# Ancient woodland indicator plants in Scotland


## *by* Carol L Crawford

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## Summary

Lists of ancient woodland vascular plants (AWVPs) are one clue to identifying ancient woodland.

The number of AWVPs is the indicator rather than individual species and should only be used with archive and other field evidence to infer antiquity.

Relevant English, Welsh, Northern Irish, Scottish and European research is summarised and their AWVP lists compiled. A new Scottish list of 74 AWVPs, derived from expert observations, is tabled.

British and European AWVPs occupy soils of average pH and fertility and are more shade tolerant than other woodland plants. Most are stress-tolerant and poor colonisers.

Methods for using the new AWVP list are given and attention drawn to factors other than continuity/longevity which can heighten AWVP numbers in a wood.

Finally research to generate AWVP lists for Scottish regions is proposed.

## Introduction

The concept of ancient woodland indicator species, flora and fauna more associated with ancient woodland than recent (post mid-1800s) woodland, has been used since the 1970s, initially in English regions and spreading to other countries. The subject has been little researched in Scotland therefore surveys or studies here often refer to English lists, which may not represent Scottish conditions. This paper, updating Crawford (2006):

- describes uses for ancient woodland indicator plants in Scotland
- summarises research into ancient woodland plants and compiles resultant lists
- proposes a list of Scottish ancient woodland vascular plants (AWVPs)
- discusses the ecological characteristics of AWVPs
- explains how the Scottish list should be used.

## Ancient Woodland Vascular Plants

Vascular plants are most commonly used as indicators because they are relatively easy to locate and identify (compared with lower plants and invertebrates) though many are above ground for only half the year. AWVPs are those species which critically depend upon woodland conditions to survive and generally have poor colonising abilities.

AWVPs are rarely enough to class a wood as ancient. Documented and other field evidence will usually also be required. An appreciable number of AWVPs is one clue to identifying an ancient woodland but species-richness can result from factors other than longevity.

Note: text and photographs refer to AWVPs by their English names (after Stace, 1997); Latin names are given in Table 2.

### Uses of Ancient Woodland Vascular Plants

AWVPs can help to:

1. identify Ancient Woodland and hence take measures to secure it
2. investigate sites on the SNH Ancient Woodland Inventory
3. indicate nature conservation value when describing a wood and its predominant communities or comparing with others
4. prioritising Plantations on Ancient Woodland Sites (PAWS) for restoration

### 1. Ancient Woodland

Ancient Woodland is woodland which could have continuity of woodland cover back to the original post–glacial forest. Ancient semi-natural woodland (ASNW) can be the richest wildlife habitat with a wide range of flora and fauna including specialists not found in other habitats or younger woodlands.

Island theorists argue that an ancient woodland must exceed a certain size (2 ha? 20 ha?) to be viable. However some ancient woodland plants cling on in the thinnest of fragments. Forest Habitat Networks (FHNs) will connect ancient woodlands with plantations, 'semi-woodland' habitats,

*Veteran oak, ancient gorge woodland, Lanarkshire*

and new native woodlands to improve viability (see Peterken *et al*, 1995).

Woodland antiquity can be confirmed from historical documents such as maps, estate records and descriptions. Timothy Pont's first maps of the 1580s-1590s and 17th century County Maps may lack detail or coverage. The General Roy survey of 1747-1755 has more of both but its military purpose and scale (1 inch: 1 mile approx) means woodlands distant from roads and rivers and narrow woodlands may have been missed.

In the absence of historical documents for confirming ancient woodland, other clues include Celtic, Norse, and Anglo-Saxon woodland place names and field archaeological or ecological evidence, including a number of ancient woodland indicator species.

## 2. SNH Inventory of Ancient, Long-established and Semi-natural Woodland (Provisional)

Ancient Woodland Inventories were drawn up in the 1980s by the Nature Conservancy Council (NCC). The Scottish inventory was revised in the 1990s (SNH 1997) and now has three main categories:

- Ancient, semi-natural origin: semi-natural on Roy's survey of the mid-1700s and/or on the First Edition Ordnance Survey (OS) of 1843-1882.
- Long-established plantation origin: plantation on Roy or 1st edition OS.
- Woods of any origin on the Roy maps, absent from the 1st edition OS but present today.

The first two classes are further sub-divided by age (Roy: mid-1700s or 1st Edition OS mid-1800s) within the inventory. Users often distinguish Ancient (mid-1700s) and Long-established (mid-1800s) woodland.

All woods in The Inventory are considered by SNH to have biodiversity and cultural value because of their antiquity, but further investigations are advisable; the inventory is provisional and usually prepared by desk research. In some areas, such as The Borders, ASNW was only included in the Inventory where old descriptive evidence and present day botanical fieldwork supported it (C Badenoch, pers comm.).

Investigations should include reviewing old maps and new fieldwork. Long-established plantations require study as well as ASNW because they may have incorporated remnants of semi-natural woodland or 'semi-woodland' habitats such as scrub and bracken (acting as refuges for some ancient woodland species after the original forest was cleared) giving them biodiversity interest. Where site conditions are challenging, such as thin or wet soils, commercial species often failed and native species reasserted themselves.

A limitation of the SNH Woodland Inventory is that it excludes woods less than 2 ha. Many ancient woodland sites in Scotland are smaller than 2 ha particularly along watercourses. In the Northern Ireland Inventory (Woodland Trust, 2007) 63% of ancient sites are less than 2 ha. Preliminary study of the 22 remaining ASNWs on the Isle of Man suggests eight are 0.2 ha or less (Dubbeldam, pers comm).

## 3. Nature Conservation Evaluation

Examples of where nature conservation or biodiversity evaluation is undertaken include ecological impact assessments and where conservation priorities are being decided. A number of ancient woodland species is one indicator of habitat value. Ideally data on many groups would be sought, especially different groups of lower plants and invertebrates. However surveying other groups requires more resources, including specialist ecologists, than recording AWVPs.

## 4. PAWS Priorities

During the 20th century many ancient woodland sites were planted with non-native conifers. The Scottish Forestry Strategy and UK Woodland Assurance Standard are driving the restoration of native woodland on Plantations on Ancient Woodland Sites (PAWS). A suite of AWVPs (plus archive and other evidence of ancient woodland) will help determine each site's status and the best candidates for re-conversion.

Note: outside the native Pine area, many conifer plantations may be in their third or fourth rotation. Experience in south Scotland suggests that propagules and hence recovery of many of the critical flora of ASNW rarely persist beyond the third conifer rotation, except in open rides, stream-sides, cliffs etc. (Graham Booth, pers comm; C Badenoch, pers comm).

# Ancient woodland indicator plants in Scotland

*Herb paris in flower, basic flush in PAWS, Deeside, May*

## AWVP Research

### Country and Regional Lists

Early lists were drawn up by Peterken (1974) in Lincolnshire, by comparing the flora of known ancient woods with that of recent secondary woods. Peterken's research was resource-intensive; lists for other counties were often prepared by expert extrapolation. By 1978 Rose and the NCC had drafted AWVP lists for four southern regions where woodlands were well recorded, also drawing on literature and views of experienced field botanists. Variations in the lists reflect different climates, geology and ecological tolerances in the regions (Rose, 1999). The Rose lists contain 100 species per region plus 52 rare species unlikely to be encountered in most woods but important when evaluating woods.

Kirkby compiled 13 regional lists in English Nature (2002/03) and Rose (2004), including Peterken (1981) and Rose lists and one Scottish list: Angus - a very provisional list of R. Tidswell's when undertaking NCC surveys (K. Kirby, pers comm).

