



JNCC Report No. 272

**An Analysis of National Vegetation Classification
Survey Data**

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Contents

Introduction.....	1
Sources of Information.....	2
Extent of Records.....	2
Distribution of Communities.....	5
Wet Woodland.....	5
Ash-Maple Woodland.....	6
Beech Woodland.....	7
Yew Woodland.....	7
Oak-Birch Woodland.....	7
Ash-Maple (W8) and Oak-Birch (W10 and W16) Woodland of Lowland Britain.....	9
Pine Woodland.....	11
Strengths and Weaknesses of the NVC.....	11
The Use of the NVC and the Stand Types Classification to Measure Biodiversity.....	14
References.....	18
Annex 1. List of Information Sources Used in the Woodland NVC Database.....	20
Annex 2. Maps of NVC Community types (Unavailable)	
Annex 3. Maps of NVC Sub-community types (Unavailable)	

Summary

A data-base has been produced by the Woodland Lead Conservation Network to collate survey information on the distribution of woodland types classified according to the National Vegetation Classification (NVC). A separate file contains information on the surveys themselves; how, when, where and by whom they were carried out, and from where the report (where available) can be obtained. 64 sources of information have so far been added to the database. This has been used to produce distribution maps of NVC communities and sub-communities. These distributions are compared to those in Rodwell (1991). Strengths and weaknesses of the NVC as a vegetation classification are discussed and its use as a tool for measuring biodiversity is also examined.

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Introduction

The woodland section of the National Vegetation Classification (NVC) has been widely used by many people and organisations in Great Britain (and, to a limited extent, in Northern Ireland) since it became available in 1986. As a result, there is a great deal of information concerning the occurrence of woodland types in this country. However, the data is distributed between many organisations and private individuals and, until a database was set up to collate it, was largely unavailable to inquirers. The first report on the database (Hall 1996) described the collection of records and the setting up of the spreadsheet. It also discussed the differences in the methodologies of surveys used to build the database, and when to use quadrats. Since this report was published much new information has been gathered, and preliminary maps of NVC communities and sub-communities produced. These are to be published by the Joint Nature Conservation Committee as *The woodland NVC atlas for Great Britain* in 1998. This interim report outlines some of the patterns that are emerging, and some of the limitations of our survey data.

For reference, the woodland NVC community types are as follows:

- W1 *Salix cinerea* - *Galium palustre* woodland
- W2 *Salix cinerea* - *Betula pubescens* - *Phragmites australis* woodland
- W3 *Salix pentandra* - *Carex rostrata* woodland
- W4 *Betula pubescens* - *Molinia caerulea* woodland
- W5 *Alnus glutinosa* - *Carex paniculata* woodland
- W6 *Alnus glutinosa* - *Urtica dioica* woodland
- W7 *Alnus glutinosa* - *Fraxinus excelsior* - *Lysimachia nemorum* woodland
- W8 *Fraxinus excelsior* - *Acer campestre* - *Mercurialis perennis* woodland
- W9 *Fraxinus excelsior* - *Sorbus aucuparia* - *Mercurialis perennis* woodland
- W10 *Quercus robur* - *Pteridium aquilinum* - *Rubus fruticosus* woodland
- W11 *Quercus petraea* - *Betula pubescens* - *Oxalis acetosella* woodland
- W12 *Fagus sylvatica* - *Mercurialis perennis* woodland
- W13 *Taxus baccata* woodland
- W14 *Fagus sylvatica* - *Rubus fruticosus* woodland
- W15 *Fagus sylvatica* - *Deschampsia flexuosa* woodland
- W16 *Quercus* spp. - *Betula* spp. - *Deschampsia flexuosa* woodland
- W17 *Quercus petraea* - *Betula pubescens* - *Dicranium majus* woodland
- W18 *Pinus sylvestris* - *Hylocomium splendens* woodland
- W19 *Juniperus communis* ssp. *communis* - *Oxalis acetosella* woodland
- W20 *Salix lapponum* - *Luzula sylvatica* scrub
- W21 *Crataegus monogyna* - *Hedera helix* scrub
- W22 *Prunus spinosa* - *Rubus fruticosus* scrub
- W23 *Ulex europaeus* - *Rubus fruticosus* scrub
- W24 *Rubus fruticosus* - *Holcus lanatus* underscrub
- W25 *Pteridium aquilinum* - *Rubus fruticosus* underscrub

Sources of Information

The Woodland Lead Conservation Network's NVC database has been compiled from 62 sources of information. Of these, 45 are surveys produced or commissioned by Nature Conservancy Council, English Nature, the Countryside Council for Wales or Scottish Natural Heritage. Four sources are composed of surveys (or groups of surveys) carried out by the Forestry Commission, four are surveys carried out by private individuals, three by consultants, two by the National Trust (one in collaboration with English Nature), one by the Environmental Change Network, one by a National Park in collaboration with English Nature and one by the RSPB. The remaining source is the original NVC data, taken from Rodwell (1991). This, unlike most of the other data sets, only gives the presence of a type in a 10km square, no information is available for individual sites or records.

The majority of the data for Scotland have been made available thanks to a contract arranged by Scottish Natural Heritage to produce an atlas of NVC information for Scotland.

Full details of all the sources used so far are provided as an appendix.

Extent of Records

At present there are 10446 records on the database (5048 in England, 2069 in Wales, 3323 in Scotland and 6 in the Isle of Man) from 4290 sites (1831 in England, 683 in Wales, 1771 in Scotland and 5 in the Isle of Man). Table 1 shows the number of records we have for each county or region of England, Scotland and Wales. It also shows the number of sites in each county for which we have information. The administrative boundaries used are those which were in force between 1974 and 1st April 1997.

We now have some information for each county of England and Wales, and for every region of Scotland, although for some there is still little data. Excluding the Isle of Wight, and the heavily urbanised pre-1997 counties of Merseyside, Tyne and Wear and Cleveland; the most impoverished zone (counties with less than 40 NVC records each) in England is the central region, reaching from Humberside south to Greater London, and from Essex west to Warwickshire and the West Midlands. This includes the natural areas of Fenland, Breckland and the Broads, which have very low cover of ancient woodland; but it also includes the Chilterns, which has high cover (Reid, Kirby & Cooke 1996). The most impoverished zone in Scotland covers the regions of Fife, Lothian, Borders, Tayside and the southern half of Strathclyde.

It should be noted that NVC does not relate solely to ancient woodland, it was designed to be applicable to any semi-natural woodland in Great Britain. Surveys tend to be concentrated in the most biologically interesting areas, and the Ancient Woodland Inventory has frequently been used (e.g. Cooke & Saunders 1990; Oakes & Whitbread 1990) as a tool to produce an initial list of sites for surveying. Areas with low coverage of ancient woodland have, therefore, been little surveyed.

Table 1. Number of Sites and Records Recorded in Great Britain

	(Pre-1997) County	Number of Sites	Number of Records
England	Avon	23	58
	Bedfordshire	19	31
	Berkshire	19	27
	Buckinghamshire	20	28
	Cambridgeshire	17	32
	Cheshire	33	86
	Cleveland	2	6
	Cornwall	52	138
	Cumbria	128	691
	Derbyshire	22	56
	Devon	138	338
	Dorset	34	102
	Durham	50	117
	East Sussex	39	137
	Essex	22	34
	Gloucestershire	31	59
	Greater London	3	7
	Greater Manchester	8	64
	Hampshire	50	83
	Hereford and Worcester	47	100
	Hertfordshire	55	70
	Humberside	13	32
	Isle of Wight	4	6
	Kent	68	225
	Lancashire	22	173
	Leicestershire	10	18
	Lincolnshire	25	36
	Merseyside	3	23
	Norfolk	27	60
	North Yorkshire	374	912
	Northamptonshire	23	27
	Northumberland	50	128
	Nottinghamshire	13	23
	Oxfordshire	17	36
	Shropshire	27	77
	Somerset	49	127
	South Yorkshire	10	21
	Staffordshire	28	58
	Suffolk	31	73
	Surrey	28	98
	Tyne and Wear	7	15
	Warwickshire	6	7
	West Midlands	3	3
	West Sussex	82	276
	West Yorkshire	67	281
	Wiltshire	32	49
	Total (England)	1831	5048
Isle of Man		5	6
Wales	Clwyd	29	100
	Dyfed	319	945
	Glamorgan, Mid	12	41
	Glamorgan, South	7	22
	Glamorgan, West	22	86

	Gwent	86	211
	Gwynedd	79	234
	Powys	129	430
	Total (Wales)	683	2069
Scotland	Borders	9	11
	Central	153	176
	Dumfries and Galloway	80	120
	Fife	4	5
	Grampian	86	263
	Highland	915	1535
	Lothian	4	8
	Orkney	1	4
	Strathclyde	455	968
	Tayside	64	233
	Total (Scotland)	1771	3323

Data are now held for every NVC woodland community except W20. This may, anyway, be better classed with upland vegetation. It is a very low (up to 90cm in height), montane community, and most of the characteristic species are those of upland and mountain communities, rather than of woodland.

