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ABSTRACT

This study uses a recognised inventory of ancient woodland indicator plants (AWIs), to investigate the antiquity of sixty-two woodlands in south-east Northumberland, prompted by Brian Roberts' analysis of Old-English place names between the Rivers Coquet and Wansbeck. Botanical evidence for woody and herbaceous plant species and other information concerning woodland history was gathered in fieldwork and desk-based enquiry. In a multivariate analysis the distribution of woodland indicators showed significant if not overwhelming correlation with site classification of ancient semi-natural woodlands (ASNW). Faithfulness, the close relationship of AWI species to ASNWs, is revealed together with some woodland species which were not previously on the AWI list. Some differences are found when comparing the results to ancient woodland designations. Our case study of one township shows however that use of all available categories of evidence offers more robust support that its woodlands were ancient. Woodlands in north-east England had not been previously researched in this way for evidence of ancient woodland. This study contributes information on the region's ecology, archaeology and landscape history, providing scope for further and ongoing research. It is suggested that fieldwork using quantitative archaeological techniques should be carried out in future to provide better chronological frameworks for woodlands in south-east Northumberland.

KEYWORDS

Ancient woodland; multi-disciplinary evidence; South-east Northumberland; indicator species; Wood banks

Introduction

Ancient semi-natural woodlands (ASNW) in the UK, are considered those which have been wooded continuously since 1600CE in England (or 1750 in Scotland), in the belief that few woods had been deliberately planted prior to those dates and that reliable cartographic evidence survives. A distinctive range of flowering plants, considered to be ancient woodland indicators (AWIs) is frequently found in them (Peterken and Game 1981; Rackham 2006). Peterken was the first to list those species commonly found in woods present on maps since at least the eighteenth century (Peterken 1974; Kirby 2020). These species, usually poor dispersers, which prefer a stable habitat and are intolerant of disturbance, are said to indicate ancient woodland (Grashof-Bokdam 1997; Hermy *et al.* 1999, 19). The affinity of indicator species with ancient woodland varies

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with its aspect, drainage, especially climate/microclimate, geology and hence soils (Rotherham 2011, 172–176). In any one woodland a score of perhaps 16 species have been suggested to indicate ASNWs in lowland Northumberland (Lunn 2004) (Table 1). It is the sum and range of species which is more important than any individual species present regarding statistical probability (Rose 1999, 241, 2006).

In the 1980s inventories of ancient woodlands indicating ancient semi-natural woodlands (ASNW) and plantations on ancient woodlands sites (PAWS), relied largely on interpretation of 1st edition Ordnance Survey maps plus historic documentary evidence. This Ancient Woodland Inventory, compiled at the Government's request to identify ancient semi-natural woodlands countrywide, is found on its 'Magic Map' of the natural environment (DEFRA 2020). The Botanical Society of Britain and Ireland's (BSBI) database of observed vascular species (with true roots, stems and leaves) consisting of flowering plants, conifers, and ferns, was used as a base study data set (BSBI 2020).

Although ancient woodland has been studied by botanists in many areas of Britain using a list of AWIs, in Northern England only Yorkshire' had been surveyed (Gulliver 1995). The Northumberland Inventory of ancient woodland used mainly documentary sources, maps and aerial photographs in the 1980s (Carter 1988).

Woodland, by broad definition, is an area of land covered by a variety of plants which can be composed of either broadleaved or coniferous trees and shrubs, or a combination of these. Historically woodlands were managed: to supply resources for light construction, fencing, tools and fuel. Some trees were coppiced—cut periodically—and others were allowed to grow straight and tall as 'standards' to supply timber for buildings (Figure 1).

Many woodlands in the medieval period or earlier had relatively substantial woodbanks of at least 9 m width with an external ditch to exclude browsing animals and

Table 1. Ancient Woodland Indicators in Lowland Northumberland.

Acer campestre	*Field Maple	Juniperus communis	Juniper
Adoxa moschatellina	Townhall Clock	Lathraea squamaria	Toothwort
Allium ursinum	Ramsons	Luzula Pilosa	Hairy Wood—Rush
Anemone nemerosa	Wood anemone	Melampyrum pratense	Common Cow-wheat
Arum maculatum	Lords and Ladies	Melica nutans	Mountain Melick
Brachypodium sylvaticum	False brome	Melica uniflora	Wood Melick
Bromopsis ramose	Hairy brome	Mercurialis perennis.	Dog's Mercury
Campanula latifolia	Giant bellflower	Milium effusium.	Wood Millet
Carex laevigata	Smooth stalked sedge	Myosotis sylvatica	Wood Forget-me-not
Carex paniculate	Great tussock Sedge	Neottia nidus-avis	Bird's Nest Orchid
Carex remota	Remote Sedge	Oxalis acetosella.	Wood Sorrel
Carex sylvatica	Wood Sedge	Paris quadrifolia	Herb Paris
Chrysoplenium alternifolium	Alt.-leaved golden saxifrage	Phegopteris connectilis	Beech Fern
Circaea x intermedia	*U/d Enchanter's-Nightshade	Poa nemoralis.	Wood Meadow-grass
Elymus caninus	Bearded Couch grass	Polystichum aculeatum.	Hard Shield-Fern
Epipactis helleborine	Broad-leaved Helleborine	Polystichum setiferum	*Soft Shield-Fern
Equisetum sylvaticum	Wood Horsetail	Ranunculus auricomus.	Goldilocks Buttercup
Euonymus europaeus	Spindle	Ribes spicatum	Downy Currant
Festuca altissima	Wood Fescue	Sanicula europaea	Sanicle
Gagea lutea	*Yellow Star-of-Bethlehem	Stellaria nemorum	Wood Stitchwort
Galium odoratum.	Woodruff	Schedonorus giganteus	Giant fescue
Goodyera repens	*Creeping Ladies-tresses	Tilia cordata	*Small-leaved lime
Gymnocarpium dryopteris	Oak Fern	Veronica montana	Wood Speedwell
Hordelymus europaeus	*Wood Barley	Viburnum opulus	Guelder Rose
Hyacinthoides non-scripta	Bluebells	Vicia sylvatica	Wood Vetch

*Species unlikely to be found. (Lunn 2004).

Figure 1. Questionable coppicing - Howburn Wood, Northumberland (photo: author, 2022).

allow regrowth of coppiced trees (Rackham 2006). It seems likely that historically Britain's countryside was composed of a mixture of coppices and more open areas where herbivores grazed amongst trees—wood-pasture, where trees were managed to prolong their life by pollarding (being cut at a height beyond the reach of livestock) (Vera 2000; Fleming 2012; Rackham 1986, 65, 2013).

Woodland in Northumberland today is composed of native woody and some introduced species; it may also contain species planted for commercial use and unintentional non-native species. The area of ancient semi-natural woodland in the county amounts to about only 0.5 per cent of the total, distributed in 401 woods of 10 ha. or less in extent (Carter 1988). This is certainly true of the area covered in this study. Two previous studies have considered historic woodlands in Northumberland. Horsley Wood in the lower Tyne Valley has been researched through several studies using a multi-disciplinary landscape approach (Davies and Turner 1979; Tolan-Smith 1997). Early mapping and documentary evidence related to the wood survives in the Duke of Northumberland's estate archives, although botanical study was not conducted here. A second study of landscape history in south Northumberland considered five woods, trees, and their management, although this research did not consider evidence of forbs (non-woody plant species) or archaeological features (Cousins 2004).

It was thought that typical lowland countryside in England was composed of small woods and hedged fields derived from the enclosure period of the eighteenth and nineteenth centuries, but it still contains remnants of medieval hedges and woods (Rackham 1980). Much of the land lying below 200 m OD (above Ordnance Datum) drained by the rivers Coquet, Lyne, and Wansbeck is studded with small woodlands and hedged fields. In this study, however, the woodlands considered are simply all wooded areas, including those under 2ha: what survives is influenced by a complex suite of interacting factors including climate, soil, topography, and land use (Peterken 2015). This study aimed to create a current database of botanical, archaeological, place-name and documentary information on woodlands within a study area of lowland Northumberland, and to use this data to assess the validity of the use of AWIs to identify old and possibly ancient woodlands.