Castle *et al* (2008) reviewed the use and reliability of ancient woodland plants in Wales. They compiled 15 lists for ten areas, added 15 potential species used elsewhere in Britain, giving 136 potential AWVPs. They sampled 20 woods by 2 ha plots, covering ancient, probable ancient, probable non-ancient and recent woodland (81 plots overall) mostly in one county (Carmarthenshire). A modified DOMIN scale was used to record cover, allowing rapid recording (2 hours/plot):

| | |
|---|---|
| 0.5 | Very Rare (1-2 individuals/small clumps) |
| 1 | Rare (3-4 individuals/small clumps) |
| 2 | Occasional (few individuals/small clumps) |
| 3.5 | Frequent but cover < 10% (DOMIN 3 & 4 combined) |
| 5.5 | Frequent/Locally Abundant; total cover 10%-33% (DOMIN 5 & 6) |
| 7 | Abundant; cover 33-50% |
| 8 | Dominant; cover 50-75% |
| 9.5 | Overwhelmingly dominant with cover > 75% (DOMIN 9 & 10) |

Eighty-six of the 136 potential AWVPs were recorded of which 17 were significantly associated with ancient or probable ancient woodland. Fourteen significant associates were found in basic woods, three in neutral to acid woods and wood anemone in both. The number of AWVPs was significantly higher in probable ancient than probable non-ancient wood. Higher numbers of AWVPs were also recorded in ancient woods but were only significant in sites with basic influence (W8 and W9 in the NVC). The small number of samples, their restricted geographic range, and proximity of ancient/probable ancient to probable non-ancient/recent samples, may have been limiting because most potential AWVPs were not significantly associated with any antiquity of wood. They conclude with lists for four Welsh regions.

In Northern Ireland the Woodland Trust (2007) produced the Ancient Woodland Inventory using ancient woodland indicator plants to help classify woodlands. Initially 2,617 woods of over 0.5 ha were found on the 1st Edition OS (1830–44). Of those 134 were classed from documented evidence alone – 69 ancient (wooded before 1830) and 65 long-established (wooded since 1830). These woods were surveyed in May-July, 2004-2006 and the data analysed statistically. Thirty-five vascular plants were significantly associated with ancient/probably ancient woodland. Variations in numbers of species per wood were closely associated with size and regression analysis was used to set thresholds for classing ancient or long-established woodland where archive evidence was weak.

*Sanicle, ancient woodland, Ayrshire, June*

**Table 1: Ancient woodland vascular plants on European, national, Northumberland, Manx and Scottish lists**

(only candidates with Scottish combined score of > 1 included)

| Latin Plant Name | 1 North & Central Europe | 2 England (from 10 region lists) | 3 Wales (from 10 area lists) | 4 Northern Ireland | 5 Lowland Northumberland | 6 Isle of Mann provisional | 7 Tidswell Scotland | 8 Angus provisional | 9 Banchory Miles & Miles | 10 Midlothian Crowther | 11 Edin & Lothian FHN trial | 12 Borders & Loth Badenoch | 13 Scottish combined score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Adoxa moschatellina* | 4 | 9 | (10) | | x | | x | | | x | x | 1 | 6.5 |
| *Ajuga reptans* | | | | ** | | | | | x | | | 3 | 3.5 |
| *Allium ursinum* | 7 | 7 | 8 | | x | | **x** | | | x | x | 2 | 8 |
| *Anemone nemorosa* | 14 | 9 | **8** | ** | x | SO | | x | x | x | | 3 | 9 |
| **Aquilegia vulgaris* | | 8 | 5 | | | | | | | | | | 2 |
| ***Arum maculatum* | | | 1 | * | x | | | | | | x | | 2 |
| *Blechnum spicant* | | 5 | 3 | *** | | | | | | x | | | 2.5 |
| *Brachypodium sylvaticum* | 2 | 1 | | ** | x | | x | | | | | 3 | 5 |
| *Bromopsis benekenii* | 4 | 1 | x | | | | x | | | | | | 5 |
| *Bromopsis ramosa* | | 6 | 8 | | x | E | x | | | x | | 2 | 7 |
| *Calamagrostis canescens* | | 2 | | | | | | | | | | | 2 |
| **Campanula latifolia* | 4 | 5 | 4 | | x | | | | | x | x | 3 | 8 |
| *Cardamine amara* | | 4 | 1 | | | | | | | x | | | 5 |
| *Carex laevigata* | 2 | 8 | 9 | | x | x | | | | 0 | | 2 | 4 |
| *Carex pallescens* | 2 | 8 | 5 | | | | | x | | | | | 3 |
| **Carex pendula* | 5 | 8 | 9 | | | | x | | | x | x | 3 | 8.5 |
| *Carex remota* | 6 | 8 | 9 | *** | x | x | x | | | x | | 2 | 6 |
| *Carex sylvatica* | 8 | 9 | **9** | * | x | x | x | | | x | | 2 | 7 |
| *Cephalanthera longifolia* | | 2 | x | | | | | | | | | | 4 |
| *Ceratocapnos claviculata* | | 5 | 3 | | | | x | | | | | | 4 |
| *Chrysosplenium alternifolium* | 7 | 5 | 5 | | x | | | | | x | | 1 | 6 |
| *Chrysosplenium oppositifolium* | 6 | 9 | 5 | ** | | | | x | x | x | | 2 | 6.5 |
| *Circaea x intermedia* | 2 | 1 | | | x | | x | | | | | | 4 |
| *Circaea lutetiana* | 4 | | 3 | ** | | | **x** | | | | x | 2 | 7.5 |
| *Conopodium majus* | 2 | 6 | **6** | *** | | | | x | | x | x | | 7.5 |
| *Convallaria majalis* | 10 | 8 | 7 | | | | x | | | | | | 3.5 |
| *Corallorhiza trifida* | | | | | | | | | | | | | 2 |
| **Corylus avellana* | 6 | 1 | | *** | | x | | | | x | | | 4 |
| *Dactylorhiza fuchsii* | 2 | | | | | | | | | x | | | 2 |
| *Dryopteris aemula* | | 3 | 6 | | | x | x | | | | | | 4 |
| *Dryopteris affinis* | 3 | 6 | 8 | ** | | | | | | x | | | 2 |
| *Dryopteris carthusiana* | 1 | 6 | 2 | | | ? | | | | x | | | 1.5 |
| *Elymus caninus* | 3 | 7 | 7 | | x | | | | | | | 2 | 5 |
| *Epipactis helleborine* | | 7 | (6) | | x | | x | | | x | | 2 | 7 |
| *Equisetum sylvaticum* | 4 | 7 | 7 | | x | | | | x | x | | 2 | 6.5 |
| *Equisetum telmateia* | | 2 | | | | | | | | | | 3 | 2 |
| ***Euonymus europaeus* | 7 | 4 | **7** | | x | x | | | | | | | 1.5 |
| *Festuca altissima* | 2 | 2 | 4 | | x | x | x | | | | | 3 | 5 |
| *Festuca gigantea* | 4 | 4 | 10 | | x | | x | | | x | x | 2 | 7.5 |
| *Fragaria vesca* | | 1 | | | | x | | | x | x | | | 5 |
| *Gagea lutea* | 2 | 4 | x | | | | | | | x | | 3 | 4.5 |
| *Galium odoratum* | | 10 | **10** | ** | x | ? | **x** | x | | x | x | 2 | 8.5 |
| *Geranium sylvaticum* | | 1 | | | | | | | | | | | 2 |
| *Geum rivale* | 5 | 7 | 7 | | | | | | | x | | | 3.5 |
| *Goodyera repens* | | | | | x | | x | | | | | | 4 |
| *Gymnocarpium dryopteris* | 4 | 1 | 2 | | x | | x | | | | | 3 | 5 |
| **Hyacinthoides non-scripta* | 7 | 8 | **8** | ** | x | SO | | | | x | x | 3 | 8 |
| *Hymenophyllum tunbrigense* | | 1 | 5 | | | | | | | | | | 4 |
| *Hymenophyllum wilsonii* | | | 5 | | | | | | | | | x | 6 |