For several communities the amount of data available is still low (Table 2). W1- W3, W5, W13 - W15, W18 - W19 and W21 - W25 are each represented by fewer than 150 samples. For some of these types, especially scrubs (W21 - W25) and wet communities (W1 - W5), this is not representative of their actual frequency in British woodland. Most of them are, undoubtedly, very common, as Rodwell (1991) points out. W21 and W22 are described as widely distributed through the British lowlands. This disparity is largely due to the tendency for surveys to focus specifically on ancient woodland. Seral woodland types such as scrub, and most of the wet communities (except W7), are rare in ancient woodland.

For other woodland types, their low frequency in the available data is more meaningful. W13 (*Taxus baccata* woodland), W14 (*Fagus sylvatica* - *Rubus fruticosus* woodland), W15 (*Fagus sylvatica* - *Deschampsia flexuosa* woodland), W19 (*Juniperus communis* ssp. *communis* woodland) and W20 (*Salix lapponum* - *Luzula sylvatica* scrub) are not common, and they are distributed quite locally. This is largely due to the local occurrence of the characteristic tree/shrub species of the communities, rather than to unusual combinations of species. *Salix lapponum*, for example, is a montane species, and so W20 is only found in mountainous regions. By contrast, W8g (*Fraxinus excelsior* - *Acer campestre* - *Mercurialis perennis* woodland, *Teucrium scorodonia* sub-community) does not contain any particularly rare or localised key species, but the sub-community appears to be restricted to the carboniferous limestone in the Cumbrian and Yorkshire Dales, the Peak District and Dyfed and Powys.

While the broad distribution patterns are believed to be correct, the frequency of each community on the database should not be used as an index of its relative abundance in woodland throughout Great Britain without qualification. They may, however, be of rather more use as an index of the frequencies of NVC types in Ancient Woodland.

Table 2. Frequency of NVC Communities in Surveys in Great Britain

Community	N°. Original Samples	England		Wales		Scotland		Total
		Number	Percentage	Number	Percentage	Number	Percentage	
W1	38	46	1	26	1.3	51	1.5	127
W2	44	47	1	12	0.5	3	0.1	62
W3	18	13	0.3	1	0.05	22	0.6	36
W4	72	118	2.4	45	2.2	429	12.4	592
W5	107	99	2	23	1.1	4	0.1	126
W6	58	130	2.6	28	1.4	16	0.5	174
W7	102	507	10	293	14	429	12.4	1229
W8	429	1191	23.5	288	13.8	33	1	1518
W9	117	513	10.1	200	9.4	343	9.9	1056
W10	379	1178	23.2	458	22.1	76	2.2	1712
W11	139	283	5.5	257	12.4	858	24.8	1400
W12	109	147	2.9	18	0.8	2	0.1	167
W13	22	50	1	7	0.3	0	0	57
W14	49	89	1.8	24	1.2	1	0.03	113
W15	59	100	1.9	40	1.9	4	0.1	141
W16	149	328	6.5	90	4.3	28	0.8	446
W17	303	215	4.2	266	12.8	639	18.5	1120
W18	77	1	0.02	0	0	478	13.8	479
W19	69	14	0.3	0	0	42	1.2	56
Total	2340	5069	100	2076	100	3458	100	10611

The total number of records for all communities is larger than the actual number of records on the database because many records comprise mosaics of more than one NVC type.

Distribution of Communities

Several communities (W3, W5, W7, W8, W9, W10, W11 and W19) show patterns of distribution which are similar to those shown in Rodwell (1991). W3 is largely a northern community, whereas W5 is very rare in Scotland. W7 is generally a north-western community but with several sites in the wetter parts of south-east England. These may, however, be only very fragmentary examples.

Cases where the new distribution maps differ appreciably from those in Rodwell (1991) are discussed below.

Wet Woodland (W1 - W7)

Records for W1 are available from further north than previously (including on Orkney) and the community seems to have been found everywhere in Great Britain where woodland colonising wet environments has been surveyed. W2 still has its centre of distribution in East Anglia, but records are available for a much wider range of sites, from Cornwall in the south, to Dumfries and Galloway in the north. Most sites outside East Anglia are concentrated in a band stretching diagonally from East and North Yorkshire to Dyfed.

Although it has been found throughout Great Britain from Cornwall to the Highlands, W4 seems to be much more of a northern type than was previously apparent. The maximum number of records for any ten km square south of Cumbria is five, whereas in the north up to 29 can be found in a single ten km square. It is a community of moist, moderately acidic peat

(Rodwell 1991), so it is not surprising that so much occurs in Scotland, where wet acid peat is abundant.

W6 was not recorded in Scotland by Rodwell (1991) but we now have records from north-western Grampian, on the Rivers Spey, Findhorn and Avon. It is not surprising that it has been found here given Rodwell's statement that its occurrence reflects the distribution of active alluvial deposition on more mature rivers and the remnants of undrained floodplains. One of the W6 sites in this area (Lower River Spey/Spey Bay) is a cSAC (candidate Special Area for Conservation) for Residual Alluvial Forest.

Distribution maps for the sub-communities of W6 were not published in Rodwell (1991) as only 58 records for the community were available. We now have 174 records, mostly in England (see Table 2), although there are only two records for W6c (*Salix viminalis/triandra* sub-community) and so no map has been produced for it.

W6a (typical sub-community) is most widespread, having been found from Grampian down to Cornwall. All the Scottish records of W6 belong to this type (which is one of the wettest sub-communities) except for a single case of W6e (*Betula pubescens* sub-community) in Dumfries and Galloway. W6b (*Salix fragilis* sub-community) appears to have two centres of distribution, one in Kent and West Sussex, and another from West Yorkshire down to Shropshire. W6d (*Sambucus nigra* sub-community) is predominantly found in northern and western England and Wales. It only occurs at one site (in West Sussex) south of a line from the Humber to the Severn. W6e appears to be a southern type and apart from an example in Dumfries and Galloway, it is not found north of Wolverhampton.

Ash-Maple Woodland (W8 and W9)

Within the sub-communities of W8 the main patterns are the north-western distributions of W8d-W8g, compared to the more even distributions across the range of the community shown by W8a-W8c. The distribution maps of Rodwell (1991) show these latter communities to have south-eastern distributions, with no instance of W8a (*Primula vulgaris* - *Glechoma hederacea* sub-community) or W8c (*Deschampsia cespitosa* sub-community) above a line from the Humber to the Severn. Since this time, these sub-communities have been widely recorded throughout England and Wales.

W8d (*Hedera helix* sub-community) previously appeared to have a southerly distribution, which included south-west England. It has now been recorded throughout Wales and western England, as well as in the south-east, and would seem to have more of a western bias. The distribution of W8e (*Geranium robertianum* sub-community) is largely as shown in Rodwell (1991), and while there are now many more records for W8f (*Allium ursinum* sub-community) and W8g (*Teucrium scorodonia* sub-community), they still appear to show distinct preferences for the west of England and Wales (see above on W8g).

The overall distribution of the sub-communities of W9 is similar to that shown in Rodwell (1991). W9a (typical sub-community) is much the commoner and more widespread; W9b (*Crepis paludosa* sub-community) is most common in northern England and Scotland, although there are a few records of it being found in Wales as well.