Methodology

Background Landscape Study

The historical geographer Brian Roberts has identified an area of Northumberland unusually rich in woodland cover in the Early Medieval period, contrasting areas of OE habitative name elements-*ham,-tun,* with woodland areas with name elements-*wudu*,-*leah.* The tract he identified as *Cocwudu* was based on names in the Newminster Abbey and Brinkburn Priory cartularies: place names on their estates in south-east Northumberland such as those ending *riding, stobs* and *ley* implying clearance of woodlands (Roberts 2015).

The Bernician Studies Group (BSG), an independent research team, proposed an initial study of this area by field reconnaissance to characterise its ancient landscape. Since there had been no detailed botanical study of woodlands designated ASNW in Northumberland, members of the group undertook to record vascular species and archaeological evidence in a selection of woodlands. The result was a database of botanical, archaeological and historical evidence which has been used to analyse how closely AWI species are associated with ancient woodland. A multidisciplinary approach to *Cocwudu*'s historical ecology (Peterken 1974; Rackham 2000; Szabo 2015) assessed available historical documents including charters; first edition Ordnance Survey maps; estate plans, and place names. Archaeological evidence included reconnaissance of wood banks, woodland structures and specific ancient woodland plants as identified by Rackham (1980, 2006).

Desk and field studies were used to analyse sixty-two woodlands in an area of lowland south-east Northumberland stretching west to east from the Simonside hills to Druridge Bay. The study area is bordered in the north by the River Coquet, in the south by the river Wansbeck, and with the river Lyne draining the central region, all flowing eastwards to the North Sea (Figure 2).

Desk based Research and Field Work

The starting point for field survey was the choice of a study area using the provisional inventory of Northumberland where it was noted that positive identification of ancient

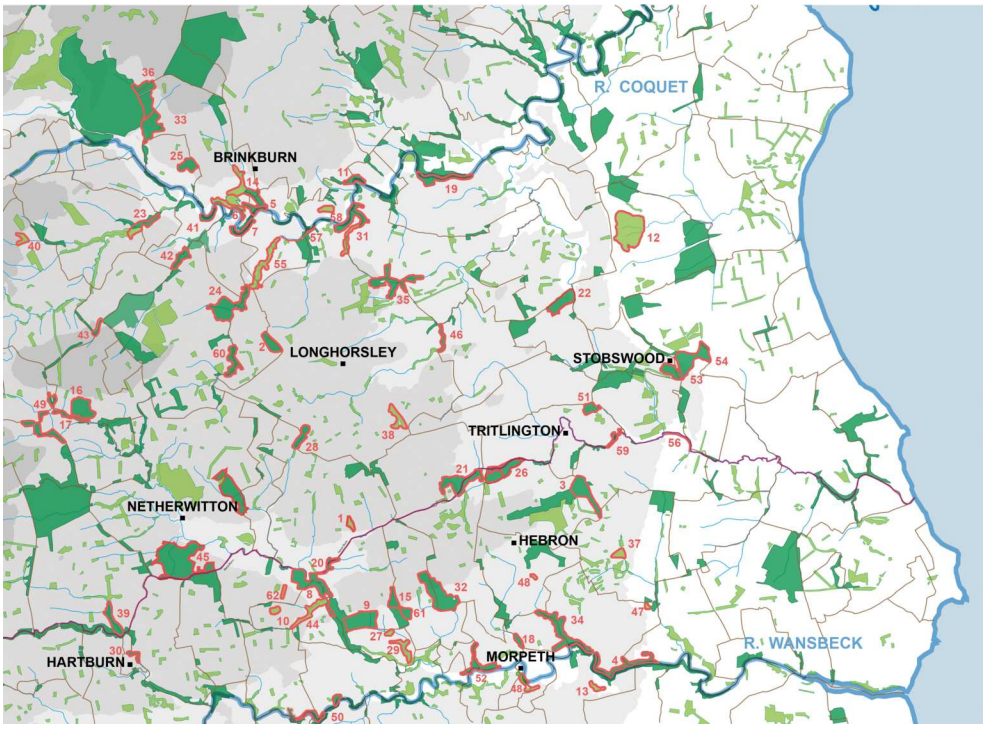

Figure 2. Woodlands in the study area: 1 Abshields 2 Beggar's Bush 3 Blubbery and Blackdean 4 Bothal Mill 5 Brinkburn North 6 Brinkburn Riverside 7 Brinkburn South 8 Broadwood Meldon 9 Broadwood Mitford 10 Buckshaw Wood 11 Carr's Island 12 Chevington 13 Clark's Bog 14 Cockshot Brinkburn 15 Cockshot Meldon 16 Coltpark 17 Combhill 18 Cottingwood 19 Duke's Bank 20 Fenceburn 21 Fenrother 22 Forest 23 Forestburn Lower 24 Garrett Lee 25 Hag's 26 Hangingleaves 27 Hardhirst 28 Hare Dean 29 Harry's 30 Hartburn Glebe 31 Hedley 32 Heighley 33 Hope 34 Howburn 35 Linden 36 Linn 37 Longhirst 38 Longhorsley Moor 39 Longwitton 40 Lordenshaw 41 Maglinburn/lower 42 Maglinburn/middle 43 Maglinburn/upper 44 Nunriding 45 Oldpark 46 Paxtonburn 47 Pegswood Community Wood 48 Posternburn 49 Ritton Langley Streams 50 Rivergreen 51 Robinhood 52 Scotch Gill 53 Stobswood 'Ancient Wood' 54 Stobswood Grange 55 Todburn 56 Ulgham Meadows 57 Weldon—Brinkheugh 58 Weldon 59 West 60 Wholme 61 Willy's 62 Woodhouse Strip (map: Max Adams and Brenda Barker, 2024, based on Ordnance Survey (OS) 1:25,000 Explorer sheet 325).

woods would require further research, and woods less than 2ha. had been excluded from the inventory (Carter 1988). A selection of woodlands, including those < 2ha., was chosen for survey between 2015 and 2019, usually by two to four members of the BSG and Natural History Society of Northumberland, plus volunteers; their combined contribution compensated for varying levels of expertise. Very few woodlands in the study area are on open-access land and permission from the landowner was necessary in most cases. Vascular plants were identified by features which occur at different times throughout the growing season so three visits were ideally made to each wood to provide a comprehensive survey. A walk-over survey incorporating all areas of the site, was chosen as a means of identifying species present, together with point and linear archaeological features (Glaves et al. 2009b).

Evidence of management, such as the presence of a woodbank, or previous land use such as rig and furrow, were recorded, together with potential areas for pollen coring in each wood.

Botanical surveys involved recording the presence of each species observed in each of the woodlands. The methodology involved the following eight steps:

(1) To enable statistical analysis, weightings rated in a scale of highest to lowest in value were allocated to historical and archaeological features noted in the field, to reflect their possible antiquity (Table 2).
(2) These weightings were summed to give each wood a Total Age Weighting score for each woodland (Table 3).

Sites were divided into four groups of possible woodland age weightings: W4 ancient >7; W3 old 6; W2 not old 4 &5; and W1 recent <4. (Table 4). There were only small numbers of woods in groups W1 and W4, so categories were combined to give groups W1/2 and W3/4 for statistical analysis.

