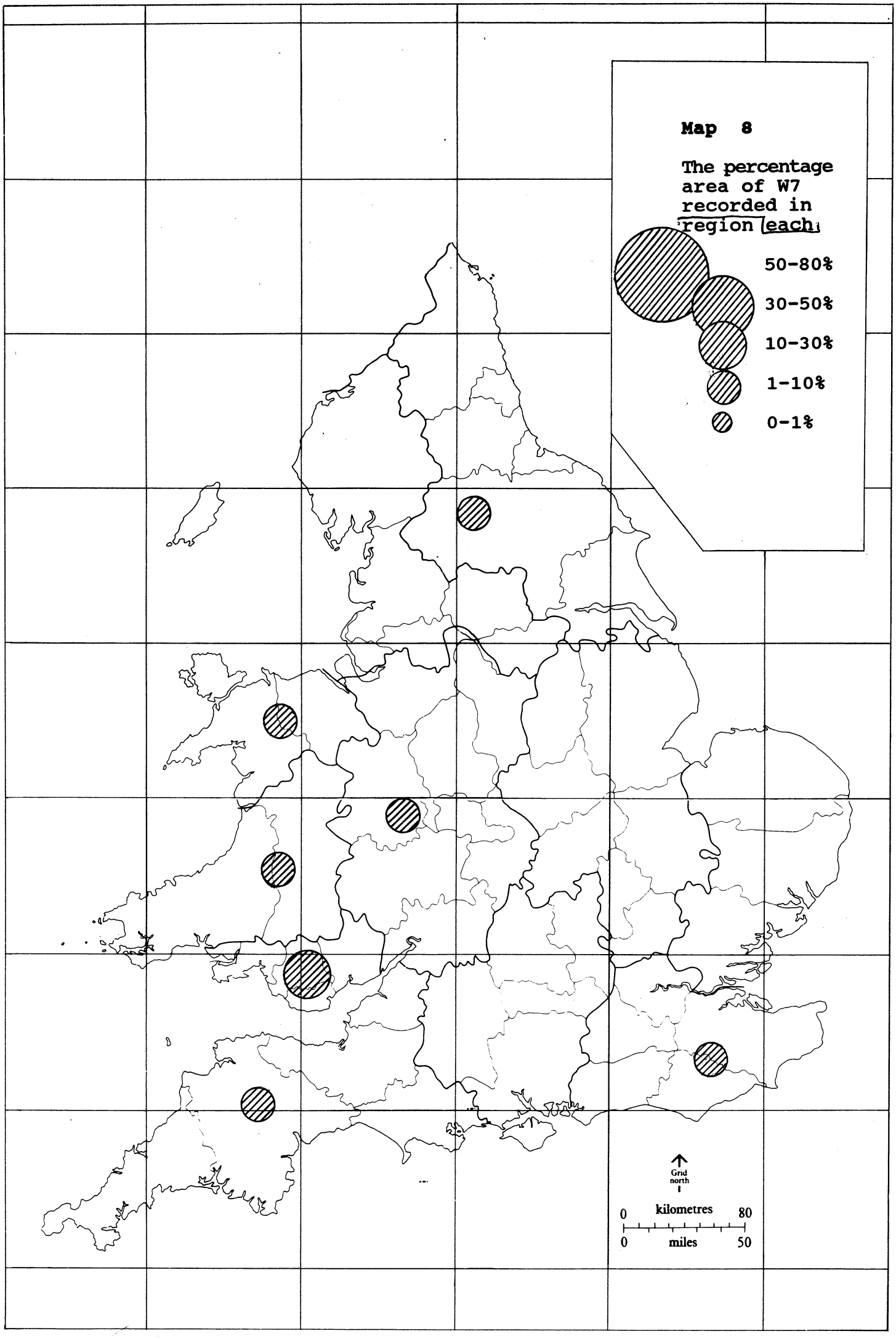


Figure 10 The frequency of wet woodland communities in each region

This community was found in two main situations, either along water courses in valley woodlands, or as alder dominated stands on level ground (plateau alder woods). The former were more frequent, occurring in many upland sites. Plateau alder woods are considered to be a scarce woodland type (Peterken 1981) because of the high agricultural value of the land, and those which survive often show signs of attempted drainage. Many such sites have been managed as coppice, alder having been a great favourite for clog soles (Linnard 1982).

Where the community occurs along valley bottoms it often represents the final stage of the continuum from acidic W17 or W16 at the top of the slope, through more mesotrophic W11 or W10 to flushed W9 or north western W8 types on receiving slopes and finally W7 at the foot of the slope, especially if there is some level ground. The boundary between any of these communities is often indistinct, and local conditions may result in a truncation of this series at either end, or indeed a mixing up of the order. Often in these situations W7 occurs in narrow linear patches, and as flat valley bottoms have usually been cultivated, most stands are now small (see page 41).


Map 8
The percentage area of W7 recorded in region each
50-80%
30-50%
10-30%
1-10%
0-1%
Grid north
0 kilometres 80
0 miles 50

Although more common in the north-west this community was frequently recorded from South East England (43 records), mostly from the Weald, where Rodwell (1991) also notes its presence. However, the records from South East England were generally very small areas and often poorly developed.

Discussion

Use of the NVC

This survey programme was the first comprehensive woodland survey project undertaken in England and Wales to exclusively use the NVC for classification purposes. The NVC has also been used in Scotland (Mackintosh 1988, 1990; Tidswell 1988, 1990).

This project was undertaken by surveyors who prior to the survey had limited experience of the NVC. Until 1988 pocket sized drafts of the woodland chapter had been unavailable, and the earlier bulky drafts were unsuitable for field use. (The woodland chapter of the NVC was published in 1991 (Rodwell 1991).) Before the surveys began the original surveyors received one week's intensive training in the field application of the woodland NVC chapter, whilst surveyors who joined the project later were largely trained on the job.

Early difficulties associated with the use of the NVC in normal phase 2 survey work, such as the recognition and appreciation of homogeneous stands, mapping and local variations to NVC communities are discussed in Cooke & Saunders (1989); references to local variations encountered in other survey areas can be found in the relevant survey reports (Barber & Cooke 1991; Cooke & Saunders 1990; Heath & Bevan 1991; Heath & Oakes 1991; Oakes & Whitbread 1990).

The overall ease with which the NVC was learnt and subsequently applied over large parts of England and Wales, using existing phase 2 survey methods (Kirby 1988a), suggests both the adaptability and robustness of the classification. Out of 2177 stands surveyed only 31 were not fully classified; these were mainly considered to be intermediate or mixed stands. However, no matter how experienced the surveyor or whatever the classification system used, some mis-classifications will inevitably occur (Kirby 1984a).

Genuine difficulties do exist with the survey of some woodland types late in the season. The identification of sub-communities W8b and W10b rely heavily on vernal species so that surveys late in the season will fail to pick these up (Kirby *et al* 1986), and their classification will be difficult. Inexperienced surveyors may put these stands into the 'default' communities (W8a, W10a).

Despite the inclusion of a few wet woods of recent origin the communities W1 to W6 are certainly under represented. This is especially true of W1, W2, W3 and W5 which tend to occur around mires and lake margins, rather than being associated with existing woods as W4 and W6 can be, and were therefore very

Table 4 Combined constancy table for W10 and W11 sub-communities
Field and ground layers only
Boxed species are those which are indicative of that sub-community

	W10a	W10b	W10c	W10d	W10e	W11a	W11b	W11c	W11d
Rubu frut	V	IV	V	IV	III	III	I	I	–
Pter aqui	IV	III	IV	V	III	III	IV	IV	IV
Loni peri	III	IV	V	III	II	III	II	II	II
Anem nem	I	IV	I	–	I	I	II	IV	II
Atri undu	I	II	I	I	I	II	–	I	II
Lami gale	I	II	I	–	–	–	–	–	–
Hede heli	II	II	IV	I	I	–	–	–	–
Gali odor	–	–	I	–	I	–	–	–	–
Gera robe	–	–	I	–	I	I	–	I	I
Holc lana	I	II	I	IV	I	–	–	I	II
Dact glom	–	–	–	I	I	–	–	–	–
Sene jaco	–	–	–	I	–	–	–	–	–
Oxal acet	I	I	I	I	IV	IV	V	V	V
Holc moll	II	I	II	I	IV	III	III	IV	V
Dryo dila	II	I	II	I	III	III	I	I	–
Eurh prae	II	II	I	I	III	III	I	I	III
Mniu horn	II	II	I	I	III	III	III	I	II
Viol rivi	I	I	I	I	II	II	IV	V	V
Thui tama	I	I	I	I	II	II	V	V	IV
Stel holo	I	I	I	I	II	II	I	I	III
Desc cesp	I	I	I	I	II	II	I	I	I
Brac rutu	I	I	I	I	II	–	–	–	–
Plam undu	I	I	I	I	II	III	I	I	IV
Isop eleg	I	–	I	I	II	–	–	–	–
Pseu puru	I	–	I	I	II	II	III	IV	V
Athy fili	I	–	I	–	II	I	II	I	I
Eurh stri	–	–	–	–	I	I	I	I	I
Oreo limb	–	–	–	–	I	I	III	I	I
Anth odor	I	–	I	I	I	IV	V	V	V
Agro capi	I	–	I	I	I	IV	IV	IV	V
Desc flex	I	–	I	I	I	IV	IV	V	III
Rhyt squa	–	–	–	–	–	III	IV	III	V
Gali saxa	I	–	I	I	I	III	IV	V	IV
Pote erec	–	–	–	–	–	I	V	IV	III
Hylo sple	–	–	–	–	–	I	IV	V	IV
Dryo affi	I	–	I	–	I	II	I	I	I
Digi purp	I	–	I	I	I	II	–	I	I
Dryo fili	II	I	II	I	II	II	I	I	I
Pleu schr	–	–	–	–	–	II	IV	III	–
Dicr maju	–	–	–	–	–	II	V	III	–
Hyac non-	III	IV	II	I	III	III	IV	I	II
Poly form	–	–	–	–	–	III	IV	I	I
Blec spic	I	I	I	I	–	I	V	II	I
Hypn cupr	I	I	I	I	I	III	III	I	I
Prim vulg	I	–	I	–	I	II	III	I	II
Isot myos	I	–	I	I	I	II	III	I	I
Rhyt lore	–	–	–	–	–	I	III	I	I
Plag dent	I	–	I	I	I	I	II	I	I
Cory avel	–	–	–	–	–	I	II	–	I
Dipl albi	–	–	–	–	–	I	II	–	I
Hylo brev	–	–	–	–	–	–	II	I	–
Spha quin	–	–	–	–	–	–	I	–	–
Plag spin	–	–	–	–	–	–	I	–	–
Rhyt triq	–	–	–	–	–	I	II	IV	IV
Luzu pilo	I	I	I	I	I	II	II	IV	I
Trie euro	–	–	–	–	–	–	I	III	I
Lath mont	–	–	–	–	–	–	I	II	I
Mela prat	I	I	I	I	–	I	I	II	I
Rubu idae	I	–	I	I	I	I	I	II	I
Plag affi	–	–	–	–	–	–	–	I	–
Vacc vitu	–	–	–	–	–	–	–	I	–
Conv maja	–	–	–	–	–	–	–	I	–
Pyro mino	–	–	–	–	–	–	–	I	–
Brac sylv	I	–	I	I	I	–	–	–	–
Vero cham	I	I	–	I	I	I	II	III	V
Loph bide	I	–	I	I	I	III	I	II	IV
Luzu mult	–	–	I	I	I	I	I	I	III
Ajug rept	I	I	I	–	I	I	–	II	III
Hype pulc	–	–	–	–	–	–	II	II	III
Fest rubr	–	–	–	–	–	–	I	I	III
Vero offi	–	–	–	–	–	–	II	II	III
Cera font	–	–	–	–	–	–	–	I	III
Rum actsa	I	I	I	I	I	I	–	I	II
Frax ex**	I	I	I	I	I	–	I	I	II
Ange sylv	–	–	–	–	–	–	I	I	II