Beech Woodland (W12, W14 and W15)

For each of the beech woodland types, W12 (calcareous), W14 (mesotrophic) and W15 (acidic), the known distribution has been extended. W12 and W14 are shown in Rodwell (1991) to have predominantly southern distributions, with only a very few outliers for W12 and none for W14. The new maps show both of these types to have south-eastern and north-western bands of distribution. The south-eastern band, in each case, covers the presumed native range of beech, with one or two outliers in Devon, Cornwall and Northamptonshire. The north-western band stretches north-east from Shropshire and Powys to North Yorkshire (with an outlier in Scotland). These northern examples result from the planting, and subsequent self seeding, of beech beyond its natural range.

W12 generally follows the pattern of the calcareous soils in these areas, whereas W14 is tolerant of more acidic soils. W15 has a much wider distribution than either of the other beech communities. In Rodwell (1991) almost all northern beech woods sampled belonged to W15. This community does not show the disjunct distribution of W12 and W14. The two bands merge in south-west England and southern Wales, presumably because this community is able to flourish on the more acidic soils characteristic of these areas.

All northern records of W12 belong to W12a (*Mercurialis perennis* sub-community). However, although W12a is common in plantation woodland, it is not limited to it. W12b (*Sanicula europaea* sub-community) and W12c (*Taxus baccata* sub-community), apart from a single record of W12b in Shropshire, appear to be confined to the native range of beech. W12b is widely distributed, almost across the native range of beech, from Kent to Gwent (and possibly to Glamorgan, although there are, as yet, no records for it here). W12c, on the other hand, seems to be rather more of a south-eastern community. Apart from two occurrences in the Wye valley it is limited to areas east of Berkshire.

Yew Woodland

W13 has two major centres of distribution, in the south (Kent to Gwent) and the north (Cumbria across to Durham), following that of the yew tree itself. Rodwell (1991) feels that local prominence of *Taxus baccata* on the carboniferous limestone around Morecambe Bay is best considered as variation within the north-western *Fraxinus-Acer-Mercurialis* woodland (W8e, W8f and W8g), but its stands appear as distinctive as those in the south and surveyors have identified it as W13.

Most yew stands are on base-rich soils, although occasional stands occur on more acidic soils, in the Lake District in particular, in association with W11. If these prove to be more widespread a new type may need to be defined to deal with them.

Oak-Birch Woodland

Mesotrophic Oak-Birch Woodland (W10 and W11) - W10a (typical sub-community) is found throughout England and Wales up to the Scottish border, although no records are available for it in East Anglia. This is not because it does not occur here, but because a lot of W10 in this area is found in recent secondary woodland (Cooke pers comm), and most surveys tend to concentrate on ancient woodland.

W10b (*Anemone nemorosa* sub-community) appears to be very much a south-eastern community, although there is a scatter of records in south Wales and in northern England, from the Humber across to the Lune. The distribution may not reflect any preference for the south-eastern climate. Rodwell (1991) states that this sub-community is associated with water-logged plateaus and hollows over undulating topographies and becomes much commoner on the very heaviest substrates on which W10 is found.

W10c (*Hedera helix* sub-community) is another widespread type, although showing a tendency to a more western distribution. We have no records from East Anglia or much of the east coast, and it is commonest in south Wales and southern England. As with W10a the apparent absence of this type from East Anglia is not because it does not occur here, but because *Hedera* is regarded as an indicator of secondary woodland in this area, and so these woods are likely to have been excluded from surveys of ancient woodland (Cooke pers comm). W10d (*Holcus lanatus* sub-community), by contrast, is absent from Wales and is the commonest of the sub-communities of W10 in East Anglia. It is even, rarely, present in eastern Scotland. This is often a species-poor type, with few species abundant except for *Rubus*, *Pteridium*, *Lonicera* and *Holcus lanatus*. It commonly occurs in young plantations (softwood as well as hardwood), thinned stands of oak in their middle years and broadleaved invasion of heathland (Rodwell 1991).

W10e (*Acer pseudoplatanus-Oxalis acetosella* sub-community) occurs in the uplands, north and west of a line from the Humber to the Severn. No examples are found below this line except along the south coast. This is an unusual area, with much higher rainfall than most of southern England (over 800mm mean annual rainfall (Goudie and Brunsden 1994)) and, especially in gill woodland, a microclimate more typical of the Atlantic regions of Britain.

Most of the English and Welsh records of W11 fall into the *Dryopteris dilatata* sub-community (W11a), which is the least common in Scotland. It is the most lush of the sub-communities, with bramble, honeysuckle and large ferns (e.g. *Dryopteris dilatata*) common, and grows on the most base-rich soils of this community. W11b (*Blechnum spicant* sub-community) is frequent in north west England, and in western Scotland. For most of our records of W11 in western Scotland, the sub-community was not assessed, but it is likely that many would be W11b (Kirby pers comm). This type is particularly rich in ferns and bryophytes and was not found outside Scotland by Rodwell (1991). It seems to be absent where average annual rainfall drops below 1000mm.

W11c (*Anemone nemorosa* sub-community) and W11d (*Stellaria holostea-Hypericum pulchrum* sub-community) are commonest in the more continental, east of Scotland with its colder winters, drier climate (mean annual rainfall between 600-1000mm (Goudie & Brunsden 1994)) and well-drained, podzolic soils.

Acidic Oak-Birch Woodland (W16 and W17) - Our maps show the distributions of these communities to be similar to those shown in Rodwell (1991), but the extra information now available to us has enabled us to close up previous gaps in the known occurrence.

Much more data for W17 (the upland community) is now available for Scotland, and the community occurs right across the country from Kintyre and Arran to the north-east tip of Grampian region. Unfortunately, there is still a dearth of information for southern Scotland, especially the southern half of Strathclyde and Borders regions (where there is little ancient woodland), so the distribution of W17 in this area is not yet known. The distributions of the

sub-communities of W17 show some regional difference, which is related to the wetness of the climate. W17a (*Isothecium myosuroides-Diplophyllum albicans* sub-community, which has the highest diversity of bryophytes) is the most western, being largely restricted to areas with more than 200 wet days yr⁻¹. W17d (*Rhytidiadelphus triquetus* sub-community), which has a more continental, northern montane character, is almost restricted to the east of Scotland, with up to 180 wet days yr⁻¹ (Rodwell 1991). W17b (typical sub-community) and W17c (*Anthoxanthum odoratum - Agrostis capillaris* sub-community) are found in conditions of intermediate rain-fall.

W16 (the lowland community) was previously known mainly from south-east (principally the Wealden clays and greensand) and central England (coal measures, millstone grit and sandstones). It had not been recorded in Wales and was largely absent from south-west England. Our current data set shows W16 occurring in a wide band from Northumberland and North Yorkshire, down through south Wales to the lowlands of Devon and Cornwall. The distribution of the two sub-communities shows a strong regional bias. W16a (*Quercus robur* sub-community), although found in the north and west of England, is much commoner in the south and east, and is barely present in Wales (five records in Wales out of 154 for W16 as a whole). The much more mossy W16b (*Vaccinium myrtillus - Dryopteris dilatata* sub-community) is almost wholly confined to north and west of a line stretching from North Yorkshire to Devon.

The distribution of W16 in comparison to its counterparts on the more basic soils of southern Britain (W8 and W10) is discussed below.

Ash-Maple (W8) and Oak-Birch (W10 and W16) Woodland of Lowland Britain

Natural Areas have been defined by English Nature on the basis of geology, soils and historical land use patterns. It is intended that they will form a basis for conservation planning and management. Natural Area boundaries were used by Kirby and Reid (1997) to set nature conservation objectives for woodland across the country.

W8, W10 and W16 form a group of communities encompassing most of the ancient semi-natural woodland in lowland Britain. The bulk of our records for these types, especially for W16, are from England; and so it is possible to look at their distribution on the basis of Natural Areas. The major Natural Areas in which each type is found are listed in Table 3.

Table 3. Distribution of Oak-Birch and Ash-Maple Woodland by Natural Area

	W8	W10	W16
W8	Southern Magnesian Limestone Wessex Vales White Peak South Wessex Downs Cotswolds Dean Plateau and Wye Valley East Anglian Plain West Anglian Plain South Downs Bristol, Avon Valleys and Ridge Mendip Hills		
W10	Low Weald and Pevensey North Downs The Culm Cumbria Fells and Dales	Dartmoor North Lincolnshire Coversands Urban Mersey Basin.	
W16	Exmoor and the Quantocks	London Basin Coal Measures Cornish Killa and Granites Southern Pennines	Midlands Plateau Sherwood.