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**Table 1 / continued: Ancient woodland vascular plants on European, national, Northumberland, Manx and Scottish lists**

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Hypericum androsaemum | | 6 | 8 | | | | | | | x | | | 4 |
| Hypericum hirsutum | 5 | 2 | 3 | | | | | | | x | | | 2.5 |
| Hypericum humifusum | | | | | | | | | | x | | | 2 |
| Hypericum pulchrum | 2 | 7 | **2** | * | | | | x | | x | x | | 7.5 |
| *Ilex aquifolium | 2 | 5 | **4** | | | | | | | x | | | 3 |
| Lathraea squamaria | 5 | 10 | 7 | | x | | x | | | x | | 1 | 7 |
| Lathyrus linifolius | 4 | 8 | 5 | | | | | | | | | | 1.5 |
| Linnaea borealis | | | | | | | x | | | | | | 3 |
| Lonicera periclymenum | 1 | 1 | 1 | *** | | | | | | | | 3 | 1.5 |
| Luzula pilosa | 10 | 10 | **10** | *** | x | x | x | | | x | x | 3 | 8 |
| Luzula sylvatica | 4 | 10 | 7 | *** | | SO | | | x | x | | 3 | 9 |
| Lysimachia nemorum | 6 | 8 | 6 | *** | | | **x** | x | x | x | | 3 | 9 |
| **Malus sylvestris | 3 | 4 | **10** | | | | | | | | | | 1.5 |
| Melampyrum pratense | 4 | 7 | 10 | | x | x | **x** | x | | x | x | | 8 |
| Melampyrum sylvaticum | 5 | 1 | | | | | | | | | | | 4 |
| Melica nutans | 6 | 2 | 4 | | x | | | | | | | 2 | 4 |
| Melica uniflora | 9 | 10 | **10** | | x | x | x | | | x | x | 2 | 7 |
| Mercurialis perennis | 11 | 4 | 7 | | x | | x | x | | x | x | 2 | 8.5 |
| Milium effusum | 8 | 9 | 9 | | x | | x | | | x | x | 3 | 7 |
| Moehringia trinervia | | 4 | 5 | | | E | x | | | x | | 3 | 6.5 |
| Moneses uniflora | | | | | | | x | | | | | | 3 |
| *Myosotis sylvatica | | 4 | 4 | | x | | x | x | x | x | | 3 | 5.5 |
| Neottia nidus-avis | 7 | 8 | 9 | | x | | x | | | x | | 3 | 5 |
| Orchis mascula | 8 | 8 | 7 | ** | | | | | | | | 2 | 2.5 |
| Orthila secunda | | | | | | | x | | | | | | 4 |
| Osmunda regalis | | | | | | | | | | | | | 2 |
| Oxalis acetosella | 10 | 8 | 9 | *** | x | | | | x | x | | 3 | 8.5 |
| Paris quadrifolia | 12 | 10 | 8 | | x | | **x** | | | x | | 1 | 8 |
| Phegopteris connectilis | 2 | 1 | 1 | | x | x | x | x | | x | | 2 | 7 |
| Phyllitis scolopendrium | | 5 | 5 | | | | | | | x | | | 1.5 |
| Plantathera chlorantha/bifolia | 4 | 6 | 2 | | | | | | | | | | 2 |
| *Poa nemoralis | 1 | 6 | 9 | | x | | | x | | x | x | 3 | 6 |
| Polygonatum verticillatum | | | | | | | x | | | | | | 4 |
| Polypodium vulgare/interjectum | | 5 | 6 | * | | | | | | x | | 3 | 5 |
| Polystichum aculeatum | 3 | 7 | 4 | *** | x | ? | x | | | x | | 1 | 6 |
| Polystichum setiferum | | 5 | 7 | | x | | x | | | | | 2 | 6 |
| Populis tremula | | 6 | 10 | | | x | | | | 0 | | | 5 |
| Potentilla sterilis | 3 | 6 | 2 | * | | | | x | | x | | | 6 |
| Primula vulgaris | 7 | 7 | 7 | | x | | | x | x | x | | 3 | 10 |
| *Prunus avium | | 7 | 5 | | | | | | | x | | | 2.5 |
| *Prunus padus | | 2 | 6 | | | | | | | x | | | 4 |
| Prunus spinosa | | | | *** | | | | | | | | | 2 |
| Pyrola media | | | | | | | | | | | | | 2 |
| Pyrola minor | | 1 | | | | | | | | | x | | 3 |
| *Quercus petraea | | 6 | 6 | | | x | | | | x | | | 5 |
| Ranunculus auricomus | 8 | 8 | 6 | | x | | **x** | | | x | | 1 | 6 |
| Ranunculus ficaria | | | | *** | | | | | | | | | 1.5 |
| **Ribes nigrum | | 4 | | | | | **x** | x | | | | | 2.5 |
| **Ribes rubrum | | 5 | 4 | | | | **x** | x | | | | | 3 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ****Ribes uva-crispa** | | | | | | | x | | | | | | 1.5 |
| *Sanicula europaea* | 10 | 7 | 10 | *** | x | x | x | | | x | x | 1 | 10 |
| *Scirpus sylvaticus* | | 5 | 4 | | | | | | | | | | 4 |
| *Scrophularia nodosa* | 1 | 1 | (7) | | | | x | | x | x | | | 5.5 |
| *Sedum telephium* | | 5 | 1 | | | | | | | | | | 1.5 |
| *Stachys sylvatica* | 4 | | | | | | | x | x | | | | 1.5 |
| *Stellaria holostea* | 6 | 3 | 3 | *** | | | | | | x | | | 5 |
| *Stellaria nemorum* | 1 | 2 | 5 | | x | E | x | | x | x | | 1 | 7 |
| *Teucrium scorodonia* | | | | | | | | | x | | | | 1.5 |
| *Trichomanes speciosum* | | | | | | | x | | | | | | 3 |
| *Trientalis europaea* | | | | | | | | | x | | x | 2 | 6 |
| *Ulmus glabra* | | 2 | **6** | | | | | | | x | | | 3.5 |
| *Vaccinium myrtillus* | 4 | 4 | **4** | ** | | | | | | | | | 2.5 |
| *Valeriana officinalis* | | 1 | | * | | | | | x | x | | | 6.5 |
| *Veronica montana* | 6 | 8 | 10 | ** | x | x | x | | | x | | 1 | 6 |
| *Veronica officinalis* | | | | | | | | | | | | | 1.5 |
| **Viburnum opulus* | 2 | 7 | 5 | | x | | | | | x | | | 4 |
| *Vicia sepium* | | 5 | 5 | | | | | x | | x | | | 2 |
| *Vicia sylvatica* | | 8 | 7 | | x | x | | | | 0 | | 3 | 4.5 |