Table 5 Combined constancy table for W8 and W10 sub-communities

Field and ground layers only

Boxed species are those which are indicative of that sub-community

	W8a	W8b	W8c	W8d	W8e	W8f	W8g	W10a	W10b	W10c	W10d	W10e
Merc pere	IV	III	II	V	IV	V	V	I	-	I	-	I
Eurh prae	IV	IV	III	II	IV	V	V	II	II	I	I	III
Rubu frut	IV	III	V	IV	III	III	II	V	IV	V	IV	III
Poa triv	III	II	II	I	I	-	I	I	I	I	I	I
Glec hede	III	II	I	I	I	-	I	-	-	-	-	-
Prim vulg	III	II	I	I	I	I	I	I	-	I	-	I
Viol ri/re	II	II	II	II	I	-	II	I	I	I	I	II
Ajug rept	II	II	II	I	I	-	-	I	I	I	-	I
Prim elat	I	I	I	I	-	-	-	-	-	-	-	-
Prim v X e	I	I	-	-	-	-	-	-	-	-	-	-
Anem nemo	I	IV	I	I	I	II	I	I	IV	I	-	I
Ranu fica	I	IV	-	I	I	II	-	I	I	-	-	I
Lami gale	I	II	I	I	I	I	I	I	II	I	-	-
Rume sang	I	II	-	I	I	-	-	I	I	I	I	-
Desc cesp	I	I	V	I	I	I	II	I	I	I	I	II
Fili ulma	I	I	II	I	I	I	II	-	-	-	-	-
Pote ster	I	I	II	I	I	-	I	-	I	I	-	I
Lysi nemo	I	I	II	-	-	-	-	I	I	-	I	I
Junc effu			II	-	-	-	-	I	-	I	I	I
Hede heli	II	II	II	IV	III	III	II	II	II	IV	I	I
Urti dioi	II	II	-	I	III	III	III	I	I	I	I	I
Gali apar	I	II	I	I	III	III	II	-	-	-	-	-
Gera robe	I	I	-	I	III	II	II	-	-	I	-	I
Eurh stri	I	I	-	I	III	II	II	-	-	-	-	I
Tham alop	I	I	I	I	II	II	I	-	-	-	-	-
Aspl scol	-	-	-	I	II	II	I	-	-	-	-	-
Cten moll	-	-	-	-	I	I	I	-	-	-	-	-
Alli ursi	I	I	I	I	II	V	I	-	-	-	-	-
Brac sylv	II	I	II	III	II	I	IV	I	-	I	I	I
Teuc scor	-	I	-	I	I	-	IV	I	I	I	I	I
Meli unif	I	I	I	I	I	-	III	I	I	I	I	I
Arrh elat	-	-	-	-	I	I	III	-	-	-	-	-
Camp lati	-	I	-	-	I	-	II	-	-	-	-	-
Poly acul	I	-	-	-	I	-	II	-	-	-	-	-
Myos sylv	-	-	-	-	I	-	II	-	-	-	-	-
Plag dent	-	-	-	-	I	-	II	I	I	I	I	II
Conv maja	-	-	-	-	I	-	II	-	-	-	-	-
Meli nuta	-	-	-	-	-	-	II	-	-	-	-	-
Rubu saxa	-	-	-	-	-	-	II	-	-	-	-	-
Rosa vill	-	-	-	-	-	-	I	-	-	-	-	-
Pter aqui	I	I	I	I	I	-	-	IV	III	IV	V	III
Loni peri	II	II	II	I	I	I	-	III	IV	V	III	II
Atri undu	II	I	II	I	I	I	II	I	II	I	I	I
Gali odor	I	I	-	I	I	-	I	-	-	I	-	I
Holc lana	I	I	I	I	-	-	I	I	II	I	IV	I
Dact glom	I	I	-	I	I	-	I	-	-	-	I	I
Sene jaco	-	-	-	-	-	-	-	-	-	-	I	-
Oxal acet	I	I	I	-	I	I	-	I	I	I	I	IV
Holc moll	I	I	-	-	I	-	I	II	I	II	I	IV
Dryo dila	I	I	-	I	I	I	-	II	I	II	I	III
Mniu horn	II	II	I	I	I	-	II	II	II	I	I	III
Thui tama	II	I	II	I	I	I	I	I	I	I	I	II
Stel holo	I	I	-	I	I	I	-	I	I	I	I	II
Brac rutu	III	II	III	II	III	V	I	I	I	I	I	II
Plam undu	III	III	II	I	III	II	III	I	I	I	I	II
Isop eleg	-	-	-	-	-	-	-	I	-	I	I	II
Pseu puru	-	-	-	-	-	-	-	I	-	I	I	II
Athy fili	I	I	-	I	I	-	I	I	-	I	-	II
Oreo limb	-	-	-	-	-	-	-	-	-	-	-	I

Table 7 Combined constancy table for W8 and W10 communities
Only species with a constancy of II or more are listed

	W8	W9
Frax exce	IV	IV
Acer camp	II	
Quer robu	III	
Acer pseu	II	
Ulmu glab	II	II
Sorb aucu		III
Betu pube		III
Acer pseu		II
Cory avel	V	IV
Crat mono	III	II
Acer camp	III	
Frax exce	III	
Samb nigr	II	
Corn sang	II	
Acer pseu	II	
Ilex aqui	II	
Merc pere	V	IV
Eurh prae	IV	IV
Rubu frut	IV	
Poa triv	II	III
Glec hede	II	
Prim vulg	II	
Viol ri/re	II	IV
Hede heli	III	
Urti dioi	II	
Gali apar	II	
Gera robe	II	III
Eurh stri	II	IV
Brac sylv	II	III
Hyac non-	III	III
Brac ruta	III	
Plgm undu	III	IV
Circ lute	III	III
Geum urba	II	III
Fiss taxi	II	
Arum macu	II	
Atri undu	II	III
Mniu horn	II	III
Frax seed	II	II
Dryo fili	II	IV
Rosa cani	II	
Loni peri	II	
Oxal acet		IV
Thui tama		IV
Pote ster		III
Dryo dila		II
Fili ulma		III
Cono maju		III
Crep palu		II
Cirr pili		II
Desc cesp		II
Rhyt triq		II
Plag aspl		II
Athy fili		III
Dact glom		II
Dryo affi		II
Prim vulg		II
Vero cham		II
Loph bide		II
Lysi nemo		II
Epilo mont		II
Sani euro		II
Hypn cupp		II

Table 6 Combined constancy table for W16b and W17b
Only species with a constancy of II or more are listed

	W16b	W17b
Betu pend	III	
Quer petr	V	V
Betu pube	III	III
Ilex aqui	II	II
Sorb aucu	III	III
Betu pube	II	II
Quer petr	II	II
Cory avel		III
Desc flex	V	V
Pter aqui	III	III
Vacc myrt	III	IV
Dryo dila	III	II
Dicr hete	II	
Hypn cupp	II	II
Isop eleg	II	
Mniu horn	II	IV
Lepi rept	II	
Call vulg	II	III
Rubu frut	II	
Rhyt lore		IV
Poly form		IV
Dicr maju		V
Hylo sple		III
Pleu schr		IV
Plgt undu		III
Isot myos		II
Dipl albi		II
Blec spic		II
Quer petr		II
Clad aqua		II
Gali saxa		II
Anth odor		II
Dicr scop		III
Thui tama		III
Loph bide		III
Hypn jutl		III
Loni peri		II
Sorb aucu		II
Spha quin		II

sparingly encountered. Similarly those sub-communities of more established woodland types which are more frequent in secondary or disturbed stands will be under recorded. This group includes W8c in the South East, W10c everywhere and W16a in the uplands. The same is true for scrub communities, W19 to W25, which were generally not considered during these surveys.

When first using the NVC in these surveys it was found useful to draw up constancy tables across communities. These have the advantage of highlighting the differences between homologous sub-communities from different communities. Examples of these are given in Tables 4 to 8. In different survey areas other types may be more problematical, and similar tables can be constructed as appropriate.

Quadrat recording

The NVC was constructed from samples of vegetation collected as quadrats. However, the collection of quadrats is not necessary for the identification of communities. In the first instance the surveyor should rely on quadrats until familiar with the community when identification then becomes possible with the key and constancy tables. If an area is surveyed extensively then most of the common communities will become familiar enough to recognise by eye. Quadrats should not be dispensed with altogether, since they remain the only objective method of community identification (although unfortunately not always unambiguously so). They should always be recorded by novice surveyors as well as by experienced surveyors when they encounter an unfamiliar vegetation type. They will also be needed as a periodic check that the classifications arrived at in the field are correct, for example from about 5% of woods (Kirby, Saunders & Whitbread 1991). Quadrat data are now required by English Nature if a site is to be notified as an SSSI, where they are used to confirm NVC classification when the site is first proposed as an SSSI.

Extensions to known ranges

The woodland chapter of the NVC was compiled from 2800 samples collected throughout Britain (Rodwell 1991). During this survey over 2100 stands were classified from parts of England and Wales. Most of the surveys were from sites not previously surveyed and therefore represent 'new' NVC records. In general the community and sub-community distribution patterns and trends observed by Rodwell (1991) are confirmed by this survey, but some significant extensions to the previously described ranges of some communities were recorded.

In this survey W9 was also recorded from the Derbyshire Peak District (see Map 12) and links the two previously separate distributions in England and Wales to form a continuous north-west distribution pattern.

The new records for W16 show that it is common in Wales, where it was previously unrecorded (Map 15) probably because acidic oak

woods in the southern half of Wales were under sampled in the compilation of the NVC.

The distribution map of W7 (map 10) shows no major extensions to the range although the community is commoner in some areas than the NVC would suggest, for example South East and South West England.

Several sub-communities were also found to have wider ranges. NVC W11b was previously only recorded from Scotland; in this survey it was found to be occasional in both North Wales and North East England (Map 14). W8g was previously only recorded from the Peak District and as a solitary record from the Wye Valley, but has now been recorded from limestone areas in South Wales and Dyfed-Powys and as solitary records in the Yorkshire Dales and West Sussex - as a probable outlier (Map 11).

The most significant of the increase in sub-community range was that of NVC W10e (Map 13). Its presence in both Wales and South West England is not surprising given the floristic composition of the sub-community, but in South East England it is a little more surprising. Its presence here may be due to the same factors which have resulted in the occurrence of W9 and W8g, its higher frequency a result of its less exacting requirements than either W9 or W8g. However, the records in South East England are all for small, rather poorly developed stands.