In addition, the Yorkshire Dales, High Weald, North York Moors and Hills, Wealden Greensand and Mosses and Meres are important for all three communities.

W8 is, indeed, principally found in the more calcareous Natural Areas, and W16 occurs mainly in the more acidic ones, with the distribution of W10 falling between the two. This is illustrated in maps 1, 2 and 3, which show particularly a broad strip across central England from the South Wessex Downs and the Wessex Vales to the West Anglian Plain, where W8 is very well represented but W16 absent.

Several Natural Areas are important for both W8 and W16, the likely reasons for some of these cases are outlined below.

Yorkshire Dales - W8 is extremely abundant in this, predominantly calcareous, Natural Area, with 185 records from 109 woods. Ash woodland generally (including W9) is the most characteristic feature of the limestone dales, accounting for half of all records, and 60% of the woodland area sampled by Graham (1991). It occurs on calcareous mull soils on the limestone. In comparison, W16 is scarce, with only 13 records from 11 sites. W16 is, however, much less common throughout England than W8 (328 records in 45 Natural Areas, compared to 1191 records in 81 Natural Areas for W8), and so the Dales is an important Natural Area for this community. Oak woodland (W10, W11 and W17 as well as W16) is most common on the poor soils overlying Millstone Grit in the south, although it is also found on the upland fringes of the carboniferous limestone (Graham 1991).

High Weald - The soils of this Natural Area are generally nutrient poor, sandy and podzolic. W16 would be expected to develop in such conditions. However, many of the stream valleys and collecting slopes have base enriched or alluvial soils, and localised areas of limestone form very lime-rich clay soils. In these areas W8 occurs.

Wealden Greensand - Soils in this Natural Area are generally light, sandy and very well drained, so podzolisation is common. Base rich soils also occur where fine beds of clay of

higher base status are found within the greensand (Oakes and Whitbread 1990). On these latter soils W8 is very common.

Exmoor and the Quantocks - The geology of this Natural Area is very mixed, with carboniferous limestone and sandstone. Hence both communities occur.

Pine Woodland

The distribution of W18 in semi-natural woods is as illustrated in Rodwell (1991). However, since the NVC was originally described, surveys have been carried out in plantations using this classification. There are now a few records for W18, away from the native range of Scots pine, in plantations of Norway spruce, Douglas fir, Scots pine and Japanese larch in Dumfries and Galloway and in Cumbria. It is unlikely that these stands contain many of the rare or specialist species associated with W18 in its native range. Their value for nature conservation is, therefore, much lower from a botanical perspective, although they may be valuable for other taxa, such as breeding raptors; cf beech stands outside of the (presumed) native range of this species. However, the purpose of the NVC is to systematically describe British vegetation as it exists, so such apparently anomalous occurrences are to be expected.

Strengths and weaknesses of the NVC

As NVC is more and more widely used, any weaknesses and gaps are being revealed, as would be the case with any classification. This should not be viewed as a negative process but as an opportunity for discussion and suggestions for how the system can be improved. This should occur publicly in order that people working in different organisations continue to use the classification in a similar way, so that the information produced is compatible. Some of the most widely raised concerns are discussed below after a consideration of some of NVC's strengths.

Size of the data set

The woodland section of the NVC (including scrub communities) was produced from 2648 samples, making this the biggest data set yet analysed for the production of a woodland classification in Britain. The number of samples from which each community type (not including scrub communities) was described is shown in Table 2. Although there is a problem with low sample numbers in particular regions, only W3 (*Salix pentandra* - *Carex rostrata* woodland, no sub-communities) and W20 (*Salix lapponum* - *Luzula sylvatica* scrub, no sub-communities) were described from less than 20 samples overall.

By comparison the Stand Type system was produced from only about 700 samples in total, almost exclusively from ancient woodland. These samples were recorded opportunistically during site visits for other purposes (Peterken 1981) and were mostly from south of a line between the Humber and Aberystwyth. There are more instances here of woodland types being described from a low number of samples: the Acid oak-lime woods (Stand Group 5) were defined from 24 samples, Suckering Elm Woods (Group 10) from 15, Pinewoods (Group 11) from 19, Birchwoods (Group 12) from 16 samples (Peterken 1981). Many individual Stand Types are based on less than ten samples. The gaps in geographic coverage are greater than for NVC, although this is not always apparent from the maps because they are produced on a 20x20 km square grid.

The Merlewood classification was produced from 1648 samples. These were taken from a stratified random sample of sites, but only 103 woods were sampled in total (Bunce 1982). It is unlikely, therefore, that they cover as wide a geographic and ecological spread as the NVC plots.

Coverage of the whole range of British Woodland

Because of the amount of data from which it was derived, another strength of the NVC is its wide coverage of the range of British woodland; it is not restricted to types occurring in ancient woodland, although ancient woods were well represented in the original data. The contract specified that all British woodland, as it exists at the present time, should be examined (Rodwell 1991). Younger secondary woods and plantations, as well as wet woods and scrub communities were included, but in the event recent conifer plantations were not covered. It therefore provides a more even baseline against which we can judge whether new samples taken from either ancient or recent woodland are very distinct. If they are, then new categories can be created for them. Wallace (in press) for example, makes a case for the need for new types to cover birch stands in Sitka spruce plantations. The flora of crop birch stands was found to lack many of the grass and moss species characteristic of native oak-birch woodland and the open vegetation from which much of this woodland has arisen. However, they supported high frequencies of many species either sparse or absent within the semi-natural woodland.

NVC, like the Merlewood system, provides greater recognition of the variation within upland woods than previous classifications (Kirby 1984). The Stand Type system, for example, put most upland oak woods into just two types: 6A and 6B; Rackham's (1980) classification, which was developed primarily as a classification of East Anglian ancient woodland, excludes upland types altogether. The reverse question - does NVC fail to pick up variation in the lowlands - is considered below.

Rackham (unpublished) has produced a comparison of the Stand Type classification, his own classification and the NVC. According to this comparison W1, W7a, W8f, W8g, W9b, W10b, W11b, W11c, W11d, W17b, W17c (all of which are upland types except W1 (*Salix cinerea-Galium palustre* community - a very wet type) and W10b (the *Anemone nemorosa* sub-community of *Quercus robur-Pteridium aquilinum-Rubus fruticosus* woodland)) all represent previously undescribed types. However, this considers only ancient woodland, and so does not deal with many of the wet woodland types or the scrub. Kirby, Saunders and Whitbread (1989) suggest that W1, W2, W3, W4, W6a-W6c (all wet woodland types); W10d; W13 (*Taxus baccata* woodland); W19 (*Juniperus communis* ssp *communis* - *Oxalis acetosella* woodland); W20 (*Salix lapponum* - *Luzula sylvatica* scrub) and W21 to W25 (other scrub communities) do not have equivalent Stand Types.

Position within the systematic classification of the Vegetation of Britain

The other widely used woodland classifications were just that, classifications of woodland alone. The woodland section of the NVC, on the other hand, is part of a much wider analysis of the vegetation of the British Isles. Indeed, Ratcliffe's perceived need for 'a national and systematic phytosociological treatment of British Vegetation, using standard methods in the field and in analysis/classification of the data' was part of the driving force behind the development of the NVC (Rodwell 1991). This means that it is possible to analyse, and map, a complex site, composed of several habitat types (e.g. woodland, scrub, heathland and bog)

using the same classification system. Successional or treatment related changes in the vegetation, for example between open glades, shaded rides and the vegetation of clear-fells can be more easily described.

Gaps in the Classification

Woodland vegetation is immensely variable. The more any classification is used, the more likely it is that places will be found where it appears inadequate. Tables 1 and 2 indicate where types or regions are poorly represented. Geographic gaps will gradually be filled as more surveys take place and the data-base is expanded. The potential 'ecological gaps' in the classification that have been identified so far are:

- I. Certain vegetation types which people feel are not covered by the classification;
- II. Communities or Sub-communities which they feel should have been further divided.