(3) The total number of species was analysed after removing: non-woodland plants in Northumberland; species thought to be planted; garden escapes or crops; species found more often in recent woods (<50 per cent faithfulness to old and ancient woods); species of <2 faithfulness (all woods) except the AWI species; species only recorded once so there is insufficient data (Hill *et al.* 2004).
(4) Factors thought to affect the total number of species recorded in a woodland (Species Richness—SR) and distribution, were analysed for statistical significance using linear models and Pearson Correlation in RStudio.
(5) Principal components analysis (PCA) run in CANOCO v4.5 (Ter Braak and Smilauer 2002) was used to investigate associations between species distributions and other factors.
(6) Faithfulness—The proportion of the records for each individual species closely associated (i.e. > 50 per cent) with each woodland was calculated (Rose 1999; Lunn 2004). These figures were used to calculate faithfulness of each species to then the woodlands were scored for the presence of these species.

Table 2. Grading historical evidence.

Historical feature	Weighting
(a) Named in the Medieval Monastic Charters	4
(b) Old English name in early documents	3
(c) Historic Woodland Earthworks	3
(d) Sinuous Boundary indicating pre-Enclosure establishment	2
(e) Estate record pre-1800	2
(f) Presence on Armstrong Map 1769	2
(g) Wood boundary coinciding with Historic Township Boundary	1
(h) Presence on 1st Ed OS map 1855	1
(i) Ancient Replanted Woodland	0
(j) Significant rig and furrow	−1
(k) Recent Plantation	−2

Table 3. Total Age weighting for each woodland (example: categories in scale above a-k).

Woodland Sites	Code	a	b	c	d	e	f	g	h	i	j	k	Total Age Weighting
Cockshot Meldon	CSP				2			1	1				4 (not old)
Stobswood Ancient	SWL	4	3		2		2	1	1				13 (ancient)
Ulgham	ULG				2				1				3 (recent)
West	WST				2		2	1	1				6 (old)

Table 4. The number of woodlands in each class suggested by weighting**.**

Weight groups		
Weighting class	Possible Interpretation	Number of sites
W1	Recent	6
W2	Not old	26
W3	Old	24
W4	Ancient	6

(7) A 'Lowland Northumberland Woodland Index' (LNWI) giving each of the proposed species a weighted score derived from the faithfulness calculations was adjusted using weightings, as shown later. A < 7 faithfulness score with weighting 5 indicated ancient woodland.

The desk study included searching for records relating to south-east Northumberland in Northumberland Archives, Woodhorn, Northumberland, where documentary evidence such as Estate Records, historic maps and plans is located. OS maps were sourced at the digital collection of the National Library of Scotland. Archaeological information is derived from Northumberland Historic Environment Records (NHER) and the journal *Archaeologia Aeliana*. Place-name origins are derived from Mawer (1920). Lastly a case study of woodlands in Netherwitton township was chosen to illustrate how combining all documentary and botanical evidence available was used to confirm its woodland was ancient.

Field Study Results

The field study identified 272 distinct species composed of 36 trees/shrubs, 182 forbs, 10 ferns, 30 grasses, 7 rushes, and 7 sedges. Thirty-seven indicator species were found in the study woodlands. The six most frequently occurring indicator species were *Oxalis acetocella* (Wood sorrel), *Hyacithoides non-scripta* (Bluebells; Figure 3), *Mercuralis perennis* (Dog's mercury), *Allium ursinum* (Wild garlic), *Anemone nemorosa (*Wood anemone*)*, and *Veronica montana (*Wood speedwell) (Appendix 1); these species were often abundant. Another three species, *Sanicula europaea* (Sanicle), *Galium odoratum* (Woodruff) and *Carex sylvatica* (Wood Sedge) were in more than thirty woodlands. *Campanula latifolia (*Giant bellflower), *Melampyrum pratense (*Common cow-wheat), *Lathraea squamaria (*Toothwort) and *Paris quadrifolia* (Herb Paris) were seen in less than four woodlands and although eight AWIs were not found, *Neottia nidus-avis (*Bird's Nest Orchid) and Gagea lutea (Yellow Star of Bethlehem) though not expected to be seen was observed (Lunn 2004).

Factors thought to affect the total number of species recorded in a woodland (Species Richness—SR) and distribution, were analysed for statistical significance using linear

Figure 3. Abundance of *Hyacinthoides non-scripta* (Bluebells), in Forest Wood (photo: Max Adams, 2018).

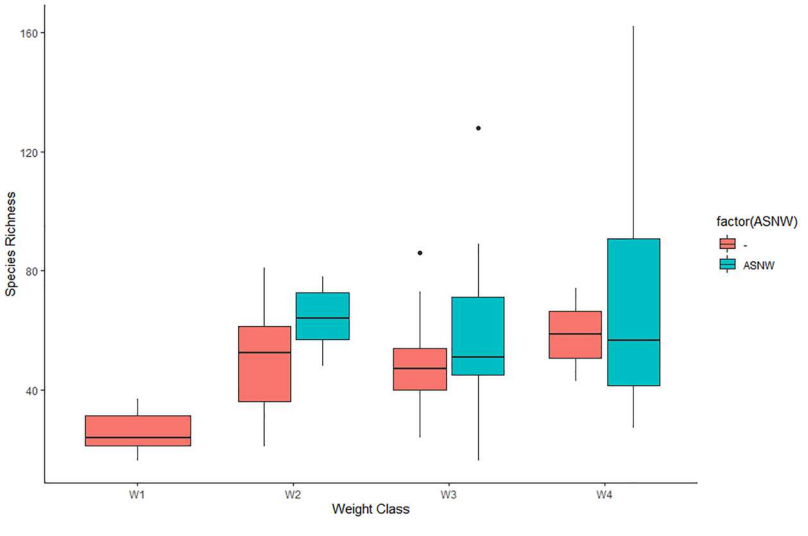

Figure 4. The linear model illustrates the association of SR with each class of woodland.

models and Pearson Correlation (Figures 4 and 5). Pearson coefficient showed the strongest correlation between SR and SR_AWI, 0.75; SR shows a moderate correlation with SR_AWI, 0.75.; Weighting shows a weak correlation with both SR and SR_AWI, 0.34. and 0.44.; area of woodland/number of visits show no significant correlation with any variable (Figure 5).

It was found that:

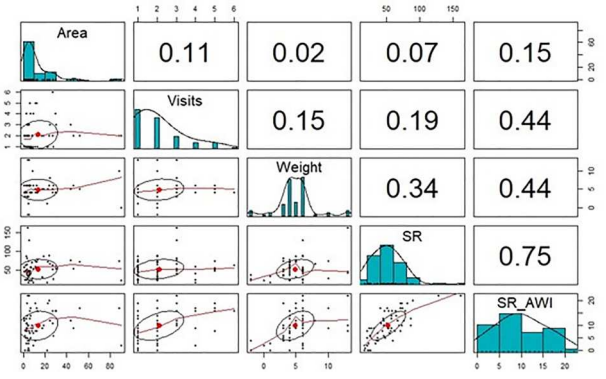

Figure 5. Paired variables Pearson Correlation Coefficient (1).

(1) Species richness and weight are both highly significant predictors of AWI ($p < 0.001$) predictors, and there is a significant interaction between them ($p = 0.005$).
(2) The number of visits is also highly significant ($p < 0.001$). Involvement of an 'expert' in botanical survey was not significant.
(3) Site area, designation (SSSI) and conservation status (nature reserve or local wildlife site) show no significant correlation.
(4) There was a significant correlation between AWIs and site classification as ASNW although weaker than expected—0.44, $p = 0.013$ (Figure 5)
(5) There was a significant correlation between AWI and site classification as ASNW (Figure 6).
(6) Correlation of weightings with LNWI—0.51 showed it to be slightly higher than AWI —0.44. (Figure 7)

The results of species richness analysis were developed using AWIs or those showing significant faithfulness to old and ancient woods of > 50 per cent were given a ranked

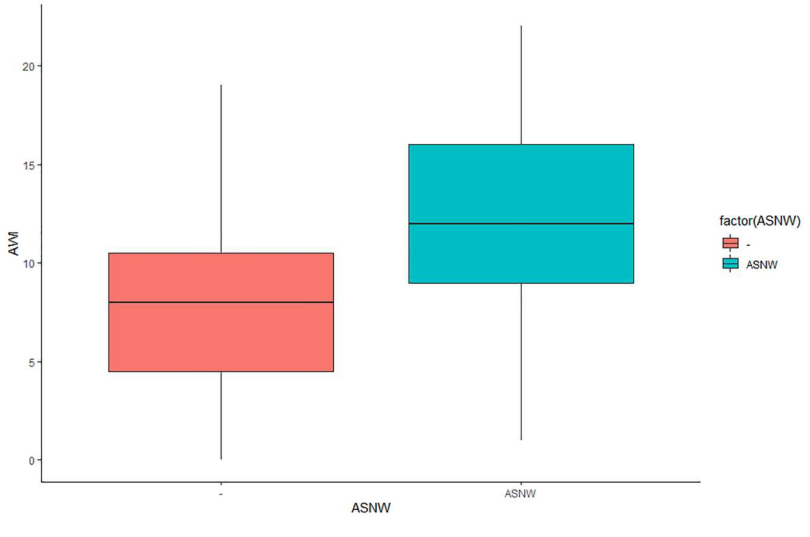

Figure 6. AWI and ASNW (blue) / non—ASNW (pink).