NVC community size

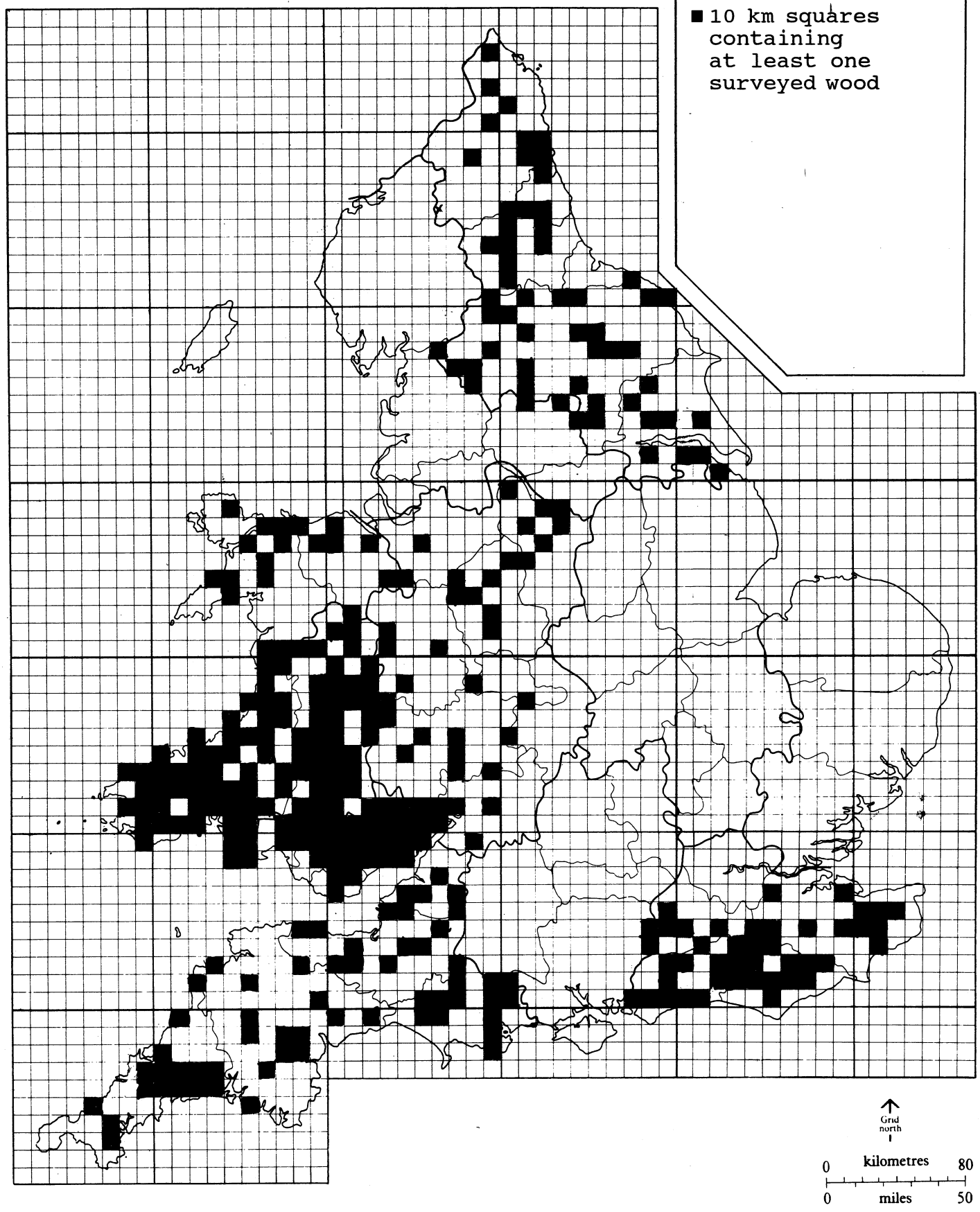
Individual areas of particular NVC communities tend to be limited by habitat availability or by the limits of suitable edaphic and climatic conditions within the wood. Different management regimes may also impose less natural but equally effective boundaries.

In the lowlands most woods occur on deep, relatively uniform soils on more or less level ground, which may mask the influence of any underlying geology. Therefore the variety of NVC types found in a wood here may be less than that in a wood of comparable size in the uplands, where soils are often shallower.

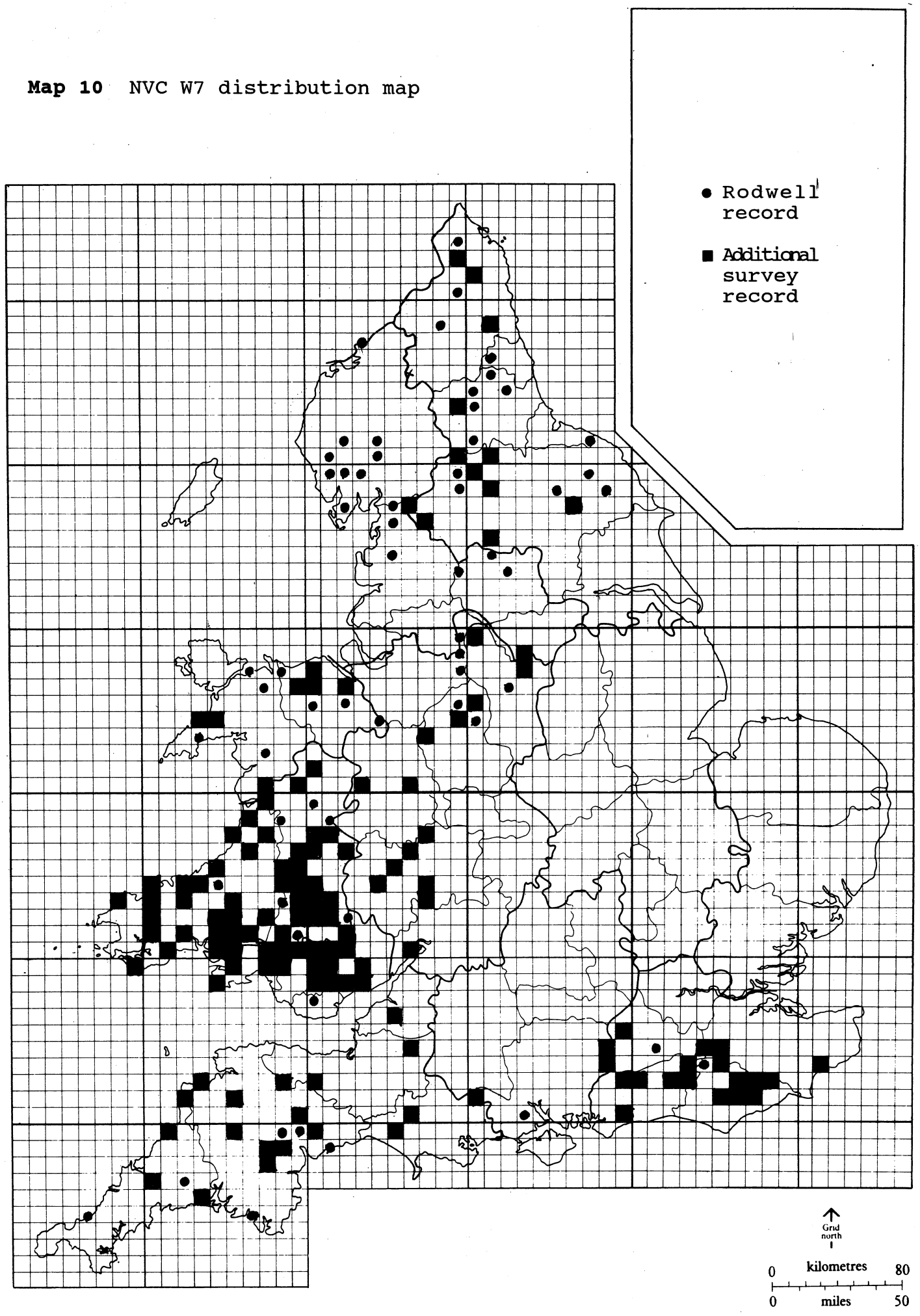
In upland areas most semi-natural woodland is confined to river valleys where the variety of NVC types will be determined by exposures of different rock strata at different levels. For example in sites around the edge of the South Wales coalfield Pennant sandstones, Millstone grits and Carboniferous Limestone are all commonly encountered in valley woods giving rise to a range of communities from base rich to base poor types.

Variation is also exacerbated by the effects of leaching. In many parts of Britain the geology is very uniform, as in mid Wales where Ordovician and Silurian shales predominate. In these areas of mainly non-calcareous rocks NVC communities of base rich substrates are still frequent; they occur on the lower slopes of hill sides and valleys where nutrients accumulate on receiving slopes. The size of communities in these situations will be limited by the topography of the site, ie those areas where

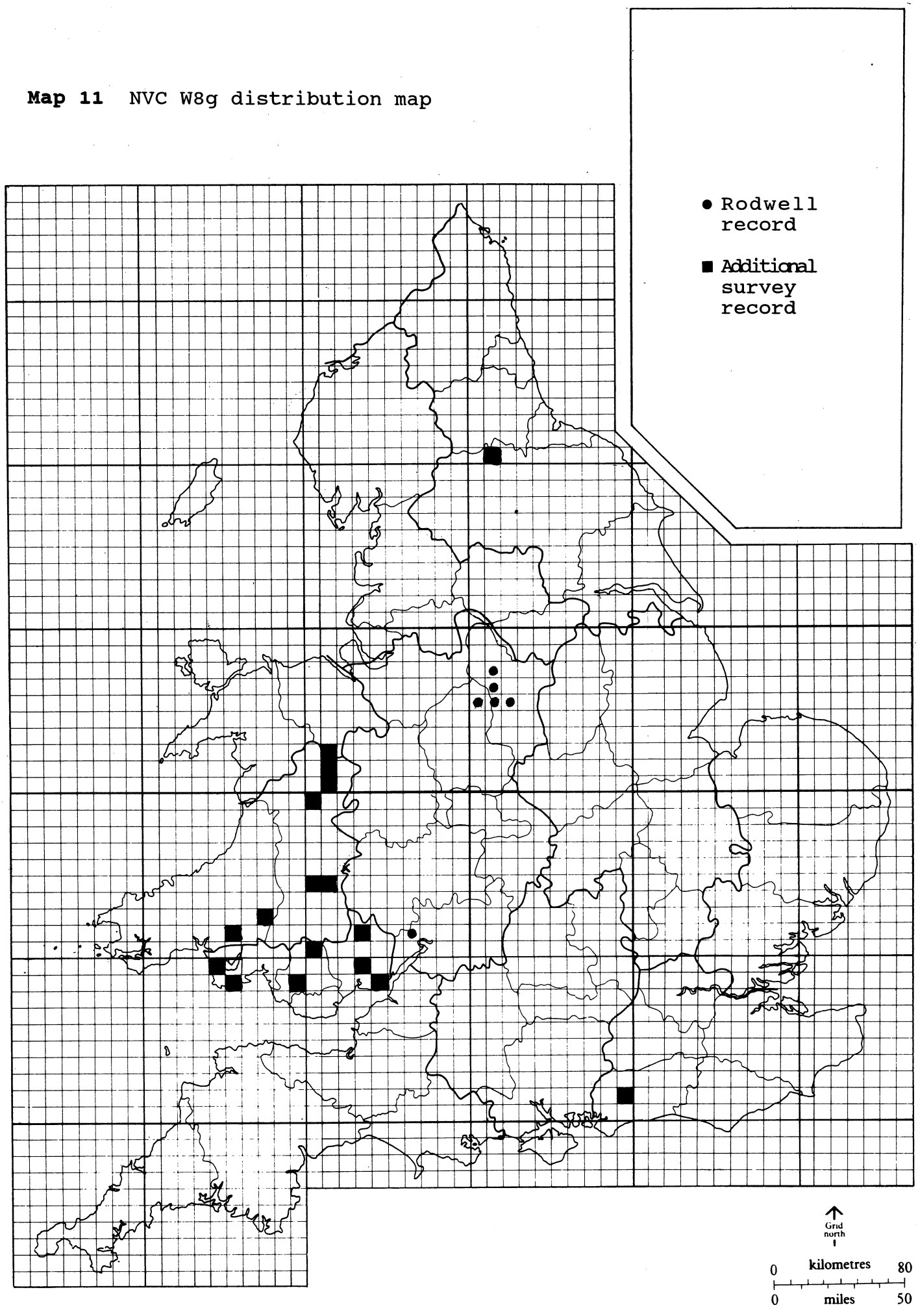
Map 9 The distribution of surveyed woods