An example of the former concerns, variants of W8 (*Fraxinus excelsior* - *Acer campestre* - *Mercurialis perennis* woodland) and W10 (*Quercus robur*-*Pteridium aquilinum*-*Rubus fruticosus* woodland) in which the ground flora is entirely dominated by *Luzula sylvatica* (e.g. Latham (pers comm), also in Cooke and Saunders, 1989; Kirby *et al.* 1991). These types are particularly common in the Wye Valley, estuarine woods in Pembrokeshire and ungrazed western oakwoods.

It is a simple matter to describe such types as variants of existing communities. W10 stands frequently have virtual monocultures in their ground flora, whether of *Pteridium aquilinum*, *Rubus fruticosus*, *Anemone nemorosa* or *Hyacinthoides non-scripta*, and the sub-community descriptions recognise this. A similar situation is the case with W8 where the ground flora is often dominated by *Mercurialis perennis* or *Allium ursinum*. *Luzula sylvatica* could be considered as simply another species that does this.

NVC is intended to be a national classification and it is impractical, therefore, to deal with every single patch that someone thinks is distinct. In the case of a very local variant occurring in a single survey, the best option may be to describe the type in the survey report and note where it was found. If more widespread variations are to be recognised within the national classification then there should be some minimum standards, such as the number of quadrat records to support the suggestion that a vegetation assemblage be considered for possible formal variant status. Our suggestion is that quadrat data from a minimum of 20 plots (tree, shrub and ground flora data) spread over at least 5 separate woods should be collected. In addition, evidence from mapping should be provided that the stands sampled are all at least 0.1 ha (i.e. about 30x30m or 50x20m or 100x10m) and that in total they cover at least 10ha.

Variations in the tree and shrub composition can impart a distinctive appearance and character to many stands without altering the NVC types (e.g Kirby *et al.* (1989, 1991). This is particularly the case in lowland Britain, where stands of lime (*Tilia cordata*) or hornbeam (*Carpinus betulus*) are not infrequent. Rackham's (1980) suggestion, that trees and ground vegetation be treated as separate plant communities, can be followed by classifying woods using NVC and Stand Type in conjunction. This is similar to the method recommended in Guidelines for Selection of Biological SSSIs (Nature Conservancy Council 1989). This enables the maximum information about the vegetation of the wood to be communicated using the minimum number of words. If, in the longer term, quadrat data are collected from

distinct stand types according to the protocol indicated above, then new variants/sub-communities can be defined as required.

The Use of the NVC and the Stand Types Classification to Measure Biodiversity

The concept of biodiversity includes variation at ecosystem as well as at species or genetic levels, so the range and abundance of vegetation types could be used as a measure of ecosystem richness or diversity. A study is being carried out of woodland vegetation patterns in England and factors that may affect the use of vegetation types as a means of measuring variation in biodiversity between different parts of the country.

Vegetation types have been widely used in the past in conservation evaluations of different sorts. However, the level of variation found depends on the way the comparison is made: whether individual woods or entire regions are compared; which classification is used; the level of division within the classification. In this section the NVC is compared with the other major woodland classification system, the Stand Type classification developed by Peterken (1981).

The Stand Type system divides woodland into twelve Stand Groups and 39 Stand Types largely on the basis of the trees and shrubs, but also using some soil characters. It was the main woodland classification system used from 1977 to 1986. As with the NVC, types may be identified from quadrat data or by field mapping.

Although there is a broad correlation between these two classifications, there is not a one to one relationship (Cooke and Kirby, 1994). For example, Seatoller Wood in Borrowdale consists of ash woodland on flushes, surrounded by oak woodland. Both classifications separate these two broad types, but under the Stand Type system the flush might be divided into areas with and without elm, which would not be separated by the NVC. By contrast the oak would probably have all been put into one Stand Type but would be split in NVC terms according to whether the ground flora was predominantly mossy or grass-dominated.

The effect of these differences in the method of classification, on perceived vegetation type richness or diversity, was investigated by comparing samples from East Anglia and Cumbria using both classification systems. The number of types found in a region, and the overlap between regions, were examined at both levels in each classification. Stand Groups were compared with communities and Stand Types with sub-communities.

Variation within Regions

A set of woods (five in East Anglia and seven in Cumbria) were chosen for which quadrat data was available that could be classified according to each system. There were between five and thirteen quadrats per wood, and they had been positioned randomly so the results were not biased according to whether the surveyor was looking for variation in Stand Type or in NVC terms.

Figure 1 shows the mean number of vegetation types per wood, and Figure 2 the total number of types in all the woods, found in each area studied. In each case the grey bars represent Cumbrian data, and the black bars, those from East Anglia.

Fig 1. Mean Types per Wood

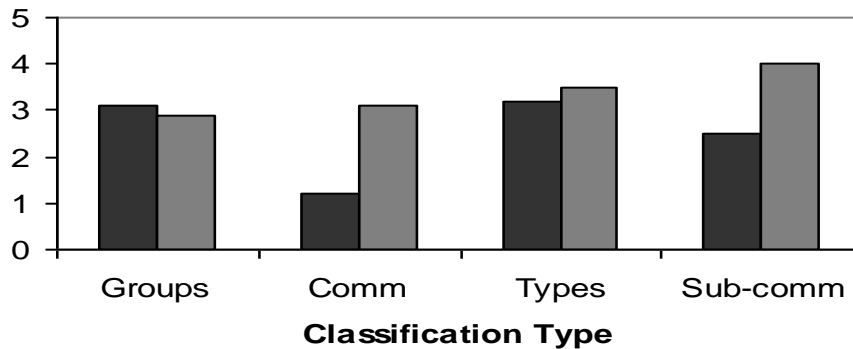
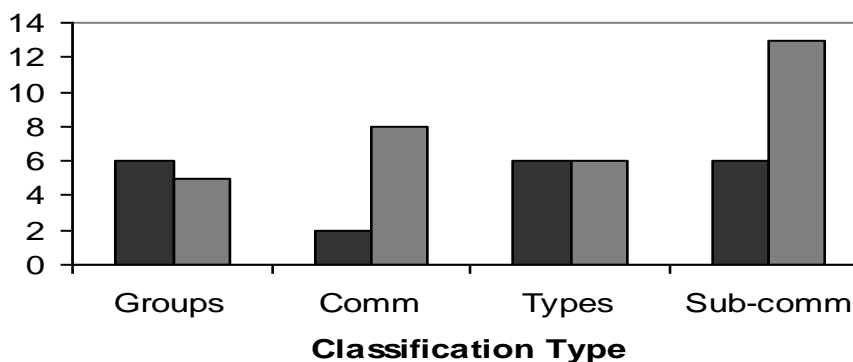


Fig 2. Total Types



There were significantly fewer NVC communities per wood in the East Anglian than in the Cumbrian set. A similar pattern appears with sub-communities, but in this case the difference is not statistically significant. Use of the Stand Type system shows no difference between the richness of vegetation types in the two areas.

NVC communities were very poorly represented in the East Anglian data, as compared to that from Cumbria. In addition, there were twice as many NVC sub-communities as Stand Types in the Cumbrian woods studied.

Using a single set of survey data, we could, therefore, come to different conclusions using different methods. A comparison based on the mean number of NVC communities or sub-communities per wood would suggest that Cumbrian woods are richer; the use of either the mean or the total number of Stand Types shows no difference; but if the total number of Stand Groups in each region is used, East Anglian woods appear very slightly richer.

Careful and selective use of the data would, in this case, allow us to draw any conclusion we wished about the relative diversity of woods in East Anglia and Cumbria.

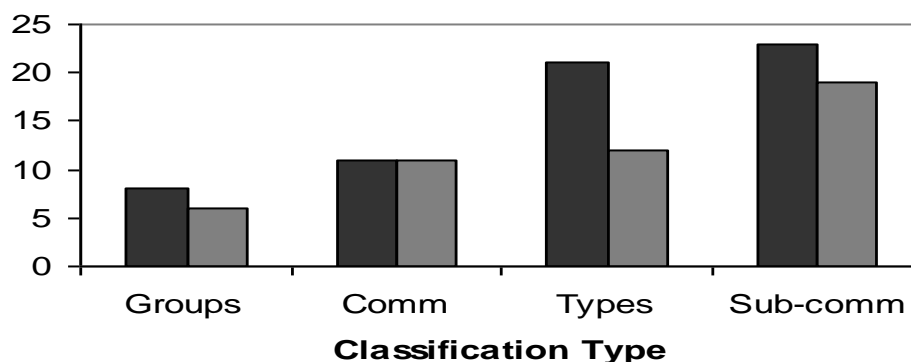
Variation Between Regions

The representation of different vegetation types in two 100km squares (TL and NY) was compared using the published accounts of the classification systems.