* Can be planted, introduced or garden escapee
** not native to Scotland or native to a restricted geographic range and naturalised elsewhere, so often as *

1. From Hermy *et al* (1999), number of citations in 22 European publications; six anecdotal, 16 quantitative (forests or plots). Of 22, five from England (2 forests, 1 hedges, 2 anecdotal)
2. Collated by Kirby (2004) in Rose (2006) excluding three of 13 lists there: Carmarthen, assumed included in column 3; Lowland Northumberland, included as column 5; and Angus, included as column 8
3. Castle *et al* (2008) occurrences on 10 Welsh area lists. Bold = significant association with probable ancient woodland, ( ) = significant association with probable non-ancient or recent wood, x = potential indicator for Wales (from other British lists).
4. From Woodland Trust 2007 surveys in Northern Ireland. The number of asterisks denotes the degree of the statistical significance of the association with ancient woodland (semi-natural and plantations) (S. Atkinson, pers comm)
5. In Lunn A (2004). Northumberland, New Naturalist, based on surveys in ancient & recent wood (K. Kirby, pers comm)
6. Provisional Manx list based on Kirby (2004) lists and preliminary survey by A. Dubbeldam (pers comm): x = listed, ? = possibly inclusion, SO = as common in secondary woods & other habitats as in ASNW, E = extinct.
7. Tidswell (1993). Scottish Woodland Plant Species for Scotland provided by SNH. x= included, **bold** as per his list.
8. Provisional list produced by R. Tidswell when doing woodland surveys for NCC. No quantitative basis (K. Kirby, pers comm)
9. In Miles & Miles (1997)sites: broadleaved woodland mapped in 1867 still broadleaved, since coniferised or rough grazing
10. In Crowther's (2006) list of 71 Rose & Peterken indicators which occur in Lothian Woods. x = recorded in 1-15 Midlothian ancient or long-established semi-natural woodlands. 0 = not recorded in those woods.
11. From Ray and Moseley's (2007) selection of 21 indicators for Edinburgh and Lothian FHN
12. On Badenoch's (2006) list for Lothian and Borders. 1 = confined to ASNW, 2= almost always confined to ASNW or cleared ASNW, 3 = usually in ancient or long-established wood, wood edge or where woodland conditions persist.
13. This combines Crawford's 2006 and 2009 consultation responses (1= include, -1 = exclude, +/- 0.5 = ? (uncertain or include/exclude in certain circumstances) and the number of Scottish lists above on which each occurs.

A statistical relationship was also shown between survey date and records of wood anemone indicating under-recording in June and July. In case other vernal species were similarly affected, 129 sites were resurveyed in May 2007. This gave 49 vascular plants significantly associated with ancient woodland. Thresholds for classifying woods by indicator score and size have been adjusted (S. Atkinson, pers comm).

Hermy *et al* (1999) collated 22 lists for old broadleaved forests from eight northern and central European countries, generating a list of 132 ancient forest plants. The publications ranged from detailed large scale studies to anecdotal evidence. The age of forests ranged from 1600-1850. Analysis showed their ancient forest species prefer mild lowland conditions to the sub-montane. They concluded that regional lists were more

appropriate for assessing nature conservation values of forests than one European list.

A provisional list of AWVPs was drafted for the Isle of Man, from existing records and preliminary visits to the 22 remaining ASNWs. The list is limited by steep sites, acid soils, the lack of woodland specialists native to the island, extinctions, and Atlantic conditions enabling woodland species to colonise other habitats (A. Dubbeldum, pers comm).

AWVPs from English, Welsh, Northern Irish, Manx and European research are given in Table 1.

## Lists from Scotland

The relative isolation of Scotland from Continental Europe, its greater westerliness, oceanicity and exposure, and preponderance of old, generally hard geology and more recent glaciation leads one to expect a more limited critical woodland flora in Scotland than in England or continental Europe.

Miles (1988) during 18 years studying vegetation succession in the Scottish uplands noted 15 of Peterken's (1974) list as colonists after disturbance or during succession. He attributed this to native pinewoods and birchwoods regenerating outwith their boundaries, hence moving over the centuries taking more mobile ground flora with them. These woodlands differ significantly from the more stable deciduous woodlands of the central and southern Scottish lowlands.

Miles and Miles (1993) tested the potential of plants as indicators at sites round Banchory. From the 1st Edition OS (1867) they studied eight broadleaved woodlands present since 1868, 11 coniferised 1867 broadleaved woods, eight rough grazings which were wooded in 1867, and five new woodlands. Plants were recorded in one 20 m x 20 m plot in each. Sixty species of vascular plant were recorded at the 27 sites (the low total due to relatively acid soils) of which 20 species occurred only in the first three types; the number declining from 18 in long-established woodlands, to seven in conifer plantations, to two in formerly wooded grazings (greater woodrush and wood anemone). Of these 12 were on Peterken's (1974) list and two were more northern (chickweed wintergreen, wood stitchwort). Miles and Miles conclude that Peterken's list could, by adding certain northern species and deleting southern species, be used cautiously to infer woodland antiquity. Note: the list from their study can only indicate long-established woodland (19th century).

Badenoch (1993) set out preliminary lists for the Borders. His 2006 unpublished list of 57 species from surveys of 800 woods in Lothian, Borders and Liddesdale has species:

- apparently confined to ASNW (9)
- amost always confined to ASNW, recently cleared ASNW or sites retaining shade and shelter (20)
- usually in ancient/long-established woodland, relic woodland, woodland edge, former woodland or where woodland conditions persist (28).

In his region woodlands are small (no parcel over 25 ha), many ASNWs are on steep burnsides with high length to breadth ratio, most are lowland, and all were subjected to land-use interference over 3,000 years, including tree cutting, coppicing and grazing, the best sites recovering and not long without cover. Similar conditions are found in other districts with cleugh, glen or den woodlands. Narrow woods on steep slopes are less able to maintain physical woodland conditions such as equability of exposure, insolation and hence temperature, humidity etc. This is particularly so if their valleys catch full sunlight or prevailing winds. In the uplands such sites may be buffered by adjoining conifer plantations.

Crowther (2006) developed a method for distinguishing secondary woodlands/plantations from long-lived semi-natural woodlands. His starting point was the NCC Ancient Woodland Inventory. Using Rose (1999) and Peterken (2000) lists, he listed 71 potential indicator species which occur in Lothian woodlands. Using data from 15 Midlothian Inventory semi-natural woodlands, assessed for the Scottish Wildlife Trust as Wildlife Sites, he tabled potential indicator species recorded in each. He postulated relationships between number of indicators, age and size, acknowledging the method as imperfect but useful for investigating longevity and ranking sites meriting conservation effort.

*Ancient glen woodland, Ayrshire coast*

*Broad-leaved heleborine fruiting, long established plantation, Ayrshire, October*

Ray and Moseley (2006) used 21 ancient woodland indicators (from Peterken and Rose lists), covering a range of soils, with distribution data from the Lothian Wildlife Information Centre to help identify sites for Edinburgh and the Lothians' FHN.

Scottish lists are also given in Table 1 (species on only one list excluded).

## Drafting the Provisional Scottish List

Crawford (2006) used Rose (1999) and Peterken (2000) lists as starting points, adding species from Tidswell (1993) and other sources. The long list was analysed and amended using these tools:

1. Rodwell's (1991-2000) National Vegetation Classification (NVC) volumes: species of woodland communities and number of woodland communities/other communities in which each was recorded.

2. Preston *et al*'s (2003) New Atlas of the British Flora prepared from Botanical Society of the British Isles (BSBI) data: habitat notes and Scottish distribution for every species.