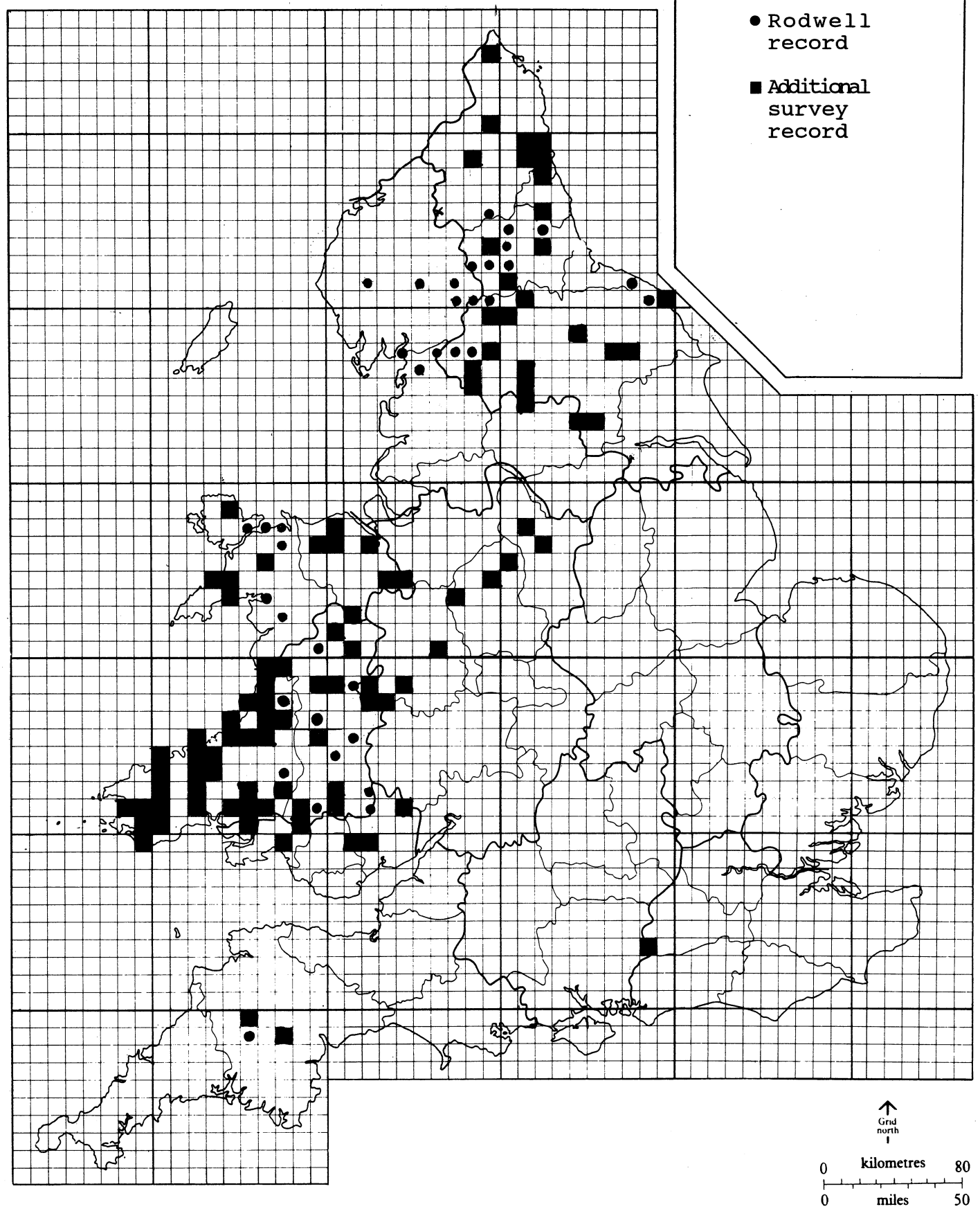
Map 10 NVC W7 distribution map



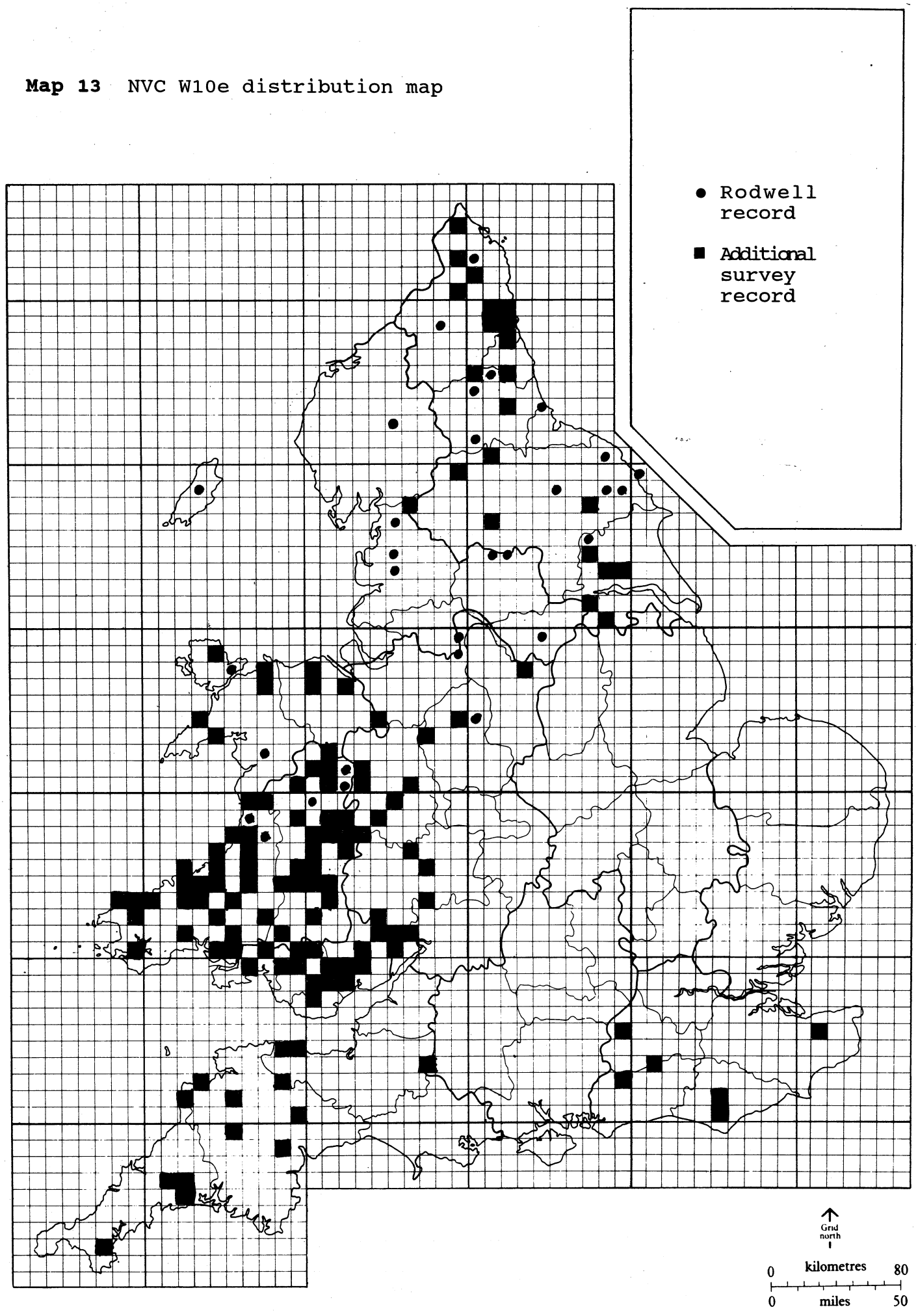
Map 11 NVC W8g distribution map



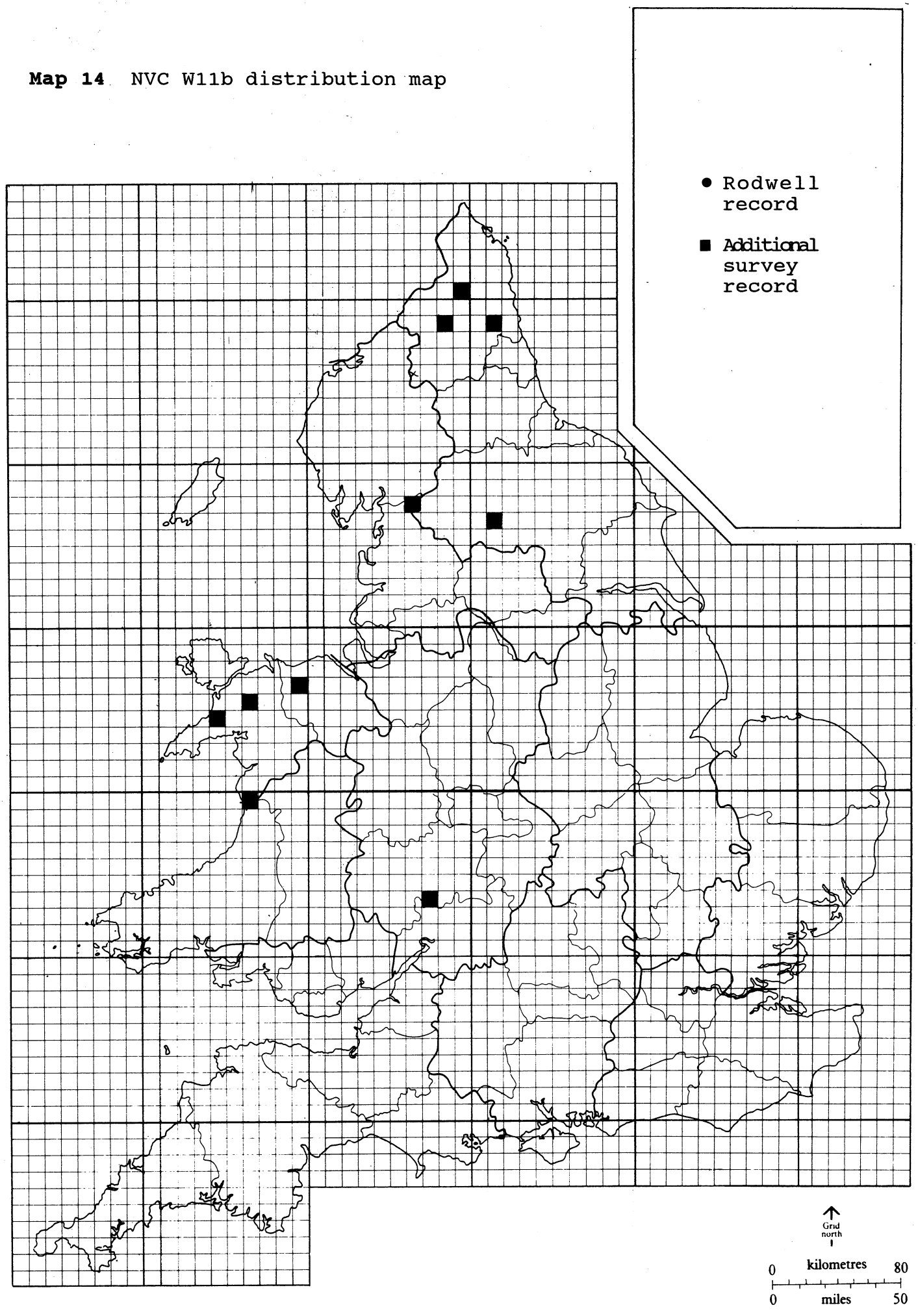
Map 12 NVC W9 distribution map



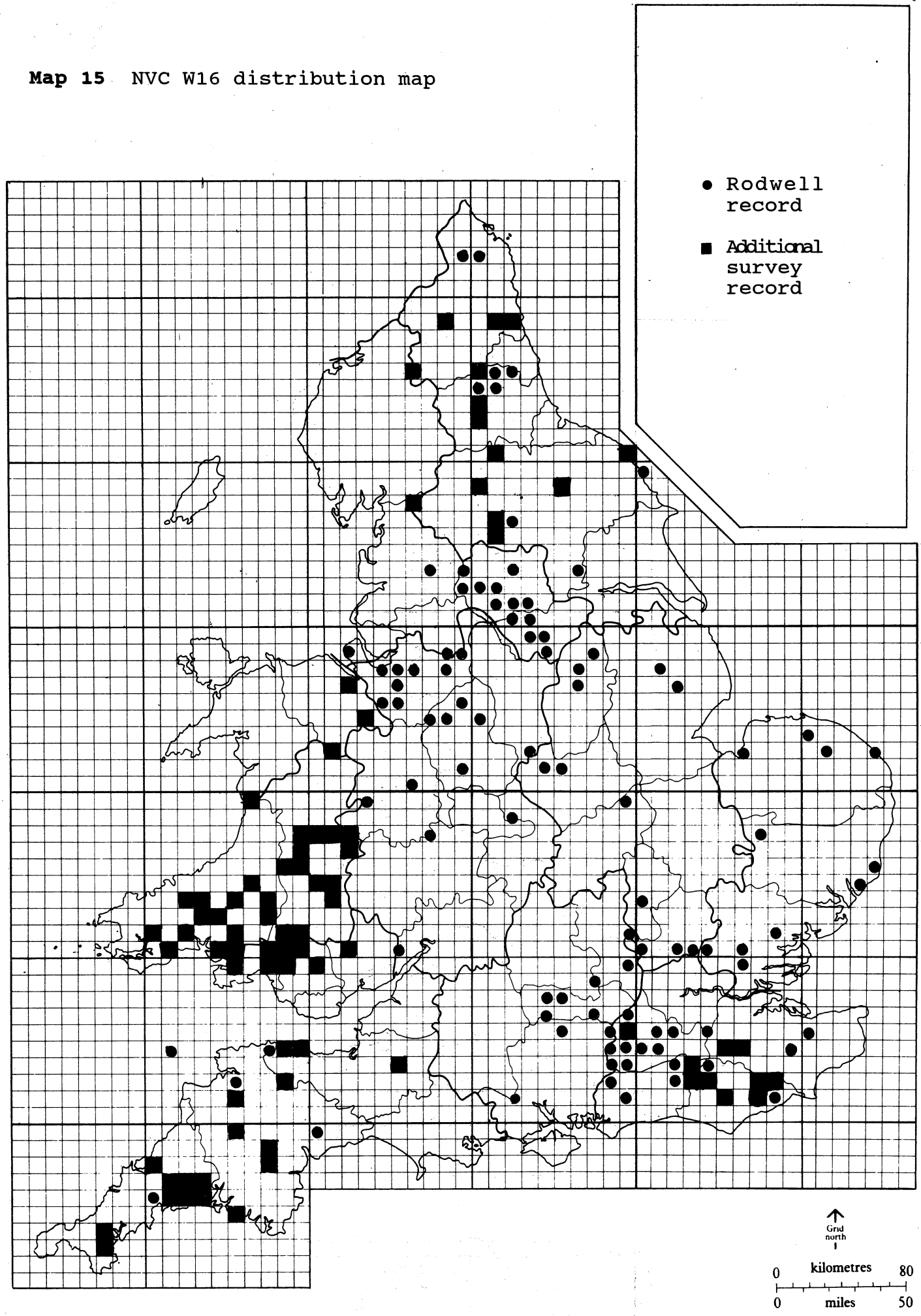
Map 13 NVC W10e distribution map



Map 14 NVC W11b distribution map



Map 15 NVC W16 distribution map



receiving soils occur. They will usually be linear in shape, and may be atypical in that much of the community will be influenced by edge effect. This contrasts with woods on limestone where, for example, W9 may occupy most if not the whole site.

Alder woodland (as W7) can be found on two main habitat types, along water courses within woods and on waterlogged level ground. The habitat type is likely to influence the community size: along water courses the wet ground is only likely to extend a few metres either side of the stream and therefore W7 will be limited to this area. In some instances the community may be so narrow that a characteristic canopy layer is absent and it may be overstood by a tree and shrub layer more typical of W8 or W9. In alder woods on waterlogged ground W7 is much more likely to occupy large stands as there will be little variation in topography within the site.

During these surveys a total of 557 ha of W7 was recorded from 304 stands giving an average area of 1.8 ha (Figure 11). By comparison W10 sub-communities were recorded from 599 stands totalling 5023 ha, an average stand size of 8.4 ha. Large stands of woodland communities that usually occur as small stands, such as W7, are, therefore, of increased importance.

Larger stands of any community are also likely to be better examples of the community type, having more of the characteristic species and larger populations of those species.

The stability of NVC communities

Changing NVC types

Factors affecting the composition of any or all of the vegetation layers in a woodland may affect the NVC community, since this is determined solely by the vegetation at a given point in time. The NVC takes no account of past or possible future plant communities, and the structure of a wood is not considered when arriving at the appropriate classification.

Changes in woodland vegetation may be natural, such as the processes of succession, response to climate change (Cannell, Grace & Booth 1989), colonisation, fire, and storm damage (Whitbread 1991), or they may be anthropogenic such as land use change, replanting (Kirby 1988b), clearfelling (Kirby 1990) and other methods of woodland management. Rodwell (1991) has speculated that pollution in the Pennine fringes may have resulted in a change from bryophyte rich W17 to bryophyte poor W16 in some stands; this may have also occurred around the southern fringes of the coalfield in South Wales where atmospheric pollution is also prevalent.