The published Stand Type maps use a 20x20 km grid, so up to 25 points are possible per 100x100km square; NVC results are published on a 10x10 km square basis so 100 points are possible, but for neither classification is there full coverage. Presence or absence of each type in each 100 km square was noted. The abundance of each type as a percentage of the total number of records for all types for each square was also measured.

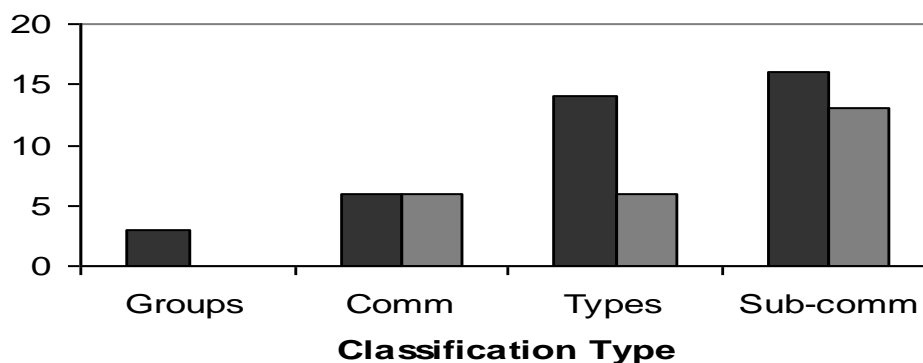
Use of the Stand Type system shows the Cumbrian square to contain less variety of vegetation types than the East Anglian square (Figure 3). This is particularly apparent at the Type level, the finer divisions.

Fig 3. Total Types per Square



This shows up even more clearly in Figure 4 which shows the number of types unique to a single square. Again, grey bars represent Cumbrian data and black bars East Anglian. Three stand groups were found in the East Anglian square but not the Cumbrian one, but there were no groups found only in the Cumbrian square. At the level of Stand Types, more than twice as many were found only in the East Anglian square. Use of the NVC, however, shows a more even balance of communities found in only one of the two squares.

Fig 4. Unique Types per Square



Conclusions

- The Stand Type system suggests a greater richness of vegetation types in East Anglia, whereas NVC shows a relatively greater richness in Cumbria.
- The NVC highlights regional differences in woodland types much more effectively. This is shown by the greater number of types unique to the Cumbrian square in this study.
- The diversity which we perceive in vegetation types is affected by the method we use. The Stand Type system is known to have a south-east bias, so the results are not surprising. What is important is that it has been demonstrated that these measures of landscape richness - the number of types in a wood, a set of woods or in a 100kmsq - are very dependent on the method. As conservation becomes more target orientated (e.g. in Biodiversity Action Plans) such measures are increasingly likely to be used to determine distribution of resources, so it is necessary to remember their limitations.
- Each system has its advantages. For each area studied, important elements of variation were identified by one classification system but not the other: the NVC identified the moss-rich oakwoods of Cumbria, the Stand Type system distinguished the lime-dominant stands in Norfolk. It is, therefore, useful to use them in combination.

Other points which it is important to note:

- not all types are of equal conservation value, so having large areas of a high value type may be more important than having a large number of types.
- not all variation is identified using vegetation classifications, because the structural element is generally ignored by them. Two areas may be classified under the same broad category in both classifications considered here, but one patch might be full of veteran trees and the other have none. In such a case major differences in nature conservation value would not be identified by either system.

This approach is being developed further.

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Annex 1. List of Information Sources Used in the Woodland NVC Database

The numbering of the sources has been changed since the production of the last report. Sources covering woods in Scotland are numbered between 101 and 199; those for England, between 201 and 299, and those for Wales between 301 and 399. Sources covering more than one of these countries are numbered between 1 and 99.

*indicates sources new since the production of the last report.

Great Britain (Surveys of woods in two or more of the countries within Great Britain)

1. Heath M. J. and Bevan J. M. S. (1991) *Woodland Surveys in the West Midlands and North Wales using the National Vegetation Classification*.
Covers a sample of 80 woods, totalling 2250 ha in Clwyd (10 sites), West Gwynedd (18 sites), Shropshire (nine sites), Staffordshire (13 sites), Cheshire (one site), West Midlands (one site), Gloucestershire (seven sites), Hereford and Worcestershire (12 sites) and Derbyshire (nine sites). As previously, most sites were over 10ha. Most sites chosen were ancient semi-natural woods, but a small number of secondary sites were chosen to pick up NVC communities usually associated with secondary woodland and not represented elsewhere. The survey methods were standard throughout the field season. Cards one to four were completed according to Kirby (1988) but no quadrats were taken. The report is available from the Countryside Council for Wales.
- *2. Keith Kirby's quadrat records, for various sites throughout Great Britain. Held at English Nature, Northminster House.
- *3. ECN records for their terrestrial sites which contain woodland. There are six sites throughout the United Kingdom (including one in Northern Ireland). They survey the whole site with up to 500 systematic quadrats; 50 random grid plots every nine years; plots in each NVC type every three years.
- *4. RSPB survey records of their reserves. Surveys were carried out by various people, and a list of the references is available from English Nature, Northminster House Peterborough.
- *5. Rodwell (1991) *British Plant Communities Volume 1*.
This book provides distribution maps for most sub-communities and for all communities from W1 to W19. 10km references were obtained from these maps by overlaying them with 10km grid and reading off the references. No site information is available.
- *6. Wye Valley Survey carried out by Ian Bolt in 1980. 21 sites in England and 16 in Wales were surveyed. Copies of the quadrat records are held by Keith Kirby at Northminster House, Peterborough.

Scottish Surveys

- *101 Tidswell, R.J. (1995) A Botanical Survey of the Semi-natural Woods of Aberdeen, Banff & Buchan and Gordon Districts. Scottish Natural Heritage Report No. NE/94/014
- *102 Tidswell, R.J. (1995) A Botanical Survey of the Semi-natural Woods of Moray and Nairn Districts. Scottish Natural Heritage Report No. NE/94/014a
- *103 Dargie, J.C. and Simpson, D. (1992) Loch Lomond Woodland Survey
- *104 Contract Survey (1995) Glen Affric Special Area for Conservation NVC Survey. Scottish Natural Heritage - Bonnington
- *105 Contract Survey (1995) Conon Islands Special Area for Conservation NVC Survey. Scottish Natural Heritage - Bonnington
- *106 Contract Survey (1995) Coulin Special Area for Conservation NVC Survey. Scottish Natural Heritage - Bonnington
- *107 Contract Survey (1995) Glenmore Special Area for Conservation NVC Survey. Scottish Natural Heritage - Bonnington
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- *109 Contract Survey (1995) Monadh Mor Special Area for Conservation NVC Survey. Scottish Natural Heritage - Bonnington
- *110 Contract Survey (1995) Pitmaduthie Special Area for Conservation NVC Survey. Scottish Natural Heritage - Bonnington
- *111 Contract Survey (1995) Rothimurchus Special Area for Conservation NVC Survey. Scottish Natural Heritage - Bonnington
- *112 Contract Survey (1995) Sheildaig Special Area for Conservation NVC Survey. Scottish Natural Heritage - Bonnington
- *113 Contract Survey (1995) Glen Strathfarrar Special Area for Conservation NVC Survey. Scottish Natural Heritage - Bonnington
- *114 Contract Survey (1993/94) Stirling Ancient Woodland NVC Survey. Scottish Natural Heritage - Stirling
- *115 SFSU (1989) Angus District Woodland Survey Record Cards (Not Complete). No report/Part of woodland database
- *117 SFSU (1989) Clydesdale District Woodland Survey Record Cards (Not Complete). No report/Part of woodland database