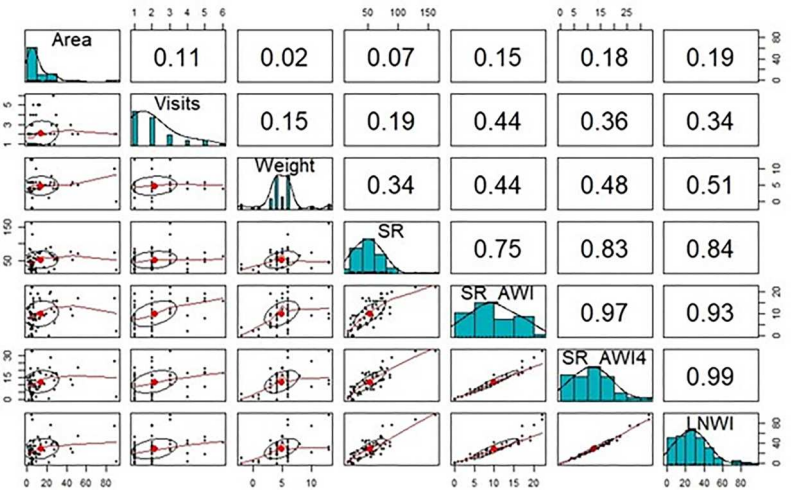

Figure 7. Paired variables using Pearson's Correlation Coefficient (2).

Weighted Faithfulness score. Fifty species resulted, including all 37 AWI species found in the study (Appendix 1). These were adjusted using weightings below (Table 5) and a list of proposed species for south-east Northumberland was derived from the study findings —a Lowland Northumberland Woodland Index (LNWI) was developed (Appendix 2).

To see the results using the LNWI, Pearson's Correlation Coefficient was repeated (Figure 7). It was found the correlation with weight is highest with LNWI but still only 0.51, with lower values for AWI 0.44 and AWI-4 0.48 (Figure 7)

Statistical analysis shows that LNWI is the most significant and AWI the least (although all are significant at $p < 0.001$ level):

AWI F = 14.4 p = 0003464 R-sq = 0.1801 ($p < 0.001$ ***)

AWI-4 F = 18.27 p = 6.966e-05 R-sq = 0.2206 ($p < 0.001$ ***)

LNWI F = 20.77 p = 2.6e-05 Adj. R-sq = 0.2448 ($p < 0.001$ ***)

Principal Component Analysis (PCA) was used to illustrate data from all woodland sites and their historical weighting represented as points in a multidimensional space (Figure 8). The scattergram shows a wide range of age weightings but the length and direction of the arrow reflect the rather weak evidence.

Table 5. Adjustment for the LNWI.

LNWI weighting	Faithfulness score
I	<2
2	<3
3	<4
4	<5
5	<7

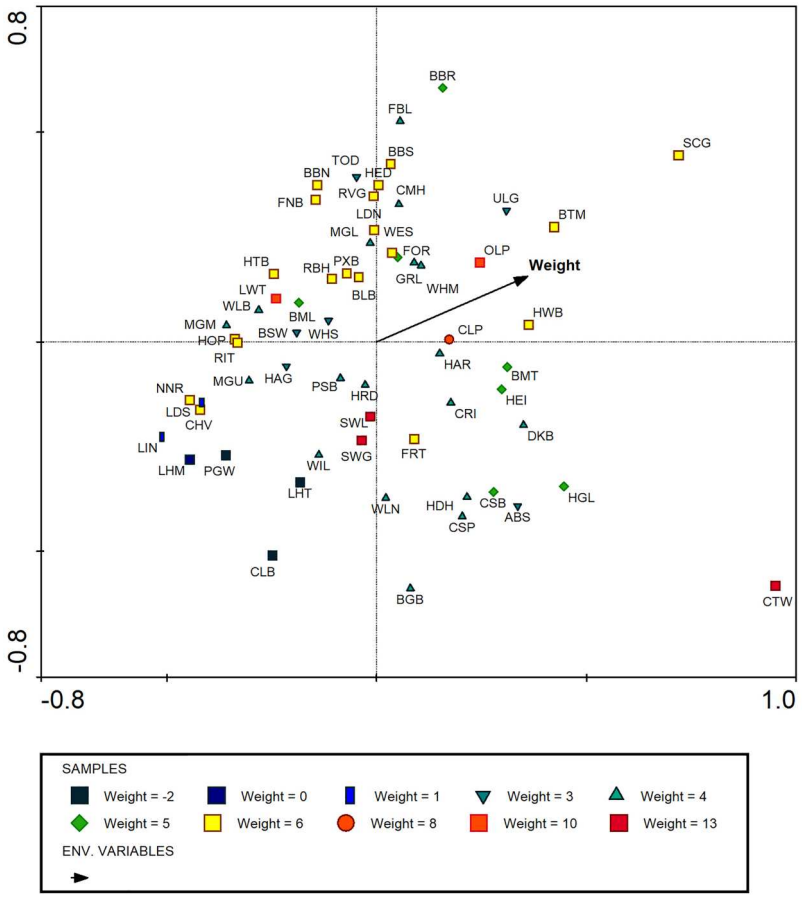

Figure 8. (PCA) Historical and Archaeological Weighting (Abbreviated woodland names are found in Appendix 3. W4 Ancient >7 red; W3 Old 6 yellow; W2 Not old 4 &5 green; and W1 Recent <4 blue).

Faithfulness to old and Ancient Woods

Faithfulness values for each site type were calculated for all species and 157 species showed faithfulness to W3 and W4 sites. Of 277 species recorded 78 species had a W3/4 faithfulness value of >50 per cent; 31 species scored >60 per cent faithfulness in the study area woodlands. In this study faithfulness proved to be an important predictive factor of ASNW. Twenty-nine WI species had a faithfulness score of >50 per cent to W3/4 woodlands in the study area. Twenty-six other vascular species also had a score of >50 per cent to all 62 study woodlands, *Moehringia trinervia (*Three-nerved Sandwort) and *Scrophularia nodosa* (Common Figwort) had the highest scores of faithfulness to W3/4 of non-AWI vascular species. Although they may be present, twelve AWI species (score 0 in Appendix 1) were not recorded on our visits.

Twenty-nine species which have >50 per cent faithfulness to old and ancient woodlands were considered adding to the AWI list. These species were thriving alongside the AWI so share the same environmental conditions. Of the non-AWI species, only

*Moehringia trinervia (*Three-nerved Sandwort) and *Elymus caninus (*Bearded Couch Grass), were solely faithful to 'Old' and 'Ancient' sites in this study. *Paris quadrifolia (*Herb Paris*)* was the only solely faithful AWI but was rarely found. Although analysis showed some non-AWIs to be as faithful as AWIs in the study area (Appendix 2) as abundance scores had not been included, the findings of data analysis and additions to the AWI list were problematic.