Changes to the woodland vegetation caused by these processes may occur gradually or abruptly, the rate of change varying with many other site factors. For example, grazing may induce both abrupt and gradual change, while coppice may cause both short term change in the field layer during a single rotation and long term

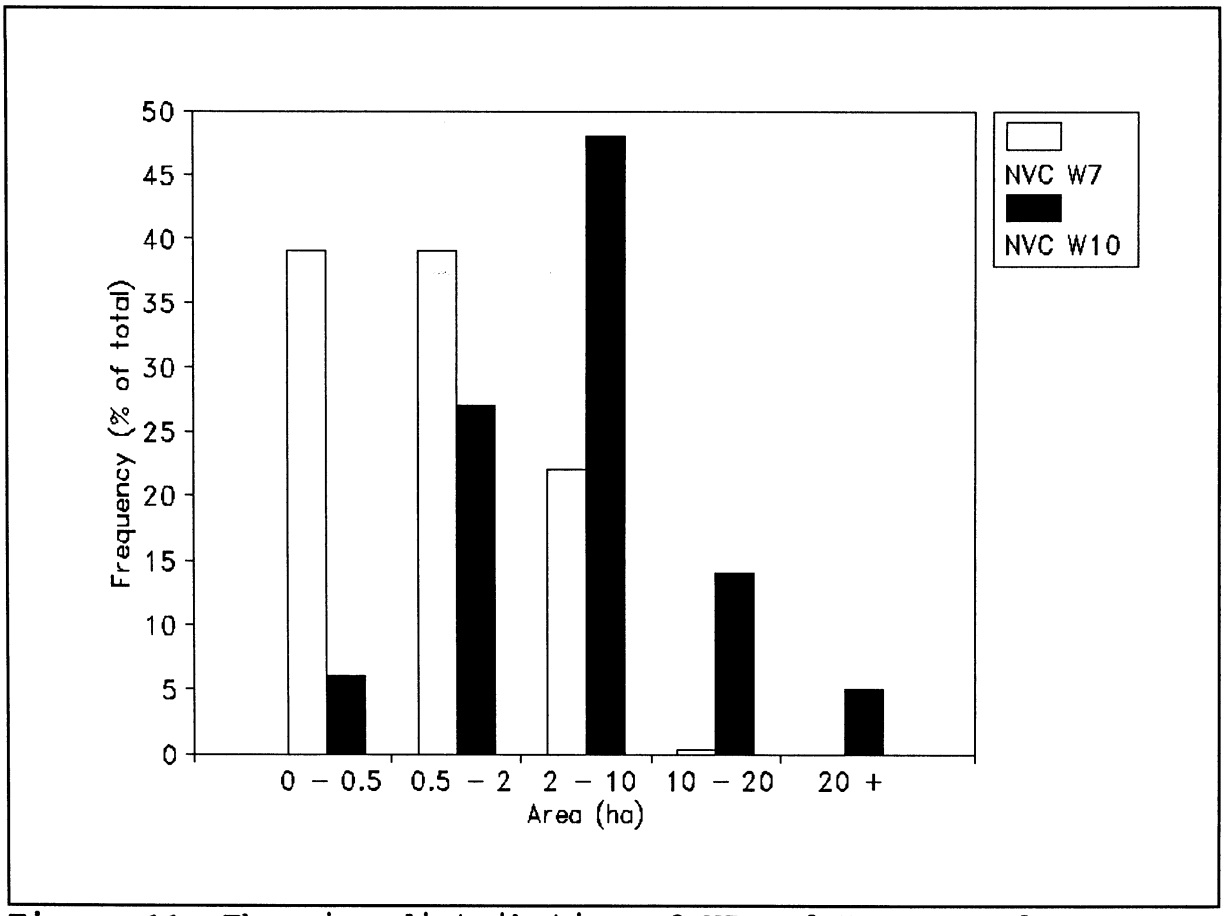


Figure 11 The size distribution of W7 and W10 records

change through the decline in non-coppicing shrubs.

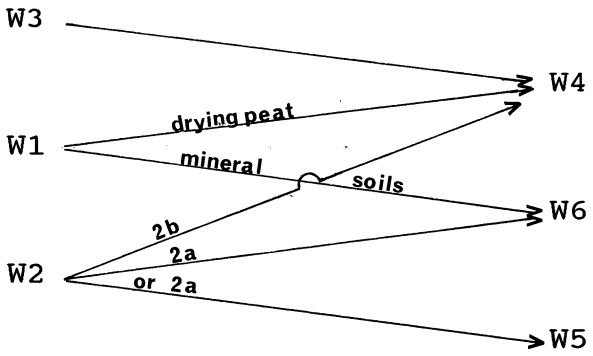
Common to both natural and anthropogenic change is that change in a single layer of vegetation, no matter how severe, may not affect the NVC community per se. For example, the death of elms and the subsequent recolonisation of the canopy by ash and/or sycamore would probably not warrant a change in NVC community. Similarly the replacement of a semi-natural stand of hornbeam coppice with oak high forest would also be unlikely to change the NVC type. (The changes in structure and composition would affect the nature conservation value of the wood but that is a separate issue.)

However, changes in the NVC type on a site may occur and they may not be reversible. For example if A goes to B and then to C under a conifer crop, then if that crop is removed C may go to A, B, or it may go to D. Very little work has been undertaken on this aspect of plant community succession pathways (Rodwell 1991).

Changes affecting the vegetation of woods

Woods change through succession. Communities W1, W2 and W3 are usually successional communities which have developed on former open wetland. Once developed these communities are not necessarily stable. Descriptions of the possible succession

pathways of all communities are given in the NVC (Rodwell 1991), and for the three examples above these are thought to be as follows.



Plant community development is not always a one way process and may be influenced by chance factors (Hester, Miles & Gimmingham 1991). For example, should the water table rise then in the above examples these processes may be reversed, and fen or mire communities redevelop. Other communities will, of course, develop from other habitat types. For example on chalk grassland scrub (W21) may develop and give rise to W8 or W12 and on heather moorland W16, W17 or W18 may develop.

Woodland is rarely allowed to develop naturally in Britain, and colonisation processes are poorly researched. In Scotland native pine woods affected by fire were often replanted (Steven & Carlisle 1959), and many windthrown sites in southern England affected by the 1987 storm have fared similarly. However, natural regeneration has been allowed to occur in some woods and the results are being monitored (Whitbread 1991).