3. Grime *et al* (1996): habitats and established strategies for common species. Established strategies are species' positions within the C-S-R model of ecological strategies. Primary strategies are **C**ompetitor (low stress/disturbance), **S**tress-tolerator (high stress, low disturbance) and **R**uderal (low stress, high disturbance). The positions of species in the model resulted from laboratory and field studies round Sheffield, which is considered to have a representative range of British ecological conditions, but may not encompass all Scottish conditions.

Crawford excluded species common in Scottish secondary woods and plantations and added northern species to give a draft list of 116 species with four sub-lists (woodland, 'common in open', uncommon and questionable. This was circulated to the Native Woodlands Discussion Group (NWDG) e-group July-September 2006. Members were invited to move species between sub-lists, exclude or add species and generally comment.

Twelve responses were received from NWDG members or colleagues. There was no dissent to establishing Scottish list(s), several respondents welcomed the idea; others recognised difficulties in agreeing a single list because of variations in ecological conditions across the country. Regional lists or lists for each woodland community were suggested to take account of geological, climatic and other gradients.

This resulted in Crawford's (2006) provisional table of 66 AWVP species (60 on 50% or more of consultation responses/then known Scottish lists; six included from observations of two experienced vegetation surveyors).

## Revising the Scottish List

After 2006 more Scottish lists or northern research came to light. In February 2009 the NWDG e-group was consulted on the provisional 2006 list and a further 45 candidates (including 10 rare or non-native species). Members were asked: if rare species should be added, which other species should be included/ excluded/added, whether species should be weighted when scoring and for other comments.

Eleven responses were received from NWDG members/colleagues (of whom eight did not comment in 2006). Six suggested including or excluding certain species of whom two thought nearly all species could be included, at least as indicators of semi-natural habitat or biodiversity value. Four had no views on inclusions/exclusions or thought the list reasonably comprehensive, two of whom thought how the list was used was more important. There was no consensus on rare species or weighting and a desire to avoid complexity. Four respondents thought separate lists for regions worth pursuing, particularly if site types were simply included.

During the 2006 and 2009 consultations 144 potential AWVPs were considered - on consultation lists, existing Scottish lists or suggested by respondents. 2006 and 2009 responses for each species were converted to scores and added to the number of Scottish lists on which each appears. Combined scores are shown in the final column of Table 1; the scoring system explained below it. The mean combined score was 4.06. Species scoring 1 or less were excluded from Table 1, leaving 117 candidates. Species scoring 4 or more make up the revised Scottish list in Table 2. The process added eight species to the provisional list, giving a new total of 74 AWVPs.

The combined score in Table 1 is not always related to how reliable an indicator a species is. There is bias towards the east, both in existing lists and respondents who commented on the whole list. Thus species such as broad-leaved helleborine and pendulous sedge score well but must be used with caution in the west where they may have more colonising abilities/opportunities. Respondents who only commented on some species often focussed on commonly encountered species, so boosting their scores. To counterbalance such effects the author judged which species have most expert consensus; these 15 AWVPs are highlighted in Table 2.

# Ancient woodland indicator plants in Scotland

**Table 2: 2009 List of 74 Ancient Woodland Vascular Plants for Scotland**

| Latin | English | Habitat | Distn | Niche | Notes |
|---|---|---|---|---|---|
| *Adoxa moschatellina* | moschatel | W | L | mean | Uncommon north of Great Glen |
| *Allium ursinum* | ramsons | W | L | SNR | Lowland. Occasionally on open banks. |
| *(Anemone nemorosa)* | (wood anemone) | WO | C | mean | Best as an indicator in S & E lowlands |
| *(Brachypodium sylvaticum)* | (false brome) | WO | L | mean | Best as an indicator in lowlands |
| *Bromopsis benekenii* | lesser hairy-brome | W | R | mean | Mid Scotland, lightly shaded sites |
| *Bromopsis ramosa* | hairy brome | W | L | SNR | Lowland. Mostly in S, scattered in N |
| **Campanula latifolia* | giant bellflower | W | L | mean | Native in S & E. Also a garden escapee |
| *Cardamine amara* | large bitter-cress | WO | L | WNR | Riparian & wet woodland, use in lowlands |
| *Carex laevigata* | smooth-stalked sedge | W | L | WMAF | Lowland. Scattered except Argyll. |
| **Carex pendula* | pendulous sedge | W | U | WNR | South lowlands. Introduced as ornamental |
| ***Carex remota*** | **remote sedge** | W | L | WNR | Uncommon in north and east |
| *Carex sylvatica* | wood sedge | W | L | mean | Less common in north and east |
| *Cephalanthera longifolia* | narrow-leaved helleborine | WO | U | mean | Western open woods, basic soils |
| *Ceratocapnos claviculata* | climbing corydalis | WO | L | mean | Lowland. Also under bracken |
| ***Chrysosplenium alternifolium*** | **alternate-leaved golden saxifrage** | W | L | WNR | Absent from north-west |
| *Chrysosplenium oppositifolium* | opposite-leaved golden saxifrage | WO | C | WMAF | Spreads along drainage lines |
| *Circaea x intermedia* | Upland enchanter's nightshade | W | L | mean | Commoner in W. More vigour than *C. lutet* . |
| *Circaea lutetiana* | enchanter's nightshade | W | L | mean | Uncommon in N. Good coloniser if shaded |
| *Conopodium majus* | pignut | WO | C | mean | Also grasslands including wood pasture |
| **Corylus avellana* | hazel | W | C | mean | Where old specimens present |
| *Dryopteris aemula* | hay-scented buckler-fern | WO | L | AIM | Grows in open on west coast |
| *Elymus caninus* | bearded couch | WO | L | PNR | Commoner in S than N. Ungrazed sites |
| **Epipactis helleborine* | broad-leaved helleborine | W | L | mean | Colonises plantations & urban habitats particularly in Glasgow and to its south |
| *Equisetum sylvaticum* | wood horsetail | WO | C | WMAF | Better used in lowlands; in upland moorland |
| ***Festuca altissima*** | **wood fescue** | W | U | SAF | Commonest in central west. |
| *Festuca gigantean* | giant fescue | W | L | SNR | Lowland. Uncommon in N except NE |
| *Fragaria vesca* | wild strawberry | WO | C | mean | In open habitats on skeletal soils, sometimes in secondary habitats |
| *Gagea lutea* | yellow star-of-Bethlehem | W | U | SNR | In SE. Moist, shady places including shingle |
| *Galium odoratum* | sweet woodruff | W | L | SNR | Good indicator in lowlands, though some may originally have been planted as a herb |
| *Goodyera repens* | creeping lady's tresses | W | U | AIM | Also in pine plantations. Mostly northern |
| ***Gymnocarpium dryopteris*** | **oak fern** | W | L | mean | Best as indicator in S & E & lowlands |
| *Hyacinthoides non-scripta* | wild hyacinth, bluebell | W | C | mean | Survives under bracken & in grassland |
| ***Hymenophyllum tunbrigense*** | **Tunbridge filmy fern** | W | U | AIM | Western oceanic |
| *Hymenophyllum wilsonii* | Wilson's filmy fern | W | L L | AIM | Best as indicator away from W Highlands |
| **Hypericum androsaemum* | tutsan | W | L | mean | Use only in west, though can be garden escapee. Not native to east |
| *(Hypericum pulchrum)* | (slender St John's wort) | O | C | AIM | Woods and old, open semi-natural habitats |
| ***Lathraea squamaria*** | **toothwort** | W | U | SNR | Southern. Parasitic on roots of woody plants |
| *Luzula pilosa* | hairy wood-rush | W | C | AIM | Good indicator in lowlands and upland oakwoods, but also found in upland heaths |
| *(Luzula sylvatica)* | (great wood-rush) | O | C | mean | Woods & little-grazed, open upland habitats |
| *Lysimachia nemorum* | yellow pimpernel | W | C | mean | Some open uplands |
| *Melampyrum pratense* | common cow-wheat | WO | L | AIM | Use in S & E lowlands, not uplands |
| *Melampyrum sylvaticum* | small cow-wheat | W | U | AIM | Highlands, humid & light shade |
| *Melica nutans* | mountain melick | W | L | SNI | Uncommon near coasts |
| ***Melica uniflora*** | **wood melick** | W | L | mean | Uncommon in N. Also relic woodland sites |
| *Mercurialis perennis* | dog's mercury | W | L | SNR | Best as indicator in S & E & lowlands |
| ***Milium effusum*** | **wood millet** | W | L | mean | Uncommon outwith central Scotland |
| *Moehringia trinervia* | three-veined sandwort | W | L | mean | In 65% of secondary woods in Lincolnshire |
| **Myosotis sylvatica* | wood forget-me-not | WO | L | mean | Eastern. Also a garden escapee. |
| *Neottia nidus-avis* | bird's nest orchid | W | U | SNI | Well-shaded sites, including under beech |
| *Orthila secunda* | serrated wintergreen | WO | U | AIM | Highlands. Also on open moorland |
| *(Oxalis acetosella)* | (wood sorrel) | WO | C | mean | Best as indicator in S & E & lowlands; poor indicator in uplands |
| ***Paris quadrifolia*** | **herb Paris** | W | U | SNR | Generally lowland; some upland basic sites |
| ***Phegopteris connectilis*** | **beech fern** | W | L | mean | Best in S, E & lowlands, OK elsewhere |
| **Poa nemoralis* | wood meadow-grass | W | L | mean | Common in E than W. Also an ornamental |
| *Polygonatum verticillatum* | Whorled Solomon's seal | W | R | mean | Moist, unstable, basic banks. Perthshire. |
| *Polypodium vulgare/interjectum* | Common or intermediate polypody | WO | C | AIM | Also epiphytic and on rock habitats |
| *Polystichum aculeatum* | hard shield fern | W | L | mean | Also in hedgerows and steep rock habitats |
| ***Polystichum setiferum*** | **soft shield fern** | W | U | mean | Lowland. Mostly in central W and far S |
| *Populus tremula* | aspen | WO | C | mean | Where old trees. Can colonise bare ground. On crags in west indicating former woodland |
| *Potentilla sterilis* | barren strawberry | W | L | mean | In open in uplands. Uncommon in far N |
| *(Primula vulgaris)* | (primrose) | O | C | mean | In open where shaded from strong sun. Can indicate formerly wooded sites |
| **Prunus padus* | bird cherry | W | L | SNR | Usually where shaded. Also planted. |
| **Quercus petraea* | sessile oak (NOT HYBRIDS) | WO | L | AIM | Where old trees/present in all layers |
| ***Ranunculus auricomus*** | **Goldilocks buttercup** | WO | L | mean | Generally lowland. Uncommon in N |
| ***Sanicula europaea*** | **Sanicle** | W | L | mean | Good indicator in lowlands & upland ravines |
| *Scirpus sylvaticus* | wood club-rush | WO | U | WNR | Mostly in S. Also at wood edges & riparian. |
| **Scrophularia nodosa* | common figwort | WO | C | mean | Competitive-ruderal. Colonises wasteland |