Two species—Three-nerved sandwort *Moehringia trinervia* (Three-nerved sandwort) and *Polypodium vulgare* (Common polypody)—however had >50 per cent faithfulness to W4 (ancient woodlands) in the LNWI, and could possibly be added to the current list of AWIs.

Desk Study Results

For most of England, Domesday Book is a source for the presence of woodland in 1086. In some counties it records the amount of woodland in acres, leagues or in the terms of the number of swine that could be fed in each woodland, although it locates woodland broadly within manorial holdings (Rackham 2006). But the Domesday survey did not cover Durham or Northumberland, and the study area was not part of the 1183 Boldon Book, a survey of the Bishop of Durham's estates north of the Tees. However, woodland was recorded in some relevant medieval documents. The earliest sources for Northumberland are the Cartularies (compilations of charters) of monastic houses of the eleventh to sixteenth centuries. Those of Newminster Abbey and Brinkburn Priory concern landholdings and rights of land (Fowler 1878; Page 1893). Both religious houses held land within the study area. Much of the land was held in the medieval period by the de Merlay family as part of the dowry inherited from Juliana, daughter of Cospatric Earl Dunbar, who also held a large estate in Northumberland (O'Brien 2023). Although named in the earliest records—the monastic charters—the locations of Cottingwood and Stobswood could not however be determined with certainty.

A much later, eighteenth-century, report on woodland management for the Board of Agriculture showed there was a need for trees to be felled earlier for 'small' wood for the collieries and lead mines in Northumberland, rather than timber from 140-year-old oak trees used earlier for ship building, which may have caused a change in the composition of woodlands. It was a time when traditional woodsmanship was declining, and the practice of 'replanting' woodland was increasing. Land suitable for agriculture had been 'enclosed' with straight hedges and recent plantations were providing for new demands (Bailey and Culley 1797).

Only major place-names—of townships and larger—have so far been studied for Northumberland (Mawer 1920; Whaley 2022), but these can contribute to the identification of woodland (Gelling and Cole 2000). Old English place name elements, such as *hyrst* (wooded hill), *wald* (forest) and *wudu* (wood) help to indicate the distribution of pre-Conquest woodland in the absence of the Domesday survey (Gelling 1994). Most useful for locating woodland in the study area were names with OE roots, for example Stobswood ('a woodland with tree stumps'); or clearance of woodland, such as Longhorsley ('woodland clearing (*leah)* for horses (*horsa)*') (Mawer 1920). Two records of the element *wudu* occur in south-east Northumberland: *Cotingwud* and *Stobeswud,* both

Table 6. Old English place-names associated with woodland—earliest recorded dates.

Personal Name	Earliest Record	Wood Element	Earliest Record	Topographic Element	Earliest Record	Clearance Element	Earliest Record
Cotingwud	*1257*	*Wottonam*	*1139*	*Helyhope*	*1216*	*Stobeswod*	*1250*
Chivington	*1236*	*Wotton*	*1242/3*				
		Langwotton	*1340*				
				Langherst	*1200*	*Ritton*	*1110*
		Evenwood	*c1138*	*Bothale*	*1212*	*Fenrode*	*1189*
		Lynchewode	*c1138*	*Toddeburn*	*1246*	*Langhorsley*	*1242*
		Hazonwood	*c1138*	*Welden*	*c1250*		
				Hangendelley	*1262*		

recorded in the thirteenth century Newminster charters and included in the study in Table 6.

The Northumberland Historic Environment Record (NHER) *was* searched for any archaeological evidence of woodland history. Earthworks and other remains found in woodlands may relate to extraction of coal or minerals and processes such as iron smelting and charcoal production, for example in the valley of the Todburn where remains of a mound with traces of slag may indicate the site of a bloomery in Garrett Lee Wood (NHER, 15272). Elsewhere in England ancient woodlands are strongly associated with woodbanks with exterior ditches (Rackham 2006, 191)—a medieval woodbank in Cambridgeshire, typically perhaps 10 m in total width, for example (Figure 9)—but no examples of this kind were recorded in the NHER for the study area, with the only exception being a thirteenth century stone park wall at Newton Park, Lordenshaw (NHER,

Figure 9. Woodbank—Gamlingay Wood, Cambridgeshire (photo: author, 2023).

N10723). However, raised boundary banks were identified by field reconnaissance in five of the study woodlands: Oldpark, Hangingleaves, Robinhood, Heighley and Abshields. In future, it may be possible to date samples from similar features to provide an approximate age for woodlands (Rackham 1980; Vervust *et al.* 2020).

A wavy or sinuous woodland outline may indicate where woodland, heath or moorland was encroached on by the medieval practice of *assarting,* creating small irregular fields (Beswick *et al.* 1993). Some traces of these early fields are shown today by the remains of rig and furrow caused by medieval ploughing. Sinuous boundaries, perhaps caused by a turning plough or avoiding large trees, may be indicative of medieval woodland (Rackham 1986), but those seen on nineteenth century maps are not in themselves diagnostic unless a bank and exterior ditch are present.

The maps of Northumberland produced by military surveyors Armstrong in 1769, (Figure 10), Fryer in 1820, and Greenwood in 1828 were used to trace woodlands in existence before the first OS maps. These county maps only showed larger woodlands, however, and the presence of smaller woods is uncertain. The 1769 map shows unnamed woodlands with tree symbols and parkland with a boundary, giving only an approximation of the size and position of woodlands. The map compiled by Greenwood in 1828 depicts much of the woodland shown on both the Tithe Maps of the 1830s and 1840s, and on the first edition OS 6 inch to the mile maps, which were surveyed in the

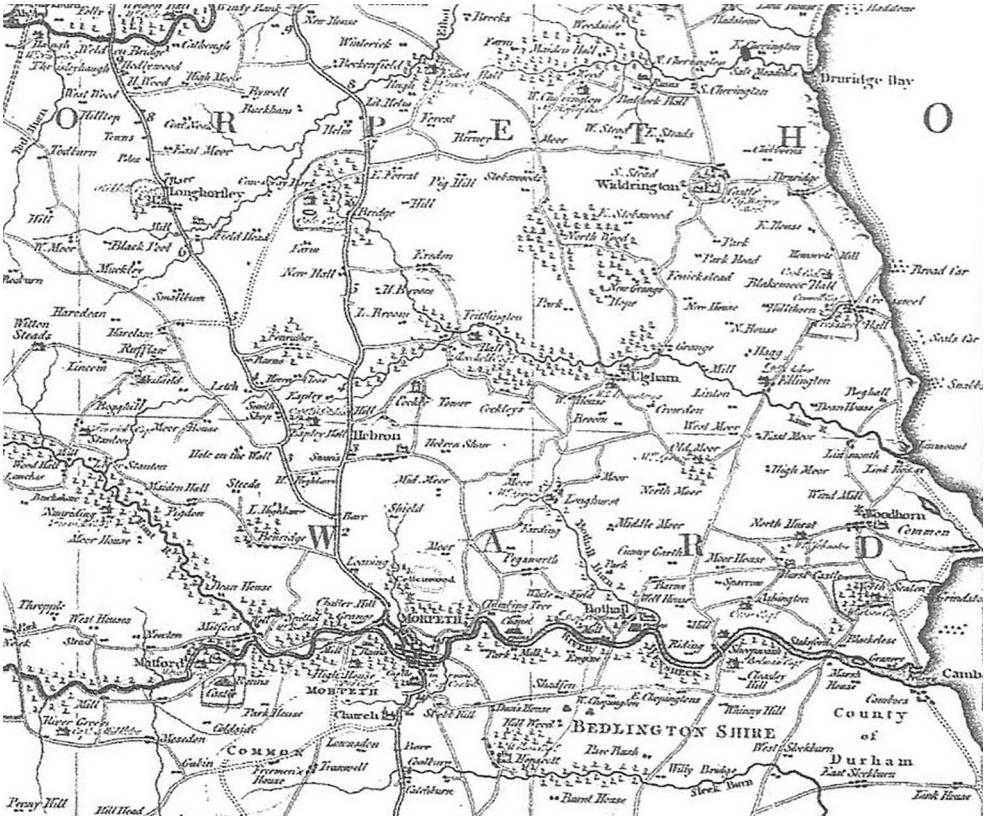

Figure 10. Armstrong's county map, 1769: south-east Northumberland.