Grazing is a natural process in the upland woods of Britain, but excessive grazing impoverishes the woodland flora (Mitchell & Kirby 1990). Grazing favours plants which are either unpalatable, or able to withstand grazing such as those with meristems below ground. In upland woods this typically means that grasses and bryophytes are favoured over ericoid sub-shrubs and herbaceous dicotyledons. In terms of the NVC the sub-communities dominated by grasses and bryophytes (W10e, W11a, W11b, W17a, W17c) will be commoner in heavily grazed woods, with their more herbaceous counterparts (W10a, W17b) in ungrazed areas. Grazed and ungrazed areas in the uplands, and hence different sub-communities, may occur either side of fences or walls. Grazing does not always affect the sub-community, however, and many grazed, (and consequently impoverished) stands of W9a, W9b, W8e and W16b were recorded, especially in the Yorkshire Dales and mid Wales.

All stands of ancient semi-natural woodland in Britain have been managed, the method of management varying with the woodland type and its geographical location. In the lowlands of Britain coppice or coppice with standards has been the predominant form of woodland management (Watkins 1990). The effects on the tree and shrub layers of centuries of coppicing are twofold; firstly, those species which are not favoured by regular cutting decline

and those which do well under a coppicing regime increase. Additionally species such as hazel or small leaved lime may have been artificially increased by planting or layering (Rackham 1980) to increase their density in coppiced woods. However, changes such as these, affecting only elements of the tree and shrub layers, are unlikely to have an effect on the classification.

The second major effect on coppicing is its influence on the field layer. Coppiced woods are noted for their abundance of vernal species (Rackham 1980). Other species often increase immediately after coppicing, but then decline as the canopy closes (Mitchell & Kirby 1989). It is therefore possible that the sub-community may change at a single site during the coppice cycle, especially where the sub-community is characterised by vernal species, as are W8b and W10b (Anemone nemorosa and Ranunculus ficaria). Following coppicing on heavy soils the moisture content of the soil increases and is often accompanied by an increase of Deschampsia cespitosa. Such an effect would temporarily shift the NVC type from W8b to W8c, but then as the canopy closes and D. cespitosa declines the sub-community reverts to W8b. Conversely, a cessation of coppicing may result in a gradual decline of vernal species and an increase of shade tolerant species, such as Hedera helix, which may change the sub-community from W8b to W8d, or W10b to W10c.

The conversion of semi-natural broadleaved woodland to conifer plantation alters both the distribution and abundance of the previous vegetation (Kirby 1988). Some species may be lost and others may arrive. There is a general convergence of plant communities (Pigott 1990) which may destroy differences in NVC types. Beech plantations have been found to change the field layer in a similar way to those of Norway spruce Picea abies in a former oak wood on acid soils (Kirby 1988), and long established beech plantations may develop a vegetation indistinguishable from native beech woods (Rodwell 1991). Replanting semi-natural woods with broadleaved trees, apart from beech and some non-native species, is unlikely to have any significant effect on the NVC type.

Changes following a clearfell

Permanent quadrats (10 x 10 m) were recorded in Sheephouse Wood (Buckinghamshire) for five consecutive years following a clearfell in the winter of 1984/85 (Kirby 1990). Field layer species were recorded using the Domin scale in the early summer of each year, to avoid missing vernal species (Kirby et al 1986).

The quadrat data were analysed using TABLEFIT (Hill 1991). The three best fits for each year are given below.

Date	Best three community fits (with goodness of fit score)
May 1985	W10e (37), W25a (36), W10a (35).
May 1986	MG9a (46), W7c (44), W8c (44).
May 1987	MG9a (55), W7c (47), M23b (46).

May 1988	MG9a (42), M23b (42), W7c (39).
May 1989	MG9a (52), M23b (51), W7c (42).

Before the clearfell the community was W10b (Kirby pers comm.). These results show that following the clearfell the NVC community changed as a result of changes in the field layer.

Immediately after the clearfell there was an increase of Holcus mollis, resulting in a shift of sub-community from W10b to W10e. H. mollis often shows a dramatic increase after coppicing (Grime, Hodgson & Hunt 1988; Ovington & Scurfield 1956) although the reasons are for this are unclear; H. mollis spreads mainly by vegetative means (Ovington & Scurfield 1956) and will regenerate rapidly from rhizome or shoot fragments (Grime, Hodgson & Hunt 1988), so perhaps ground disturbance associated with coppicing or clearfelling (Kirby 1984b) assists its spread.

In the following years the H. mollis decreased and Deschampsia cespitosa and species characteristic of damp grasslands such as Juncus effusus increased, resulting in a community resembling a mesotrophic grassland (MG9a - Holcus lanatus - Deschampsia cespitosa coarse grassland, Poa trivalis sub-community), a community often found in woodland rides and clearings (Rodwell in press). The increase in D. cespitosa following clearfells is well known (Davy 1980), arising from a persistent soil seed bank (Grime, Hodgson & Hunt 1988) as a result of increased light flux, an increase of soil moisture and mechanical disturbance. (The closest woodland community, W7c according to TABLEFIT, also occurs on wet soils, and has its field layer dominated by D. cespitosa.)

As the canopy closes in future years the D. cespitosa is likely to die down until the next clearfell, giving rise to a cyclic pattern of abundance (Davy 1980). Providing the disturbance associated with the clearfell was not too severe, then it is probable that W10b will return when canopy closure is reached.

In another compartment at Sheephouse Wood four random quadrats (10 x 10 m) were recorded in the spring and summer from August 1986 until May 1988 in undisturbed woodland. The quadrat data for each year were combined and again analysed using TABLEFIT (Hill 1991). The results show that there was no change in the NVC sub-community between spring and summer, or over the three years. Although this is not a control to the clearfell data, it does suggest that changes in the ground flora in the those plots arose as a result of the clearfell rather than a in the wood as a whole.

Date	Best three community fits (with goodness of fit score)
August 1986	W8c (73), W8a (72), W10a (69).
May 1987	W8c (74), W8a (72), W10b (68).
August 1987	W8c (77), W8a (76), W10a (68).
May 1988	W8c (78), W8a (77), W10a (71).
July 1988	W8c (73), W8a (70), W10a (68).
May 1989	W8c (74), W8a (70), W10a (69).

The use of MATCH and TABLEFIT computer programs

TABLEFIT (Hill 1991), used above is one of two computer programs, the other being MATCH (Malloch 1990), which have become available recently to aid the classification of either individual quadrat data or constancy tables using the NVC. Both programs were unavailable to surveyors during the survey program.

The programs use different calculations to arrive at a similarity coefficient for field collected data, and list the best five (TABLEFIT) or ten (MATCH) fits.

Outline methodology

TABLEFIT. This account has been summarised from Hill (1991); further details can be found in Hill (1989). TABLEFIT arrives at an overall goodness of fit by averaging four individual goodness of fit values. These are; i) the compositional satisfaction - whether or not the right number of constancy class V, IV, III, or II species are present, ii) the mean constancy - the mean constancy (for that type) of species in the sample, as a proportion of what would be expected, iii) the dominance satisfaction - whether or not those species that would be expected to have high abundance in the type are actually present with high abundance, iv) the weighted mean constancy - each species is weighted by the square root of its cover value, and compared with its expected value.

MATCH. Data entered are converted into constancy tables and then these derived constancy tables are compared with the published community and sub-community constancy tables found in Rodwell (1991 *et seq*). The comparison is achieved using the Czekanowski co-efficient:

$$C = \frac{200 \sum \min(xj,yj)}{\sum xj + \sum yj}$$

where xj is the constancy (on a scale of 1 to 5) for species j in sample x, and yj is the constancy of the same species in sample y; min(xj,yj) is the lesser of the two values xj and yj (Malloch 1990).

As the matching process involves the creation of constancy tables, more accurate results will be achieved when several sets of quadrat data are used to create the constancy table; if only one quadrat is used then all species will have a constancy of V. Malloch (1990) recommends a minimum of five sets of quadrat data for each constancy table. MATCH does not use quantitative values ie the Domin scores of each species in its matching procedure, but does allow their visual comparison on screen if desired.

Both programs are relatively easy to use, and species data is either entered using abbreviated names or by using numerical codes. (MATCH can also be used in conjunction with other programs in the VESPAN II package (Malloch 1988) such as TWINSPAN, DECORANA and various programs allowing the manipulation of quadrat data.)

Trial Results

One hundred 14 m x 14 m quadrats from various woods (collected for other purposes) were run through both MATCH and TABLEFIT programs as part of a larger trial (Palmer 1992). (The quadrats were neither the 'correct size' for the NVC, nor were they combined into constancy tables: it was thought that using non-standard data would be a better approximation to the likely usage of the programs within EN.) Each quadrat was also classified by Keith Kirby (EN woodlands specialist). The results obtained were as follows;

No. of samples in which KK choice was:

	1st	2nd	3rd	other position	not listed
MATCH	32	29	27	12	0
TABLEFIT	53	23	10	5	9

The results show that while TABLEFIT gives the highest proportion of correct first choices, it also failed to classify 9 stands correctly (it should be remembered that TABLEFIT only lists the top five matches whilst MATCH lists the top ten, so perhaps a fairer comparison would be MATCH mis-classifying 12 samples and TABLEFIT 14 - although of course the 9 samples not listed using TABLEFIT are not available for consideration, even if they were all the sixth choice!) The spread of results does demonstrate the need for caution when using these programs, and the program answers should taken as a guide only to the likely community. The overall trial (Palmer 1992) concluded that TABLEFIT worked better with single samples and MATCH with constancy tables.

Nevertheless, the programs can at least point you in the right direction. A stand of vegetation was sampled from Aber Valley in Gwynedd: a combined tree and shrub layer of alder with sallow occurred over a flora dominated by Juncus effusus, Sphagnum spp., Holcus mollis, Viola palustris, Agrostis stolonifera, Cirsium palustre and other herbs characteristic of wet acidic conditions. The community had been assigned to W4b, but with the note that it was a very poor fit. However on running the data through both MATCH and TABLEFIT the community M6c (Carex echinata - Sphagnum recurvum/auriculatum mire, Juncus effusus sub-community) appeared to be the best fit. This example demonstrates that all is not what it may appear to be, and that rather than sampling an established woodland community the surveyor had inadvertently wandered into an area of recent woodland invasion on a mire.

Stand Type comparison

To date no large scale comparison has been made between Stand Types (Peterken 1981) and NVC communities. The table which exists in the SSSI selection guidelines (NCC 1989) was based on the likelihood of comparability according to experience. As part of this review 695 separate quadrats were classified using both the Stand Type method and the NVC. The classifications were arrived

Table 8 Comparison between NVC and Stand Types
(bold - more than one third of samples)

Stand Type	NVC Community														
	W18	W4	W17	W11	W9	W7	W6	W5	W8	W10	W16	W12	W14	W13	W15
11A	**14**			1											
12A		9	**21**	**12**	1										
7B		4		1	3	**24**	3	1	2	1					
6A		3	**37**	**55**	3					12	12				
6B		2	2	**5**						1					
7A		2		5	1	5			4	7					
12B		1		**8**	3										
3D			1	7	**15**	1			4	8					
7D				3	1	**20**	2								
1D				2	**19**	2			**12**	3					
6D				1	1				4	**21**	5				
7E				1	1	**4**	**4**								
3B				1					**7**						
11B				1											
4C					3				**8**	1					
1B					3	1			**5**						
3A					1				**6**	**9**					
1A					1				**15**						
7C					1	3	4		7	**8**					
6C									1	**8**	**10**				
5B									2	**4**	1				
9A									7	**18**					
2B									**10**	3					
5A									3	3					
2C									**12**	2					
1C									**9**	1					
9B									**2**	1					
4A									**4**						
4B									**7**						
2A									**33**						
10A									**4**						
8C										1		**7**			
8E												**6**	3		
8A				1						2	1		6	1	**8**
8B										1			**8**		1
8D															
10B															

at by keying out the community using published keys. The results are given below. There is not a one-to-one relationship but certain Stand Types are more likely to be associated with certain NVC communities, with usually only one or two types each containing more than a third of the samples. The wide variation in Stand Type possible within NVC W8 and W10 communities is part of the reason for introducing canopy (Stand Type) variations as a second level of representation in the SSSI guidelines (NCC 1989). Given the differences between these two classification systems these results are not unexpected as different layers of vegetation in the wood are only weakly correlated at the quadrat scale (Kirby 1984a).