- *118 Mackintosh, J. (1990) A Botanical Survey of the Semi-natural Woods of Lochaber District. SFSU Report: S39
- *119 SFSU (1989) Stewartry District Woodland Survey Record Cards (Not Complete). No report/Part of woodland database
- *120 Mackintosh, J. (1988) The Woods of Argyll and Bute. Nature Conservancy Council Research and Survey in Nature Conservation (Report No. 10)
- *121 Survey of Forestry Commission woods in Dumfriesshire and Kirkcudbrightshire. Carried out by David Hawker in July 1995. 13 woods were surveyed and assessed using the NVC. Survey methods are, as yet, unknown. Summary information is available at English Nature, Northminster House in Peterborough.
- *122. Survey of Forestry Commission woods in Castle Douglas Forest District, which lies within Stewartry District, Dumfries and Galloway Region. Carried out by K. Stewart in 1995. 31 Ancient Semi Natural Woods were surveyed. Identification of NVC communities was by eye. Information is available from English Nature, Northminster House in Peterborough.
- *123. Tidswell, R. J. (1990) A Botanical Survey of the Semi-Natural Woods of Angus District.
42 woods, covering 1295 ha, in Angus district, Tayside, were surveyed. All known deciduous woods were considered in selecting sites for survey. 22 of the selected woods were rejected during the survey, of which the majority were Beech plantations. Standard Nature Conservancy Council survey cards were completed for each site.
- *124. Tidswell, R. J. (1988) A Botanical survey of the Semi-Natural Deciduous Woods of Badenoch and Strathspey District.
83 woods, covering 4438 ha, in Badenoch and Strathspey district, Highland Region, were surveyed. All known deciduous woods were considered for survey, plus deciduous woods with small stands of native, or apparently native, Scots Pine. Small woods (below five hectares) were not surveyed, and three of the sites selected were rejected during the survey, as they were too small, had been replanted with conifers or the canopy was too sparse. Standard Nature Conservancy Council survey cards were completed for each site. Quadrat samples of some representative examples of NVC sub-communities were recorded at a number of sites. SFU Report: S34

English Surveys

- 202. Oakes H. and Whitbread A. (1990) *Woodland Survey in the South East of England 1988*. Covers 82 woods, totalling 2612ha in Kent (23 sites), Surrey (seven sites), East Sussex (28 sites) and West Sussex (24 sites). Sites were selected from the Inventories of Ancient Woodland using size as a criterion. Semi-natural sites of 10ha or more were chosen, although smaller sites with special features, such as gill woods, were also included. A standardised survey procedure was followed as far as possible, the methods followed those in Kirby (1988). Standard Nature Conservancy Council woodland record cards were used throughout, but no quadrats were taken. The report is available from English Nature.

203. Heath M. J. and Oakes H. (1990) *Woodland Surveys in South West England using the National Vegetation Classification*.
Covers 81 woods, totalling 2142ha in Avon (10 sites), Dorset (20 sites), Somerset (15 sites), Devon (15 sites) and Cornwall (21 sites). Initially sites were selected from the Ancient Woodland Inventory using size (>10ha) as a criterion. Where woodland types could not be represented elsewhere smaller woods were included (e.g. wet alder valley woods). Some recent semi-natural woods were also included to reflect NVC communities occurring mainly in secondary woodland. Survey methods were standard throughout the field season, cards one to four were completed according to Kirby (1988) but no quadrats were taken. The report is available from English Nature.
204. Hobson, D. (1994) NVC information for woods in Exmoor, North Yorkshire and Surrey. The information is held at English Nature, Northminster House.
205. Hirsch, N. (1995) *A Comparison of the Factors Affecting the Composition of Six Woodland Communities in the Upper Eden*.
Eight quadrats (Field and ground layer 2x2m, shrub and canopy layer 50x50m) were recorded on each site using 'random walk' method. The data were processed by Vespan, TWINSPAN, DECORANA and Match. The information is held at English Nature, Northminster House.
206. Barber, A. G. And Cooke, R. J. (1990) *Woodland Surveys in North-East England Using the National Vegetation Classification*.
90 woods, totalling 2089ha in Northumberland (21 sites), Durham (17 sites), North Yorkshire (41 sites), Cleveland (one site) and Humberside (nine sites). Initially selection was from the Ancient Woodland Inventory using size as a criterion. A sample of sites were then chosen to encompass all major geological, ecological and topographical variations represented within the region. A standardised survey procedure was followed as closely as possible, using the methods of Kirby (1988), although no quadrats were taken. Standard Nature Conservancy Council woodland record cards were used throughout. The report is available from English Nature.
- *207. Lunn, A. NVC information for Nattrass Gill in Cumbria, which he owns.
- *208. Graham, K. *Survey of Broadleaved Woodland in YDNP (North Yorkshire Section) 1990-1991*.
301 sites were identified for survey, NVC information was, however, only available for 215. These covered approximately 1150ha in the North Yorkshire section of the Yorkshire Dales National Park. The selection criteria were:
- Woods identified in the Nature Conservancy Council Phase I survey of the National Park containing a substantial component of semi-natural vegetation, including all sites classified with 'high' or 'excellent' conservation grades in target notes.
 - Ancient woods within the National Park listed in the Craven and Richmondshire Districts 'Inventory of Ancient Woodland' (Nature Conservancy Council, 1987). This identifies woods of about two hectares and above.
 - Small woods of approximately one hectare identified from the Phase I 1:10 000 OS maps. Survey methods follows standard procedures (Kirby 1988). A Nature Conservancy Council Woodland Record Sheet was completed for each wood surveyed but no quadrats were taken. The report is available from English Nature.

- *209. Duddon Valley Survey carried out by Keith Kirby in 1980. 24 sites were surveyed. Copies of the quadrat records are held by Keith Kirby at Northminster House, Peterborough.

- *211. Survey of West Yorkshire 1993/94. 58 sites were surveyed. The site information is available on Paradox and Quattro Pro. The survey is held at English Nature's Blackwell office.

- *212. Stewart, A.; Donnison, E. And Dalton A. (1993). Woodland Surveys in North West England using the National Vegetation Classification. 75 sites were surveyed in Cumbria, 25 in Lancashire and 18 in Greater Manchester and Merseyside. Sites were selected to represent the range of physical and climatic conditions found in the Region, and also to select woods across the size range for ASNW in the Region. Woods were selected from the AWI, Phase I habitat surveys (where available) and county lists of Sites of Biological Importance (in Metropolitan Counties). Woodland SSSIs were automatically included and sites of less than two hectares were discounted unless some noteworthy feature was known of. A standardised survey procedure was followed as closely as possible, using the methods of Kirby (1988). Standard Nature Conservancy Council woodland record cards were used throughout. Quadrat cards were filled in for about 20 woods as a check on NVC types, although none were taken for Greater Manchester or Merseyside due to lack of time. The report is available from English Nature and the site information is available as a spreadsheet from English Nature's Blackwell office.

- *213. National Trust Biological Survey Reports. Carried out between 1989 and present. Reports previous to 1989 contain no NVC information. Methodology is not described in the reports, but in almost all cases the NVC communities present have been determined from notes made during walk about surveys, rather than from quadrats. In many cases the list of communities is incomplete. There will, for example, be no reference to the NVC for most plantations, nor for recent semi-natural woods which appear to be of little biological interest. Many areas of coastal scrub will also have been excluded, as will types covering only small areas. Reports for all English properties are held in English Nature library, reports for all properties are held by the Joint Nature Conservation Committee.

- *214. Stewart, A. and Tidswell, R. (1995) Survey of Woodland Communities in Borrowdale using the National Vegetation Classification. 23 sites in the Borrowdale woods were surveyed. All the woods in Borrowdale designated as SSSIs are included, as well as the non-SSSI, NT owned woods of Cockshot, Brandlehow Park, Dalt and Scarbrow, Low Hows, Holmcrag and Frith. Woodland survey cards were filled in for each site. The report is available from English Nature.

- *216. NVC records for woods within the Bardney Limewoods SSSI, Wickenby Wood (Lincolnshire) and Bevercotes Park (Nottinghamshire).