1850s and 1860s with woodlands drawn and named in a consistent way using standardised symbols to illustrate vegetation. Nevertheless, it remains unclear to what extent the woodlands of the mid-nineteenth century matched the boundaries of those a hundred years earlier.

Some Estate plans contain detailed information about land use in the pre-Enclosure period, though the location of woodlands is often difficult to verify. Plans with seventeenth—to nineteenth-century illustrations of woodlands for part of the study area were found in records of the Bothal estates, including maps of some of the study woodlands drawn in 1632 by William Senior for the Earl of Newcastle. These plans show two un-named woods which have a striking match by position and shape to Robinhood Wood and Forest Wood. More certainty may be gained on further investigation (NA ZSA 51/1/6; Mastoris 2017).

Some non-woodland earthworks such as hillforts, linear defensive ditches, trackways, and hedge banks were recorded in what is now woodland, based on evidence from aerial photographs and LiDAR survey, which penetrates woodland cover and can be used to detect surface features (Crow *et al.* 2007). For example, LiDAR imagery of Weldon Wood shows probable nineteenth-century 'narrow rig' cultivation which suggests that this is at least in part secondary woodland. Medieval 'broad' rig and furrow, generated by ploughing strips drawn by unwieldy ox teams, resulting in a reverse 'S' double curve, can also be found in woodland, indicating that the woodland is secondary even though it may have been established long before 1600CE (Glaves *et al.* 2009b).

In central England there is good evidence of woodland along the territorial frontiers of the Anglo-Saxon period. Wyre, Kinver, and Arden woodlands lie thickly along boundaries of the *Hwiccan* and *Magonsaetan* kingdoms of the seventh century (Hooke 1998, 139). Many woodlands in south-east Northumberland were found to be situated along historic township boundaries as shown on first edition OS maps. Woodlands lying on township boundaries were recorded to investigate their distribution in the landscape as they reveal stable territorial units of land management and survive at the periphery of such units. A 2019 survey of the boundary woodlands of the Cospatric land holdings suggested these may fossilise pre-Conquest territorial units (O'Brien 2023).

Case Study: Netherwitton

The origin of the name Netherwitton lies in OE *wudu* + *tun*, signifying a wooded settlement, farmstead or estate. This implies not merely the presence of wood, but also its active exploitation (Gelling 1994, 227). Netherwitton township was studied in greater detail to show how the available evidence could be combined to investigate the age of its woodlands. Lidar data shows that there is no visible rig and furrow in Oldpark Wood, but that plough marks abut against the wood in the fields on the northern edge (shown in brown), some of which are broad rig (Figure 11). This land may have been *assarted* from the woodland for agriculture in the late twelfth or early thirteenth centuries. A sinuous boundary bank runs along the northern edge of the wood showing the maximum extent of agricultural intake here. In the south-east corner of the township, on the edge of the land unit identified as the Cospatric estate, a section is named Spring Wood; this could have derived from OE *spring*, 'a water source' or more likely a Middle English word for regrowth of underwood, indicating coppiced woodland.

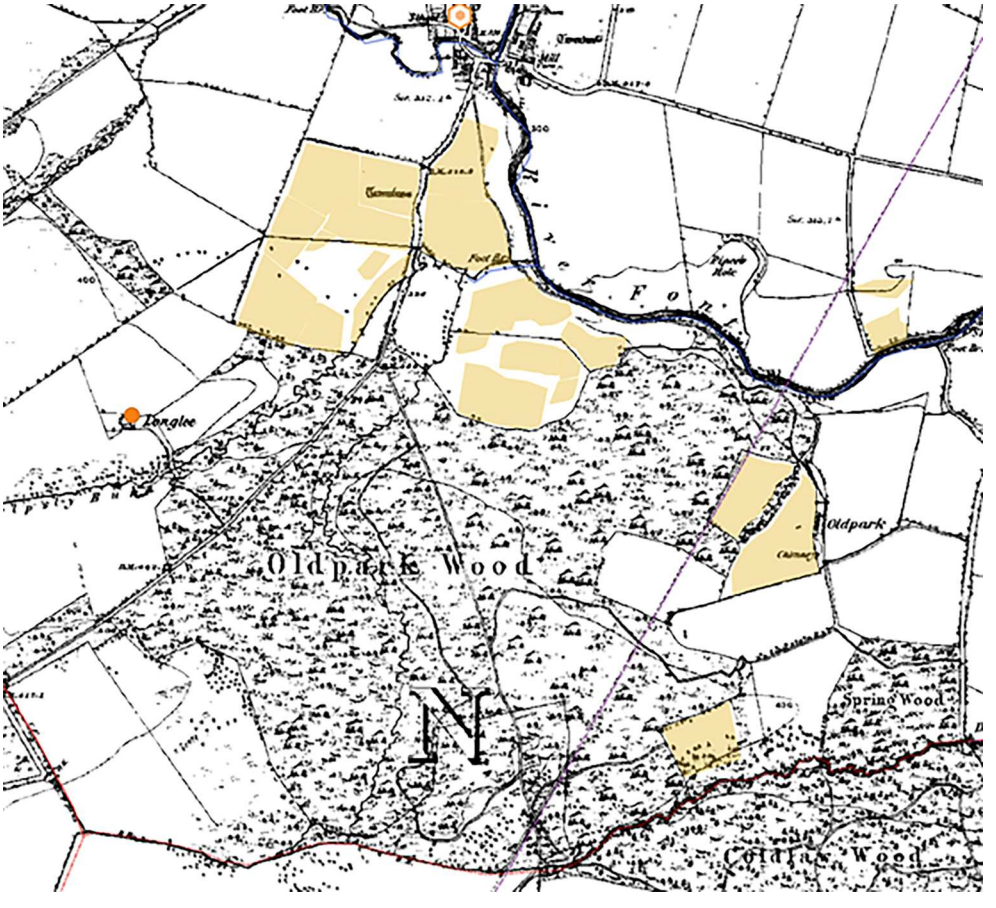

Figure 11. Oldpark Wood, Netherwitton, showing possible assarts overlaid on 1st Edition OS 6 inch map (map: Colm O'Brien).

The oldest documentary evidence for the woods of Netherwitton comes from the Newminster Foundation Charter (O'Brien 2020) which records that Ranulph de Merlay gave Ritton and part of the wood of Witton to the monks of Newminster Abbey. The botanical study recorded seventeen AWIs and a species richness of 74; AWIs were also recorded in the south-eastern, assarted area. In this case historical, archaeological, and botanical evidence relating to Oldpark Wood showed this area is most likely to be an ASNW and may be part of the twelfth-century 'Wood of Witton'. The smaller woodland of Longwitton, which has ten AWIs and was shown on Greenwood's 1828 map, may be the southern remnant of a once more extensive woodland.