The relationship between the NVC types and CORINE (Europaen Community Habitats Directive codes) has yet to be finalised; an initial cross referencing appears in Hill (1991), but this has been revised and should not be used.

Estimates of the total area of each NVC type

Estimates of the total area of woodland NVC communities have been produced using the results from this survey. These are extremely approximate because they assume a representative sample of woods were chosen from each survey area (they were not). Despite the limitations of the method the figures provide a first guide to the relative abundance of types at a national level. Regional abundance patterns may however be very different (see pages 8 - 34).

The area of each community recorded has been calculated from the area category boxes on the record card, the figure used for calculation being the mid-point of the range (except for the fifth box where the actual area was used). For England the survey results from North East, South East, South West and West Midlands were used, for Wales; North Wales, Dyfed-Powys and South Wales and for Scotland; Argyll, Badenoch & Strathspey and Lochaber. The Argyll survey results were only classified to community level, so these results were only included in the area calculations for the communities. This is why the totals of the sub-communities in Scotland (calculated from Badenoch and Strathspey and Lochaber) do not equal the community totals (which includes the Argyll data).

Calculation method - the areas of each community recorded were converted into the percentage of the total area surveyed in each survey region. These percentages were then averaged between survey areas. The total area was the calculated by converting this percentage into hectares using the total area of ancient semi-natural woodland as given in Spencer and Kirby (in press) and Roberts et al (in press).

Table 9 Estimated total areas of NVC types in Britain

If these figures are used outside EN it should be made clear that they are first approximations. They should be rounded to the nearest thousand (or hundred for those below 500 ha) or preferably expressed as broad area classes.

	England	Wales	Scotland	GB Total		England	Wales	Scotland	GB Total
W1	273	10	534	817	W11	4548	5984	35691	46223
W2	62	54		116	W11a	2941	5283		8224
W2a	62	54		116	W11b	1236	480	12644	14360
W2b				not recorded	W11c		90	18125	18215
W3	170			170	W11d	371	131	5602	6104
W4	335	337	9096	9768	W12	4537	97		4634
W4a	278	53		331	W12a	2987	97		3084
W4b	57	235	6962	7254	W12b	541			541
W4c		49	1080	1129	W12c	1009			1009
W5	41	116		157	W13	623	16		639
W5a	26	20		46	W13a	185			185
W5b		80		80	W13b	438	16		454
W5c	15	16		31	W14	2554	398		2952
W6	1210	121		1331	W15	1071	239		1310
W6a	185	9		194	W15a	479	76		555
W6b	232			232	W15b	546	145		691
W6c				not recorded	W15c	15	18		33
W6d	633	83		716	W15d	31			31
W6e	160	29		189	W16	12905	1856	560	15321
W7	7179	1702	4321	13202	W16a	3651	19		3670
W7a	2899	561	240	3700	W16b	9254	1837		11091
W7b	1854	678	800	3332	W17	557	4605	19019	24181
W7c	2426	463	1440	4329	W17a	201	699	1640	2540
W8	46173	5004		51177	W17b	191	2745	7802	10738
W8a	18441	277		18718	W17c	165	1161	4921	6247
W8b	2518	176		2694	W17d			7282	7282
W8c	3250	631		3881	W18			10995	10995
W8d	6741	283		7024	W18a				not recorded
W8e	11443	2781		14224	W18b			960	960
W8f	3311	140		3451	W18c			1977	1977
W8g	469	716		1185	W18d				not recorded
W9	16525	2410	6506	25441	W18e			2561	2561
W9a	12014	2245	2041	16300	W19			640	640
W9b	4511	165	2961	7637	W19a			440	440
W10	106251	6560		112811	W19b			520	520
W10a	57297	2695		59992	W21	312	18		330
W10b	6484	14		6498	W21a	70			70
W10c	6566	953		7519	W21b	242			242
W10d	5994	54		6048	W21c				not recorded
W10e	29910	2844		32754	W21d		18		18
					Other	706	596		1302

W20, W22-W25 - not recorded

References

BARBER, A.G. & COOKE, R.J. 1990. Woodland surveys in North-East England using the National Vegetation Classification. Peterborough, Nature Conservancy Council. (CSD Commissioned Research Report 1238.)

CANNEL, M.G.R., GRACE, J. & BOOTH, A. 1989. Possible impacts of climatic warming on trees and forests in the United Kingdom. Forestry, 62, 337-364.

CLAPHAM, A.R., TUTIN, T.G. & MOORE, D.M. 1987. Flora of the British Isles, 3rd ed. Cambridge, Cambridge University Press.

COOKE, R.J. & SAUNDERS, G.R. 1989. Woodland surveys in Dyfed-Powys Region, 1988 using the National Vegetation Classification. Peterborough, Nature Conservancy Council. (CSD Commissioned Research Report 981.)

COOKE, R.J. & SAUNDERS, G.R. 1990. Woodland surveys in South Wales Region and Brecknock District 1989, using the National Vegetation Classification. Peterborough, Nature Conservancy Council. (CSD Commissioned Research Report 1013.)

DAVY, A.J. 1980. Biological flora of the British Isles: Deschampsia cespitosa. Journal of Ecology, 68, 1075-1096.

EVANS, J. 1984. Silviculture of broadleaved woodland. London, HMSO.

FORESTRY COMMISSION. 1988. The Woodland Grant Scheme. Edinburgh, Forestry Commission.

GODWIN, H. 1975. History of the British Flora. A factual basis for phytogeography, 2nd ed. Cambridge, Cambridge University Press.

GRIME, J.P., HODGSON, J.G. & HUNT, A. 1988. Comparative plant ecology. London, Unwin Hyman Ltd.

HEATH, M.J. & BEVAN, J.M.S. 1991. Woodland surveys in West Midlands and North Wales using the National Vegetation Classification. Peterborough, Nature Conservancy Council. (CSD Commissioned Research Report 1240.)

HEATH, M.J. & OAKES, H. 1990. Woodland surveys in South-West England using the National Vegetation Classification. Peterborough, Nature Conservancy Council. (CSD Commissioned Research Report 1239.)

HER MAJESTY'S STATIONARY OFFICE. 1990. Environmental Protection Act 1990. London, HMSO.

HESTER, A.J., MILES, J. & GIMINGHAM, C.H. 1991. Succession from heather moorland to birch woodland. I. Experimental alteration of specific environmental conditions in the field. Journal of Ecology, 79, 303-315.

HILL, M.O. 1979. TWINSPAN - a FORTRAN program for arranging multivariate data in an ordered two-way table by classification of the individuals and attributes. Ithaca, New York, Section of Ecology and Systematics, Cornell University.

HILL, M.O. 1989. Computerized matching of releves and association tables, with an application to the British National Vegetation Classification. Vegetatio, 83, 187-194.

HILL, M.O. 1991. TABLEFIT program manual (version 1). Huntingdon, Institute of Terrestrial Ecology.

HILL, M.O., PRESTON, C.D. & SMITH, A.J.E. 1991. Atlas of the bryophytes of the British Isles. Volume 1, liverworts (Hepaticae and Anthocerotae). Colchester, Harley Books.

JERMY, A.C., ARNOLD, H.R., FARRELL, L. & PERRING, F.H. 1978. Atlas of ferns of the British Isles. London, Botanical Society of the British Isles.

KIRBY, K.J. 1984a. A comparison of two methods for classifying British broadleaved woodland. Field Studies, 6, 103-116.

KIRBY, K.J. 1984. Forestry operations and broadleaved woodland communities. Shrewsbury, Nature Conservancy Council. (Focus on nature conservation No. 8.)

KIRBY, K.J. 1988a. A woodland survey handbook. Peterborough, Nature Conservancy Council. (Research and survey in nature conservation No. 11.)

KIRBY, K.J. 1988b. Changes in the ground flora under plantations on ancient woodland sites. Forestry, 61, 317-338.

KIRBY, K.J. 1990. Changes in the ground flora of a broadleaved wood within a clear fell, group fell and a coppiced block. Forestry, 63, 241-249.

KIRBY, K.J., BINES, T., BURN, A., MACKINTOSH, J., PITKIN, P. & SMITH, I. 1986. Seasonal and observer differences in vascular plant records from British woodlands. Journal of Ecology, 74, 123-131.

KIRBY, K.J. & PATTERSON, G. 1992. Ecology and management of semi-natural tree species mixtures. In: The ecology of mixed-species stands of trees, ed. by M.G.R. Cannell, D.C. Malcolm & P.A. Robertson, 189-209. Oxford, Blackwell Scientific Publications. (Special Publication Number 11 of the British Ecological Society.)

KIRBY, K.J., PETERKEN, G.F., SPENCER, J.W. & WALKER, G.J. 1984. Inventories of ancient semi-natural woodland. Peterborough, Nature Conservancy Council. (Focus on nature conservation No. 6.)

KIRBY, K.J., SAUNDERS, G.R. & WHITBREAD, A.M. 1991. The national Vegetation Classification in nature conservation surveys - a guide to the woodland section. British Wildlife, 3, 70-80.

LINNARD, W. 1982. Welsh woods and forests. Cardiff, National Museum of Wales.

MACKINTOSH, J. 1988. The woods of Argyll and Bute. Peterborough, Nature Conservancy Council. (Research and survey in nature conservation No. 10.)

MACKINTOSH, J. 1990. A botanical survey of the semi-natural woods of Lochaber District. Edinburgh, Nature Conservancy Council. (Scottish Field Survey Unit Report S39.)

MALLOCH, A.J.C. 1988. VESPAN II, a computer package to handle and analyse multivariate species data and handle and display species distribution data. Lancaster, University of Lancaster.

MALLOCH, A.J.C. 1990. MATCH, a computer program to aid the assignment of vegetation data to the communities and sub-communities of the National Vegetation Classification. Lancaster, University of Lancaster.

MARREN, P. 1992. The wildwoods: a regional account of Britain's ancient woodland. Newton Abbot, David & Charles.

MITCHELL,,D.L. & KIRBY, K.J. 1989. Ecological effects of forestry practices in long-established woodland and their implications for nature conservation. Oxford, Oxford Forestry Institute. (Occasional paper No. 39.)

MITCHELL, F.R.G. & KIRBY, K.J. 1990. The impact of large herbivores on the conservation value of semi-natural woods in the British uplands. Forestry, 63, 333-353.

NATURE CONSERVANCY COUNCIL. 1989. Guidelines for the selection of biological SSSIs. Peterborough, Nature Conservancy Council.

OAKES, H & WHITBREAD, A. 1990. Woodland surveys in the South East of England, 1988. Peterborough, Nature Conservancy Council. (CSD Commissioned Research Report 1090.)

OVINGTON, J.D. & SCURFIELD, G. 1956. Biological flora of the British Isles: Holcus mollis. Journal of Ecology, 44, 272-280.

PAGE, C.N. 1982. The ferns of Britain and Ireland. Cambridge, Cambridge University Press.