**Table 2: 2009 List of 74 Ancient Woodland Vascular Plants for Scotland**

| Latin | English | Habitat | Distn | Niche | Notes |
|---|---|---|---|---|---|
| *Stellaria holostea* | greater stitchwort | WO | C | mean | Wood margins, hedge banks & road verges |
| ***Stellaria nemorum*** | **wood stitchwort** | W | L | SNR | South half of Scotland |
| *Trientalis europaea* | chickweed wintergreen | WO | L | AIM | Eastern. Best in SE; in open moorland in NE |
| *(Valeriana officinalis)* | (common valerian) | O | C | WMAF | Little grazed wet habitats. |
| ***Veronica montana*** | **wood speedwell** | W | L | mean | Generally lowland, uncommon in N |
| **Viburnum opulus* | guelder rose | W | L | mean | If mature plants present. Uncommon in N. |
| *Vicia sylvatica* | wood vetch | WO | L | LNF | Wood edge, ungrazed grass, rock habitats |

**Bold** species for which there is most expert consensus
( ) species most commonly found in non-woodland habitats in NVC tables, which could be excluded as AWVPs in some localities
* consider only if they occur well within the wood and do not appear to be planted or escapee/introduction or recent coloniser, especially at edges or along watercourses

**Habitat**
W: commonest in woodland or other shaded habitats, sometimes present in open habitats.
WO: equally common in woodland and other communities or present in open woodland, woodland edge, scrub, hedgerow, other partially shaded habitats or former woodland
O: more common in other communities than woodland communities; i.e. found in open ground within or beside the woodland. Also found on sites of former woodland.

**Scottish Distribution**
(Based on the number of ten km squares (in the BSBI Atlas) in which the species is native)
C: Common - native in more than 50% of Scottish ten km squares, distribution widespread or scattered over most of Scotland
L: Limited – native in 11 – 50% of Scottish squares, distribution scattered over part(s) of Scotland, species uncommon in some regions.
U: Uncommon – native in 2 – 10% of Scottish squares, absent from large parts of country
R: Rare – native in 0.2 - 1% of Scottish ten km squares (2 - 11 squares).

| Niches | | Ellenberg Values for Britain | | | | |
|---|---|---|---|---|---|---|
| Code | Site and soil factors | Light 3=shade | Moisture 7 = damp | Reaction Soil/$H_2O$ pH | Nitrogen 7 = rich | Number in niche |
| mean | Around mean values for whole population | 4 - 6 | 4 – 7 | 4 - 7 | 4 - 6 | 38 |
| SNR | **S**hade, **N**eutral (weakly acid to weakly basic), **R**ichly fertile | 3 - 5 | 5 – 6 | 6 - 7 | 6 - 7 | 10 |
| SNI | **S**hade, **N**eutral, **I**nfertile to intermediate fertility, moist – dry soils | 2 - 4 | 4 - 5 | 7 | 3 - 5 | 2 |
| SAF | **S**hade, **A**cid, **F**ertile (intermediate fertility), moist | 3 | 5 | 4 | 5 | 1 |
| LNR | Partial shade/well **L**it, **N**eutral, **R**ichly fertile | 7 | 6 | 7 | 8 | 1 |
| LNF | Partial shade/well **L**it, **N**eutral, **F**ertile | 7 | 3 | 7 | 5 | 1 |
| AIM | **A**cid to moderately acid, **I**nfertile, **M**oist, semi-shade | 4 - 6 | 5 – 6 | 2 - 5 | 2 - 4 | 12 |
| WNR | **W**et, **N**eutral, **R**ich soils, semi-shade | 4 - 6 | 8 - 9 | 6 - 7 | 6 | 5 |
| WMAF | **W**et, **M**oderately **A**cid, **F**ertile, semi-shade | 5 - 6 | 8 –9 | 5 - 6 | 4 - 5 | 4 |
| **All** | **Mean values for whole population of Scottish AWVPs** | **4.75** | **5.82** | **5.64** | **5.07** | **74** |

Table 2 shows habitat, Scottish distribution, niche (all explained below the table) and notes on using each indicator. The niche is based on typical Ellenberg indicator values for Light, Moisture, Reaction (soil/water pH) and Nitrogen (fertility). The Ellenberg values used were those recalculated or estimated by Hill *et al* (1999) for British conditions from original Ellenberg values used in central and western Europe. Note: species vary in the range occupied round such typical values, eg wood anemone is most frequent in soils of pH6 and occupies a range of four pH units; large bittercress has a mode of pH6 and a range of one pH unit (Grime *et al* (1996)).