Discussion

Oliver Rackham observed that ancient woods tend to survive in remote situations and are often found along old parish boundaries on maps (Rackham 1976, 112). In north-east England they are often found along steeper valley sides on sites that are too steep, wet,

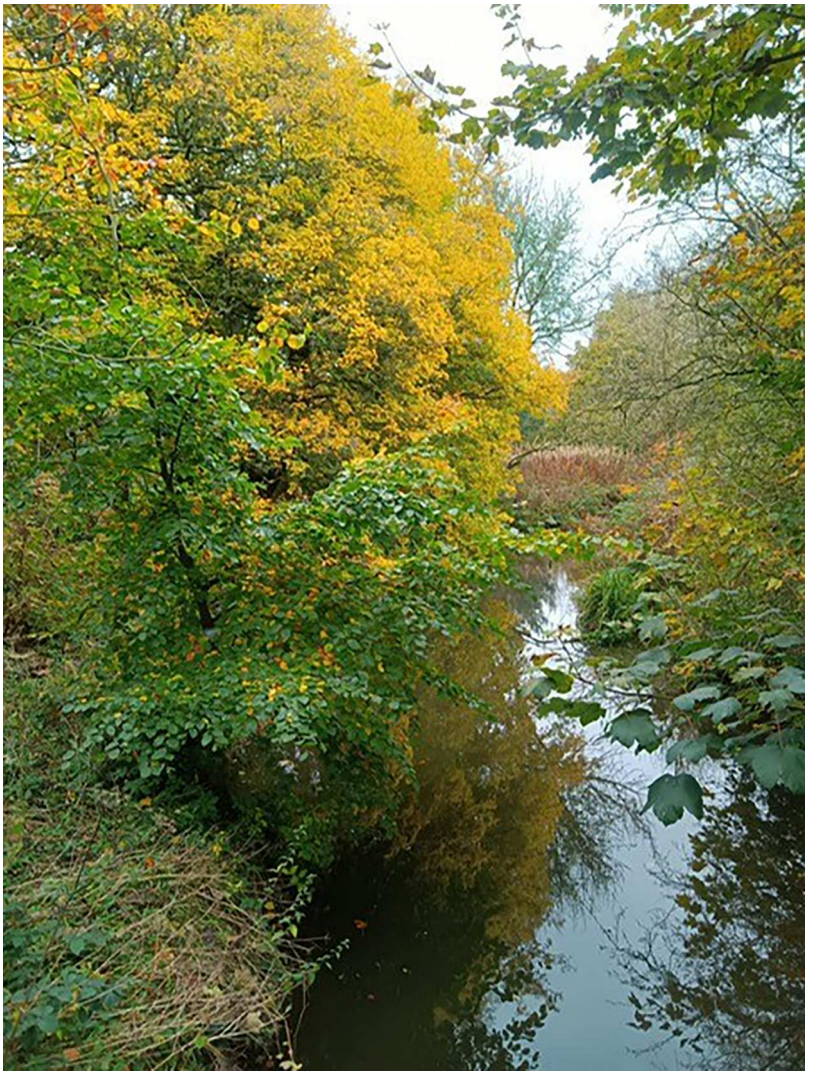

Figure 12. Riverside woodlands with Duke's Bank Wood (photo: Cathy Cushnahan).

infertile or too rocky for cultivation. In this study woodlands were found to survive in frequent association with parish/township boundaries, where streams fork, along steep-sided denes and along rivers (Figure 12).

Although there has been little written about the history of woodland in Northumberland to date, land management has been recorded in different ways. Estate records can be useful in revealing contemporary landscape knowledge but the location of woodlands on estate plans and early historical maps may reflect the compiler's personal view or the client's needs. Care is needed in interpretation of size and position of woodland until the nineteenth century, when woodlands were named and drawn using standardised symbols. Maps and plans of south-east Northumberland can give evidence of the continuity of woodland presence over the last two hundred years, but not as far back as 1600 CE.

Traditional ways of managing woodland such as coppicing trees for everyday uses, where they are cut near the ground every few years then grow again from the stool, declined significantly as demand for wood for tools and craft products fell with growth in the use of manufactured materials. Since the medieval period many former woodlands have been planted with conifers, predominately for softwood timber, while many woodlands are now only managed by episodic felling or left relatively unmanaged. Together with intensive deer grazing this is leading to structural changes within woods, often shown by lack of regeneration.

Coppicing continued until the early twentieth century but in this study the signs of management observed in the woodlands revealed that results of coppicing were not the huge bolls and stools that could indicate substantial systematic historic management, although some trees had multiple large stems, such as ash trees in Howburn Wood (Figure 1). The minimum age of a wood is said to be the age of its oldest tree, but species grow differentially so the age of an individual tree is an unreliable measure of a woodland's age (Harding and Wall 2000, 121). Any tree may have started to grow years before, or after, the wood developed so cannot be used to establish the age of the woodland.

Sinuous woodbanks, the classic sign of the boundary of a medieval managed coppiced wood, were found in very few of the study woodlands. In future research, samples of sediments from beneath such woodbanks could be dated using quantitative laboratory methods such as optically stimulated luminescence profiling and dating (OSL-PD) (Vervust *et al.* 2020).

The definition of what constitutes an ancient woodland indicator rather than a woodland species or non-woodland plant has been attempted using measures of light, temperature, moisture, and soil but no consensus has been reached (Kirby *et al.* 2012, 66). Latterly studies have sought to make the lists of AWI species more accurately reflect the character of the vascular plant community. Ian Rotherham concluded that there needs to be a better understanding of how strongly indicator species are associated with a woodland site: whether AWIs' presence was due to ecological continuity, not antiquity (Rotherham 2011). It was emphasised that species were more resilient to disruption than previously thought and that ancient woodland flora were able to regenerate (Webb and Goodenough 2018). The latest studies have developed weighting with biological variables such as temperature and aspect or using negative indicators (Wright 2016; Swallow 2018; Haycock 2019; Swallow *et al.* 2020). This study has measured how strongly indicator species are associated with woodland sites in south-east Northumberland but cannot be applied to other areas which may have different environmental conditions.

Research has shown that AWIs differ significantly from other woodland vascular species in having distinct ecological profiles. Their plant life traits have been studied, with the resulting proposition that there is a 'guild' of woodland plants, correlating with their preferred ecological profile. They are shade and stress tolerant; avoid very wet or dry soils; prefer weakly acid to neutral soils; have relatively large seeds but no persistent seed bank; have specific germination requirements and limited fertility (Hermy *et al.* 1999). Why and how guilds operate has been debated in many studies. however. Taking account of internal variation in woodlands was thought to be crucial, as the composition of species found depended on differing meso-and micro-habitats, which emphasises the heterogeneity of woodlands (Wright and Rotherham 2011). Rotherham suggested that AWI species need a climate, micro-climate, soils, and the right drainage,

creating an environment in which they can survive and reappear if suitable conditions return (Rotherham 2011, 172–8). It is not possible to confirm a woodland's age by the presence of AWIs at any one time, although 'shadows' or 'ghosts' of former woodlands may remain in the landscape. Many woodlands have been cut down over the centuries; their presence may only be evidenced by buried seeds (Rotherham 2013, 2017).

Throughout Britain it is not clear how strictly lists of AWIs have been used to assess woodlands. It appears to have been an *ad hoc*, inconsistent process. The species in lists of AWIs have been very variable countrywide, as have the threshold of species sufficient to classify a woodland as 'ancient.' An estimated one-third of the records in the Inventory were based on map evidence alone (Spencer and Kirby 1992), but no systematic survey of lists and how they should be derived and applied or agreed systematic survey has been devised (Glaves *et al.* 2009a). A review of the revision of the Ancient Woodland Inventory for the South-East of England found it was still primarily a mapping exercise, supported by research of historical maps for Natural England (McKernan and Goldberg 2011).

The number threshold of AWIs (16) used to indicate ancient woodland is problematic, since the proximity of edges has a substantial effect on the composition and number of species. A study in the Cotswolds indicated edge of woodland conditions are less suitable for the majority of AWIs. As many woods are fragmented and small, they are more likely to be affected by a dual-edge effect (Swallow and Goodenough 2017). Some regions such as Wales suggested woods of less than 2ha. with <5 AWIs should be considered. The current update of the Ancient Woodland Inventory (2025) includes smaller woods, over 0.25ha rather than the previous 2ha. In this study thirteen AWIs were observed in a woodland of 1ha. As Francis Rose reminded us, indicator species are a measure of diversity of woodland species, and this is more important than antiquity in conservation terms (Rose 2006, 21). Grading of woodland should perhaps reflect this more clearly.