PALMER, M. 1992. Trial of MATCH and TABLEFIT computer programs for placing survey data within the National Vegetation Classification. Peterborough, Joint Nature Conservation Committee. (UK nature conservation report No. 20.)

PETERKEN, G.F. 1981 Woodland conservation and management. London, Chapman and Hall.

PETERKEN, G.F. & ALLISON, H. 1989. Woods, trees and hedges: a review of changes in the British Countryside. Peterborough, Nature Conservancy Council. (Focus on nature conservation No. 26.)

PIGOTT, C.D. 1990. The influence of evergreen coniferous nurse-crops on the field layer in two woodland communities. Journal of Applied Ecology, 27, 448-459.

RACKHAM, O. 1980. Ancient woodland. London, Edward Arnold.

RATCLIFFE, D.A. 1968. An ecological account of Atlantic bryophytes in the British Isles. New Phytologist, 67, 365-439.

RATCLIFFE, D.A. 1977. A nature conservation review. Cambridge, Cambridge University Press.

ROBERTS, A.J., RUSSEL, C., WALKER, G.J. & KIRBY, K.J. In press. Regional variation in the origin, extent and composition of Scottish woodland. Botanical journal of Scotland.

RODWELL, J. 1991. British plant communities. Vol 1; Woodlands and scrub. Cambridge, Cambridge University Press.

RODWELL, J. In press. British plant communities. Vol 3; Grasslands and miscellaneous upland communities. Cambridge, Cambridge University Press.

SMITH, A.J.E. 1978. The moss flora of Britain and Ireland. Cambridge, Cambridge University Press.

SMITH, A.J.E. 1990. The liverworts of Britain and Ireland. Cambridge, Cambridge University Press.

SPENCER, J.W. 1989. Ancient woodland in Huntingdonshire and the Soke of Peterborough: continuity and change over the last forty years. In: 40 years of change in the county, ed. by T.G.E. Wells, J.H. Cole & P.E.G. Walker, 21-28. Huntingdon, Huntingdonshire Fauna and Flora Society.

SPENCER, J.W. & KIRBY, K.J. In press. An inventory of ancient woodland for England and Wales. Biological Conservation.

STEVEN, H.M. & CARLISLE, A. 1959. The native pinewoods of Scotland. Edinburgh, Oliver and Boyd.

SYDES, C. & GRIME, J.P. 1981a. Effects of tree leaf litter on herbaceous vegetation in deciduous woodland. II. An experimental investigation. Journal of Ecology, 69, 249-262.

SYDES, C. & GRIME, J.P. 1981b. Effects of tree leaf litter on herbaceous vegetation in deciduous woodland. I. Field investigations. Journal of Ecology, 69, 237-248.

TIDSWELL, R.J. 1988. A botanical survey of the semi-natural deciduous woods of Badenoch and Strathspey District. Edinburgh, Nature Conservancy Council. (Scottish Field Survey Unit Report S34.)

TIDSWELL, R.J. 1990. A botanical survey of the semi-natural woods of Angus District. Edinburgh, Nature Conservancy Council. (Scottish Field Survey Unit Report S44.)

WALKER, G.J. & KIRBY, K.J. 1989. Inventories of ancient, long-established and semi-natural woodland for Scotland. Peterborough, Nature Conservancy Council. (Research and survey in nature conservation No. 22.)

WATKINS, C. 1990. Woodland management and conservation. Newton Abbot, David & Charles.

WHITBREAD, A. M., ed. 1991. Research on the ecological effects on woodland of the 1987 storm. Peterborough, Nature Conservancy Council. (Research and survey in nature conservation No. 40.)

WHITBREAD, A.M. & KIRBY, K.J. 1992. Summaries of National Vegetation Classification woodland descriptions. Peterborough, Joint Nature Conservation Committee. (UK nature conservation report No. 4.)

Appendix 1 Organisation of future surveys

When planning surveys it is essential to leave enough time for writing up, at least one day a week, and also to allow enough time to write up the project when completed. If a backlog builds up then it is a good idea to forego a days survey in order to catch up. The office day can also be used to obtain permission for forthcoming surveys. Obtaining permission can be a thankless and time consuming process, and you should always have some reserve sites just in case! How you actually obtain permission, and how far ahead you need to start thinking about it will vary from area to area. In rural areas most woods will still be owned by the nearest farmer, and these can be approached directly. On large estates then Land Agents will usually be the point of contact and it is as well to make initial approaches well in advance. It is worthwhile drawing up a monthly timetable, listing sites and the days on which they are to be surveyed. Inevitably this will become amended as the month progresses but at least you have something to work to, and it helps when asking for permission if you have a definite date on which you want to survey the wood. Make sure you have photocopied maps and spare record cards before you actually embark on the survey (it is a good idea to keep some spare survey cards in the car).

Suggested structure of a regional report

Regional reports should provide the results of the field surveys, analysed as appropriate and provide an overview of the woods surveyed. Unless the whole resource has been surveyed and evaluated it is better not to include lists of pSSSIs.

Circulation list - Important to know where copies were sent.

Contents - Table of contents, with page numbers.

List of figures, tables and maps - Again with page numbers.

Summary - A summary of the overall results of the surveys covered by the report. Total area surveyed, number of woods, NVC communities identified, most abundant communities (in area as well as frequency).

Acknowledgements - Don't forget the landowners who gave you permission (but don't name individually!).

Introduction - Include the background to the project, why the surveys were carried out. It also 'sets the scene' if there is a general preamble about the woods in the area, the common types, their historical usage and current distribution. General information on the geology, soils, climate and relief of the survey area should also be included here.

Method - Site selection procedure, field survey procedure (what you did once in the wood, how the woods were surveyed and classified). Were quadrats used, if so how often were they recorded? Why weren't they recorded from all sites/stands? How

was access permission to the woods obtained? How were the individual surveys written up (and where are the reports)? Include maps of survey site location, geology and any other relevant physical characteristics of the survey area. (Several maps can easily be overlain eg survey site on geology with rainfall etc but remember that they will probably be photocopied at some stage. Don't make them too complicated.)

Results - Summary of results by county/district etc. Number of woods and area surveyed in each. Maps of the distribution of each sub-community recorded in the survey. The frequency and area of each sub-community recorded should be calculated (state your method, ie how you got the areas when they are only recorded as ranges on the record card). This should be done for each county as well as the whole survey area as local differences will then become apparent. These results should then be presented in a bar graph (for 'at a glance' interpretation). However the actual figures used for the construction of the graphs should be included as an appendix if not in the main body of the report. The average size class of each community should be given (eg was W10e most commonly found as large stands, W4b as small stands. (In the latter case any large stands would then be of added importance.) Are particular communities associated with particular substrates? (Map/graph). A list of woods surveyed with grid refs etc should be included, if not here then as an appendix. Statistical tests using probability theory - don't use them unless you have a statistically valid sample (In most cases you wont!).

Discussion - How the NVC communities occur in the survey area, their geographic and geological distribution. Do they differ from the descriptions in the NVC, how? Are all the types recorded considered to be semi-natural? How has management affected them?

Site summaries - If these are to be included (they seem to be liked by people in receipt of previous reports) then they are far more accurate and easier to write if they are written while the surveys are being done. It only takes 10-20 minutes to write one if it is done after the survey report is written. If they are left to the end of the field season then they take longer (and are more tedious) as it is first necessary to re-familiarise yourself with the site from record cards and site reports. Include wood size and extent of all NVC communities in each.

References - As cited.

Appendices - Example of completed woodland report and record card. If you've referred to NVC communities by their numbers then you need a list of numbers and names here. Also site lists, area data and frequency data, preferably broken down into counties, if only presented graphically elsewhere.

Existing NVC regional reports

None of these reports contain all of the above. With hindsight they probably should have, and omissions have resulted in tedious

and time consuming calculations when comparing data between survey areas.

Suggested contents of a site report

Sitename County (or District, AoS) Grid ref.
Surveyor Date Conservation status Area

Owner - Be careful, site reports will often be seen by the owners (do they own the whole wood?), and other outside bodies. Details should not be stored on a database etc.

Location - Geographical, where the wood is, its situation, aspect, geology and soils.

History - Site history. Is it ancient? Why? - field evidence, vegetation, structure, physical features (wood banks, charcoal hearths etc). Do you agree with the inventory? If not why not? Past management deduced from present structure and documentation (if known or available). Presence of wood on old maps etc. [It may be that information from this section will be used to amend the AW inventory.]

Vegetation - A general description of the vegetation of the wood as a whole ("acidic oak/birch communities on the upper slopes grading down to more base rich ash/alder woodland along the river bank" etc etc), followed by more detailed and structured accounts of each community identified. Community descriptions can be viewed as expanded versions of the 'stand target notes' on the record cards. Any anomalies in the community should be noted (eg the absence of Mercurialis in W8 or W9 stands, unusual canopy dominants or variants etc).

Other groups - Unless you have experience of other groups it is probably best to concentrate on their likely presence through suitable habitats (dead wood, hollow trees, sap runs etc). This section could almost be treated as a zoological phase 1 survey.

Management - What is currently happening (or has recently happened) to the wood and when? eg coppicing, felling, planting, grazing (by what - sheep, deer, rabbits etc. Numbers where appropriate). Recreation use (nature trail, informal, wargames etc). What are the boundaries of the wood (wall, fence, hedge etc)? are they intact?

Conservation value - The quality of the site. The national and local scarcity of communities/species recorded. Is the wood particularly species rich or variable (NVC communities, stand types). Is a particularly good (or poor) example of its type? (Direct comparisons between sites are best considered in regional/annual survey reports, but it does no harm to think in these terms when assessing the site.)

Minimum information required on a stand

The information recorded on a stand should form a concise 'target note' on the record card, describing the dominant components of each layer of the vegetation (tree, shrub, field and ground), the structure of the stand and notes on any management (current or past). The presence of any specific habitats should be noted (stream, dead wood, rocks etc) and the stand classified using the NVC. Each stand, community or other notable feature should be recorded in this way.

Whilst surveying the wood it is good practice to write a note every 20 mins or so. In very uniform woods it is unnecessary to repeat the description but it should be noted that, for example, "the vegetation at Y is the same to that at X". I am not in favour of using a single number to describe a stand, and then recording this number wherever the stand occurs. The temptation here is to slot the stand into an existing description, possibly overlooking some less obvious, but potentially significant differences in one or more of the layers or management or history etc.

The stand description needs to refer to a marked area on the survey map. If the description refers to an NVC community then this should be mapped, although the boundary will be inevitably imprecise, especially in steep woods. Where possible survey maps should be of a scale of 1:10,000 or larger.

A textual stand description is not a substitute for recording quadrats (although stands may be classified from both). Where quadrats are recorded, for classification of difficult stands, as a check on classifications, research, monitoring etc then they should be accompanied by a textual description - this will complement the quadrat data and provide important backup information.

Use of the record card

Surveys will inevitably involve filling in a survey card. These should be completed in the field, and not copied once back in the office - unless the record card is illegible (through falling in a stream or some other unforseen catastrophe) it is a waste of time to simply copy it. Make sure ALL the sections of the card are filled in (in the field). Even if they are irrelevant to the requirements of your particular survey they will be of use later when the cards are examined for other purposes. More often than not yours will be the only survey of a particular wood and so it is essential that as much information as possible is recorded.

Mapping procedure

Woodland community boundaries should be mapped (see Kirby, Saunders and Whitbread 1991). The scale and level of detail will be determined by the need, for example a SSSI community map should be at a larger scale and more detailed than that of a phase 2 survey, but 1:10 000 is a suitable minimum scale to work

at for most sites. The following conventions should be used:

W17b(W17a) - Mostly W17b, but with small areas (too small to map) of W17a.
W17b/W17a - An intermediate stand.
W17b-W17a - A transitional stand.