## Ecological characteristics of ancient woodland plants

The revised Scottish list contains 18 widespread species, 41 restricted species, 13 uncommon species and two rare species (lesser hairy-brome and whorled Solomon's seal, which appear to be true woodland species (B. Averis, pers comm). Species not native to Scotland were excluded.

Some AWVPs are uncommon because ancient woodland is uncommon. Others may be rare in a woodland because soil or drainage conditions are unsuitable or because the woodland is not yet at that structural stage which permits their full expression, eg canopy closure, coppice regrowth etc.

No AWVPs are confined to ancient woods and absent from secondary or recent woods. Peterken (2000) found wood anemone the nearest (91% ancient woods, 5% secondary woods). Spencer (1990) considers species having the closest affinity with ancient woodland including wood anemone and herb Paris. Vegetative spread of wood anemone is slow: 1-2 m/100 years and most seed set in Britain is sterile both of which curtail new colonisation. Herb Paris has poor dispersal powers - each plant only produces one seed - and favours damp, nutrient-rich soils which are often of limited extent in woodlands and rare on new sites.

Table 2 has 46 woodland species, 24 species equally common in open habitats and four species more common in open habitats.

Kirby *et al* (in press) used NVC tables, Ellenberg values and functional attributes (in Grime *et al*) to compare 'woodland specialists' (on Kirby's (2002/03 lists), 'other woodland species' and 'non-woodland plants'. Each tool has limitations but because each is derived independently, common threads reveal ecological patterns. Woodland specialists were more strongly linked to the woodland environment than other woodland species and occur less in other habitats. The authors suggest regional lists should concentrate on species not recorded in other NVC habitats common in that region, or on species with similar functional attributes and Ellenberg values to known ancient woodland

indicators. AWVPs from the Scottish list most frequently recorded in non-woodland NVC tables are primrose, wood anemone, greater woodrush, false brome, slender St John's wort, wood sorrel and common valerian; these are annotated in Table 2.

Table 2 shows over 50% of Scottish AWVPs occupying mean conditions. Of eight other niches the most populous are AIM: Acid, Infertile, Moist soils; SNR: Shaded, Neutral, Rich sites; and Wet sites. Sixty-nine species (93%) are of mean, SNR, AIM or Wet sites. Average Ellenberg values (below Table 2) are similar for moisture (5.8 *cf* 5.7), higher for nitrogen (5.1 *cf* 4.7) and lower for light (4.75 *cf* 5.2) for this population of 74 species *cf* 158 woodland specialists analysed by Kirby *et al*. Their groups were most clearly separated by light values: woodland specialists having the lowest (most shade-tolerant); 61% with an Ellenberg value of 5 (semi-shade) or less. Scottish AWVPs are more shade-tolerant; 81% have light values of 5 or less. This difference may be because Kirby *et al*'s list contains proportionately more species common in open conditions perhaps owing to continuing coppice management on some ancient woodland sites in England (where 10 of their 12 lists originate). Hermy *et al* (1999) also found their 132 European ancient forest plant species shade-tolerant and typifying sites with intermediate pH and fertility but wet sites were avoided.

*Dog's mercury and sweet woodruff leaves, ancient gorge woodland, Ayrshire, September*

Established strategies are given in Grime *et al* (1996) for 43 species on Table 2. Most are stress-tolerant or between S and intermediate strategies (20 species), ten are SC (four trees, dog's mercury and greater woodrush) or SR, nine are CSR and other intermediate strategies and four are CR or C/CSR (large bittercress, enchanter's nightshade, figwort and bearded couch). The last group and SC may be the best colonisers but perhaps mainly of adjoining woodlands; less able to leap to more distant recent woods.

Hermy *et al* found the stress-tolerant strategy significantly more abundant in ancient forest species than in other forest plants and vice-versa for the competitive strategy. The poor ability of ancient forest species to colonise new forests may result from limited dispersal abilities, low diaspore production and poor competitive ability etc. Kirby *et al* also found woodland specialists most stress-tolerant and least ruderal and other woodland species most competitive. Woodland specialists had most polycarpic perennials, potentially long-lived species that may require stable conditions.

Hermy *et al* found hemicryptophytes (overwintering buds around ground level) to be the preponderant life form of ancient forest species and geophytes (buds overwinter below ground) significantly more frequent than in other groups. The latter explains the high frequency of vernal species. The majority of ancient forest species are summer green (61%) but 22% have some over-wintering foliage, higher than expected.

Fuller understanding of AWVPs will come with more knowledge of their autoecology. Much can be gleaned from Grime *et al* (1986) though most uncommon species and 40% of restricted species in Table 2 are not included.

## Using the Scottish List of Awvpss

### Historical research

First search for historical records of the wood. Old maps (Pont, Roy, 1st Edition OS) can be viewed on the National Library for Scotland website (www.nls.uk/maps). A former larger extent is relevant where woodland species occur outside current boundaries. Note limitations of Roy above and that the 1st edition OS sometimes missed woods in remote glens or steep ravines (mapped as rough grazing). Other documented evidence may be found on estate maps and records held at the National Archives of Scotland at West Register House. The woodland name may also provide clues.

### Fieldwork

Botanical survey could record all plant species in the wood or Table 2 AWVPs. In different localities surveyors may add species from Table 1 or subtract species. Caution is necessary when using AWVPs which can live in open habitats, though they may indicate formerly wooded sites or other old habitats of biodiversity value. Open habitats have probably always occurred in mosaics with Scottish woodlands; today this is more obvious in the uplands.

It is useful to record the cover of each species, rather than simply presence. The modified DOMIN scale developed by Castle (2008), reproduced above, is one suggested method for rapid survey of small woods or sample plots. Notes on the distribution of AWVPs in a wood (eg widespread or localised to open ground/edges, burnsides, wet soils, banks, rocky areas etc.) will enhance understanding. In PAWS the survey of such

local areas should be most rewarding. Care is essential for species which are introduced, garden escapees or often planted – and indicated by an asterisk * in Table 2. Trees and shrubs should be recorded in canopy, understorey and field layers.

Two visits are advised: one in May/June for vernal flora and one in late summer for later flowering species.

Surveyors should note site conditions (soils/geology, slope, aspect etc), land-use/woodland management, adjoining land use, linkages to/isolation from other woodlands and other relevant factors.

Field evidence of antiquity could include veteran trees, ancient coppice stools, ancient stumps/deadwood, hummocks and hollows – root plate and pan positions of long-decomposed trees, native trees/shrubs in all layers, irregular edges and boundary features. The Woodland Trust (2007) found old coppice stools strongly associated with ancient and probably ancient woodland in Northern Ireland.