- *217. Ecological Advisory Service (1994) North York Moors National Park Phase II Woodland Survey. 88 woods, covering 1350 ha, were surveyed in the National Park. Survey cards were completed for each site and the NVC communities present in the woodland were

mapped as accurately as possible at either 1:10 000 or 1:2 500 scale. NVC communities were identified in the field by eye. However, where an NVC community was not readily identifiable in the field, a full species list for the homogenous stand was recorded and the MATCH computer program was used to aid identification. No quadrats were taken.

- *218. Penny Anderson Associates (1992). Survey of Woodland around Manchester Airport. NVC information is available for 16 woods (others were also surveyed). All NVC categories were identified by eye with no quadrat data available, diagnosis to sub-community level is indicative only.
- *219. Clifton, S. (1996) Mission Training Area: an evaluation of its scientific interest. Survey of this remnant of the Mission/Idle Levels, mostly in Nottinghamshire, with a small section in South Humberside. Most of the site is topogenous floodplain fen, with carr woodland, dry secondary woodland and dry scrub. Quadrats were taken within discrete blocks, and broadly assigned to communities and sub-communities where possible on the basis of reference to Rodwell. Report held at English Nature.
- *220. Morgan, V. (1994) Survey of East Dereham Rush Meadow SSSI, Norfolk. The survey was carried out for the site's management plan. Data is fully supported by NVC style quadrats. The data is available at Northminster House, and at the local office.
- *221. BHWB (1994) Vegetation Survey of the Went Valley. The survey was carried out for the Highways Agency in connection with the A1(M) Redhouse to Ferrybridge Improvement. 64 samples (of which 49 are from woodland or scrub) were recorded using NVC methodology. The spread of samples provided a comprehensive view of the range of vegetation present in the Went Valley. A copy of the report is held by the local team and all is available except for the sections on the impact of widening the A1. Copies of the tables and appendices are held at Northminster House.
- *222. Ancient Woodland Inventory
Information which has been included on the AWI, now held on ENSIS. It is not known what methods were used to identify communities or who the surveyors were.
- *223. Gardiner, A. J. (1992) A Survey of Non-SSSI Forestry Commission Woods in the Central Lincolnshire Limewoods.
11 woods or wood complexes were surveyed between 11th and 15th May 1992 by the staff of English Nature's Grantham office (Bob Lord, Tony Smith, Ian Butterfield, Max Coleman, Greg Smith, Charron Pugsley, Graham Weaver, Adrian Gardiner, Ingrid Green, John Shackles, Jane Ostler, Louise Robinson, Roger McCulloch, Claire McDonald, Julia Dennis and Lorraine Walton after training by Rachel Thomas). A number of woods were identified as being priorities in terms of assessment, based on previous knowledge. NVC type was identified using the standard NVC procedure. The report is available from English Nature.

Welsh Surveys

301. Cooke R. and Saunders G. R. (1989) *Woodland Surveys in Dyfed - Powys Region, 1988, using the National Vegetation Classification*.
Covers 156 sites, mostly at least 10ha, in Ceredigion (33 sites), Pembrokeshire (36 sites), Carmarthenshire (excluding Llanelli district) (32 sites), Radnor (30 sites) and Montgomery (25 sites). Sites were selected from the Inventories of Ancient Woodland using size as a criterion. A small number of secondary woodland sites, mostly wet woods, were included in order to reflect fully semi natural stand type variation in the region. Surveys took place between June and October 1988. Methods follow Kirby (1988), standard Nature Conservancy Council woodland record cards were used throughout. Quadrats were recorded on about 10% of sites, these are not included in the report but can be found in the relevant site files at Northminster House. The report is available from the Countryside Council for Wales.
302. Cooke R. and Saunders G. R. (1990) *Woodland Surveys in South Wales Region and Brecknock District 1989, using the National Vegetation Classification*.
Covers a sample of 110 predominantly ancient, semi natural woods covering 1647ha in the counties of Gwent (35 sites), West Glamorgan (18 sites), Mid Glamorgan (10 sites) and South Glamorgan (five sites), together with the district of Brecknock in Powys (35 sites) and the borough of Llanelli in Dyfed (six sites). Again, individual sites were mostly 10ha or larger, and were selected from the Inventories of Ancient Woodland using size as a criterion. A small number of secondary woodland sites, mostly wet woods, were included in order to reflect fully semi natural stand type variation in the region. Methods follow Kirby (1988). Standard Nature Conservancy Council woodland record cards were used throughout. Quadrats were recorded on about 10% of sites, these are not included in the report but can be found in the relevant site files at Northminster House. The report is available from the Countryside Council for Wales.
303. Latham, J. (1995/6) *Welsh Alder Wood Survey*.
Covers 10 SSSIs and one non-SSSI. Quadrats were taken. The report will be available from the Countryside Council for Wales.
304. The Countryside Council for Wales' site files held at the Countryside Council for Wales' headquarters, Bangor.
305. Alan Hale's 1992 NVC surveys of pSSSIs in Ceredigion. Files held at the Countryside Council for Wales' headquarters, Bangor.
306. Doug Oliver's North Wales Surveys. Done at various times between 1987 and 1992. All supported by full quadrat records and maps. Files held at the Countryside Council for Wales' headquarters, Bangor.
307. Ruth Lowther's 1992 Study into Vegetation Changes. Based on non-standard NVC quadrats. Files held at the Countryside Council for Wales' headquarters, Bangor.
308. Keith Kirby's record cards. From various times between 1987 and 1990, held by Jim Latham, the Countryside Council for Wales' Headquarters, Bangor.

309. Castle J. and Mileto R (1993/4) *Survey of Carmarthenshire (Part I)*
Covers 72 woods with a semi-natural component, and a few others which are purely plantations. 560ha of NVC woodland communities are covered in West Dinefwr (i.e. parts of Dinefwr to the north and west of the Brecon Beacons National Park). The report is available from the Countryside Council for Wales.
310. Castle J. and Mileto R (1995) *NVC Woodland Survey of Carmarthenshire (excluding West Dinefwr)*.
Covers 112 sites, totalling 1180ha, in Dinefwr (20, of which 18 are within the Brecon Beacons National Park) and Carmarthen and Llanelli (92). Sites were selected if they:
- appeared to be mainly, or wholly, semi-natural in character (according to the 1:10 000 Ordnance Survey map),
 - contained at least five hectares of semi-natural stands (according to the Inventory of Ancient Woodland),
 - had not previously been surveyed to NVC.
- NVC field survey methodology followed procedures given in Rodwell (1991), at least one quadrat was recorded in each stand type present on the sites. Standard Countryside Council for Wales (ex-Nature Conservancy Council) woodland record cards were also completed for each site. The report is available from the Countryside Council for Wales.
311. Butler, J. S. and Gray, D. E. (1986) *Summary of woodland sites surveyed in the Merthyr Cynog, Aberyscir, Nant Bran parishes (Brecknockshire, Powys) during 1986*. 23 sites, totalling 175.4 ha of woodland. Not all the sites were surveyed according to the NVC, six were surveyed using Peterken Stand Types and two according to dominant species. For these no species lists were recorded. For the others the number of woodland species identified is recorded. Comments are also given, and a subjective assessment of each site was made, on a scale from A (Excellent) to E (poor, hardly worth survey, write off sites). Report available from the Countryside Council for Wales.
312. Kerry, S. (1987) *Forestry Commission Woodland Survey in Gwent 1987*. 25 sites in the Ebbw area, and three in the Wentwood area; totalling 224.5ha semi-natural woodland. Sites were selected using FC stock maps to identify areas of broadleaved woodland likely to be semi-natural. Areas classed as Low-Grade Broadleaf, Scrub, Miscellaneous or Unplantable or with a planting date before 1900 were recorded. For each site NVC woodland cards (sheets one to four) were completed. Until complete familiarity with the NVC was achieved, five quadrats were taken of the ground flora (5x5m), shrub layer (10x10m) and tree canopy (c50x50m) to produce a species frequency table. This was compared to those in the woodland section of the NVC. A subjective assessment of the nature conservation interest of each site was given, on a scale from one (excellent) to five (of little interest). The report is available from the Countryside Council for Wales.
- *313. Castle, J. And Mileto, R. (1996-97) surveys of SSSIs in Wales.