Peterken (2000) found 4-49 of his 80 indicator species in ancient Lincolnshire woods. His scores in woodland types by area were:

| | Ancient | | Secondary | |
|---|---|---|---|---|
| Size (ha) | mean | range | mean | range |
| < 5 | 12.4 | 4-24 | 2.5 | 0-17 |
| 5–20 | 22.3 | 7-43 | 5 | 0-22 |
| > 20 | 30.6 | 15-49 | 4.1 | 0-17 |

The relationship with area was not close. Twenty-one of his 273 secondary woods contained at least 10 indicators, of these 16 woods (76%) were, or had once stood, beside or near ASNW.

Castle *et al*'s (2008) statistical analysis of Welsh survey data suggest a score of over 25 for ancient woodland and less than 24 for probable non-ancient. For W8 and W9 woods thresholds were higher: > 28 probable ancient, < 26 probable non-ancient.

*Yellow pimpernel, willowwood beside ancient woodland, Loch Lomond, May*

## Numerical thresholds

As the number of AWVP species increases the statistical probability of the wood being ancient increases. Rose (1999) and Peterken (2000) stress that one or several species have little or no significance. Though indicators are more reliable collectively they are unlikely to identify all woods that are ancient. Similarly the absence of AWVPs cannot prove that a woodland is recent.

Rose (1999) found the best sites in South England contained 50-70 combined ancient and rare indicator species from his list of up to 152, and most were large (over 100 ha). His top sites were divided equally between acidic and calcareous soils. The richest woods were on sites with varied topography and soils. Without such variation even the oldest undisturbed woods rarely had scores over 30. In other areas top scores were lower; Somerset: 33–41, Cornwall: 21–34.

Crowther (2006) found 20-50 of his indicators in 15 Midlothian old semi-natural woods of 4-55 ha in size. Ten woods where wholly or largely ancient, three were long-established (20-40 ha) and two contained areas of both. His graph suggests ancient woodlands held 27-50 species, long-established woods 20-26 species and secondary woods/plantations less.

Such scores are likelier in the south and east lowlands of Scotland; lower scores will apply in the north and west, particularly their uplands. The length of Castle *et al*'s (2008) list for west Wales illustrates how few AWVPs apply there compared to north, north-east and south Wales (42 *cf* 90 – 115).

Ray and Moseley (2007) took scores of 8 or more (of their 21 indicators) to indicate very high quality woods, scores of 4-8 are high quality woods, and less than 4 low quality woods for the Edinburgh and Lothian FHN. Their list may have been biased towards some site types; in hindsight they would have included a larger range of indicator species (D. Moseley, pers comm.)

Botanical data for seven south-western woodlands, ranging from PAWS to ASNW, is held on the Cree Valley Community Woodlands Trust website (www.creevalley.com). These are being de-coniferised, managed and linked with new native planting in a FHN from 'source to sea'. Samples through the woods yielded 11-22 of the AWVPs in Table 2 in each and 34 AWVPs in total. The lowest scoring was the PAWS; the highest two lowland oakwoods: Wood of Cree (ASNW with history of intense management, now RSPB reserve) and Garlies (long-established semi-natural). In an upland oakwood SSSI (Buchan/Glenhead ASNW) 14 AWVPs were recorded. Sizes are given for three woods: 29-42 ha.

The most northerly site for which information was received was Gearrchoille Community Wood Ardgay (head of the Dornoch Firth), a 13-ha site with three NVC communities

(W4, W7 and W11) and former wood pasture (B. Geddes, pers comm). The Gearrchoille appears semi-natural on Roy and Choille is Gaelic for woodland. Botanical data includes 21 AWVPs on Table 2 and lichens such as *Lobaria pulmonaria* (a recognised indicator of ancient woodland). The wood contains old hazel coppice, oak pollards and remnants of a possible medieval boundary hedge. The evidence suggests this woodland is ASNW.

Caution is necessary when defining score thresholds by area and linking numerous AWVPs to longevity. Species-richness is also a function of soils/geology (basic sites often richer), slope/topography, altitude, latitude, climate, oceanicity, varied site conditions, past management, adjoining land-use etc.

### Other woodland indicators

Lower plants (fungi, lichens and bryophytes) and invertebrates such as molluscs and beetles can also be good indicators of longevity, ecological continuity, and biodiversity value. Western woods can be richer in bryophytes and lichens than vascular plants. The Woodland Trust found 14 bryophytes significantly associated with ancient woodland in Northern Ireland (S. Atkinson, pers comm.) of which 13 are described in Crawford (2002). See Coppins and Coppins (2002) for epiphytic lichens and Fowles *et al* (1999) for deadwood beetles.

## Further research and survey

To obtain definitive geographic lists, quantified research is necessary; compiling and comparing plant lists from verified ASNW with lists from recent woods distant from ancient sites. ASNW plant data is contained in woodland survey reports and files held by SNH, conservation trusts and others; data for recent woods may be less available and may need to be gathered anew. To be strictly comparable ASNW may need to be resurveyed by the same method as recent woodland. Regions could be as simple as east, west and north Scotland with upland, lowland and coastal/island sub-divisions.

More work is needed to refine statistics and to suggest probabilities for minimum numbers of AWVPs for ancient woodland in each region. Relationships between number of AWVPs and factors such as size, soil pH, site variation (eg number of NVC communities) also need to be investigated in Scotland.

More work is needed to correlate data (existing and new) for AWVPs with other groups: bryophytes, lichens, fungi, beetles, spiders, molluscs etc.

More analysis is required on soil differences/preferences for AWVPs to compare inter-woodland and inter-community requirements/characteristics.

## Conclusions

AWVPS should be used with historical documented and field evidence to confirm sites are ancient. The list of 74 AWVPs in Table 2 was derived from the observations of 11 expert vegetation surveyors and botanists and requires more field testing in Scottish ASNW. Some lists for other countries and their regions are based on field research with statistical analysis, but many other lists were also derived by expert

*Wilson's filmy fern, Killarney, November*

observation. Table 2 is more robust than Table 1, though all candidates in Table 1 could be useful where biodiversity value only is being assessed.

There is a movement to define AWVPs by their ecological characteristics using Ellenberg values and functional attributes but this could exclude the unexpected species which field survey often throws up. The ecological characteristics of the Scottish group of AWVPs are similar to those for Britain and Europe except that the Scottish group appears to tolerate more shade than the largely English group and includes more species of wet soils than the European group. Much can be learned from such desk research but the tools currently available may not encompass all Scottish conditions. Field observations, backed by ecological knowledge and historical documents should be most definitive.

Care is necessary if using numbers of AWVPs and site size only in assessments; species-richness results from other factors and site variations and lower plants/ invertebrates should also be considered. AWVPs may be most useful in the south and east lowlands becoming increasingly less revealing towards the north and west uplands. In Atlantic sites lichens and bryophytes may be more useful tools (with historical

*Tunbridge filmy fern on right and with Wilson's filmy fern on left*

*Ramsons (wild garlic) and old elm coppice, long-established plantation, Deeside, June*

evidence) for identifying ASNW. This can only be tested once there are regional lists of AWVPs based on quantitative field research and that is the logical next step for making good use of ancient woodland indicators in Scotland.

## Acknowledgements

The author wishes to thank everyone who responded to the 2009 consultation or provided information, particularly Andy Acton, Sian Atkinson, Ben Averis, Chris Badenoch, Andre Dubbeldam, Gill Castle, Brigitte Geddes, Darren Moseley, The Woodland Trust and Barry Wright. Special thanks are due to Chris Badenoch, Scott Wilson and Barry Wright for commenting on the first draft of this paper.

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