Optimum environmental conditions are vital for every living organism. Every plant has an optimal niche, an individual range of environmental conditions where it can prosper. Soil and environmental conditions allow plants to germinate, grow, mature, set seed, and disperse. Lacking these conditions, the plant will not be found. These are the driving factors for the species found in any habitat and this should be considered when assessing woodlands (Fitter and Fitter 2002). Perhaps the entire woodland should be considered, not only above ground, but particularly the soil, and microorganisms within, on which the plants rely. Although no vascular plant species is exclusively found in woodland, using a list of AWI species in a guild compiled by expert botanists nevertheless contributes valuable information about the woodland community at the time of survey.

The original concept of 'ancient woodland' with distinctive AWIs and 'ancient countryside' coined by Rackham, has been challenged by Barnes and Williamson, who used archaeological and botanical evidence in their exploration of woodlands in Norfolk to see how far the history of woods can be 'read' and argued that the state of woodlands reflected the intensity of exploitation and the vagaries of natural processes. Some woodlands on the Ancient Woodland Inventory in Norfolk which originated after 1600 had similar AWIs to those known to be earlier (Barnes and Williamson 2015; Williamson 2013). These authors agree with Rotherham that woodlands could be less stable than previously suggested. It would be interesting to test this in Northumberland.

Table 7. Woodlands with <16 Ancient Woodland Indicators (AWIs).

Woodland	AWI	Weighting	LNWI	ASNWs in 1988 Designations	in 2019 *ASNW
Bothal Mill	20	6	3	ASNW	*
Brinkburn Riverside	19	5	6		*
Broadwood Mitford	17	5	5	ASNW	*
Cockshot Brinkburn	19	5	6	ASNW	*
Cottingwood	22	13	1	ASNW	*
Duke's Bank	16	4	11	ASNW	*
Fenceburn	17	6	8		*
Forestburn Lower	16	4	10		*
Garrett Lee	16	4	9		*
Hedley	17	6	7	ASNW	*
Maglinburn Lower	16	4	11		*
Oldpark	17	9	4	PAWS	*
Paxtonburn	16	6	8	ASNW	*
Scotch Gill	22	6	2	ASNW	*
Ulgham	19	3	7		*

Grading of Ancient Status

Woodlands recorded in 2019 were compared with their status in 1988 using the suggested number of sixteen AWIs. Of the twenty-nine woodlands surveyed in this study included on the provisional Northumberland Inventory maps twenty-three were then judged to be ASNWs, four were PAWS, and two were both in 1988. Six woods—Hope, Blubbery/Blackdene, Oldpark, Heighley, Robinhood and Chevington were judged to be of doubtful ancient status; others were probable, but none had 'highly probable' ancient status. In 2019 all these woodlands barring Hope and Chevington had scores of over nine AWIs, and seventeen AWIs were observed in Oldpark—one of the highest scores of all the woodlands studied. Six woodlands, Brinkburn Riverside, Fenceburn, Forestburn Lower, Garrett Lee, Maginburn Lower and Ulgham which had not previously been classified, reached the criteria for ASNW in 2019 (Table 7).

Conclusion

No definitive method of identification of ancient woodland has been agreed to date. This study used the multi-disciplinary approach, as recommended in reports to the Woodland Trust by the Biodiversity and Landscape History Research Institute at Sheffield Hallam University, to evaluate the status of sixty-two woods in south-east Northumberland (Glaves *et al.* 2009a, 2009b, 2009c). The principal historical sources used were place-name, estate record, mapping and documentary evidence and the field study approach taken was historical ecology using AWIs (Peterken and Game 1984; Rackham 2000; Szabo 2015). The challenge has been to identify with certainty those woodlands likely to be ancient, i.e. to have origins earlier than 1600 CE in areas where few documentary records remain such as Northumberland. Old English place-names contributed evidence to ancient woodland identification. Enclosure records and other documents held in the National Archives such as the Pipe Rolls may contain further relevant evidence. To be able to assess the age of woodlands it is suggested that further quantitative evidence relating to woodland would be helpful, for example by investigating raised woodbanks using OSL-PD or palaeo-environmental deposits from boggy areas using radiocarbon dating.

The woodlands studied contained broadleaved trees; about half had conifers (Figure 12); four were on larger riversides; twenty on burns varying from Broadwood Mitford (88ha) to Harry's (1ha); eight were grazed woodland; three newly planted; two were heaths; and one was regenerating moorland. Ten of the woodlands are currently local nature reserves and Woodland Trust sites, while five have SSSI conservation status. Twenty-nine had been graded as potentially ancient in the 1980s though none of the study woodlands listed in the Northumberland Inventory of Ancient Woodland were considered ancient with certainty, and nine were judged to be doubtful ASNW. Six more ancient woodlands were identified in this study using the 16 AWI threshold.

Field and desk study results were analysed statistically to give an indication of which species were shown to have faithfulness to ancient woodland in south-east lowland Northumberland. The botanical study found that a small number of AWI species found in a woodland does not mean it could not date from 1600 CE, nor did a large number necessarily indicate it did. Woodlands named in the earliest records—the monastic charters—did not have a large enough number of AWI species to indicate ASNW. In retrospect it would have been advantageous to incorporate objective quadrat surveys of abundance to provide more accurate plant community assessment. Even so, significant correlation between AWIs and ASNW was found, and the LNWI suggested additional species which had a strong association to woodlands in south-east Northumberland.

The case study of Netherwitton township showed the usefulness of a multivariate approach in identifying ancient woodland status in absence of documentary evidence. The most compelling evidence of ancient woodland was found, despite designation as doubtful PAWS. The botanical evidence clearly indicated woodland here was ASNW using the measure of sixteen indicators, and historical earthworks plus its twelfth-century documentary evidence strongly suggests Oldpark is likely to be part of the 'Wood of Witton'.

To judge the quality of woodlands in conservation terms, tiny woodlands such as Harry's (1ha.) and Woodhouse strip (1.7ha.) are as important as larger ones. The smaller woodlands can easily be regarded as less significant because they cannot easily be shown to be ancient; they are just as valuable, if not more valuable, components of the historic landscape. This has broad implications for the protection and management of woodlands.

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No potential conflict of interest was reported by the author(s).

Notes on contributor

Dorothy Anne Cowans worked in early years teaching and special education. In retirement she returned to her earlier passion for the countryside with the Natural History Society of

Northumbria. A parallel interest in local history and archaeology was broadened with the Bernician Studies Group. She led the survey of woodland flora for the BSG *Cocwudu* project researching ancient woodland and Early Medieval landscapes in Northumberland, co-ordinating a team of volunteer botanists.

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Appendices

Appendix 1

The fifty AWI species used to develop a Lowland Northumberland Woodland Index – LNWI including Yellow Star-of-Bethlehem and Bird's Nest Orchid.

Table A1. Fifty AWI species used to recalculate faithfulness weightings.

Table ancient woodland	Indicator species	Number of sites	% Total
*Acer campestre	Field Maple	4	6.45%
Adoxa moschatellina	Townhall Clock	26	41.94%
Allium ursinum	Ramsons	43	69.35%
Anemone nemerosa	Wood Anemone	43	69.35%
Arum maculatum	Lords and Ladies	12	19.35
Brachypodium sylvaticum	False Brome	16	25.81
Bromopsis ramose	Hairy Brome	13	20.97
Campanula latifolia	Giant Bellflower	4	6.45
Carex laevigata	Smooth Stalked Sedge	0	
Carex paniculate	Great Tussock Sedge	2	3.23
Carex remota	Remote Sedge	21	33.87

(*Continued*)

Table A1. Continued.

Table ancient woodland	Indicator species	Number of sites	% Total
Carex sylvatica	Wood Sedge	33	53.23
Chrysoplenium alternifolium	Alt.-leaved Golden Saxifrage	5	8.06
*Circaea x intermedia	Up. Enchanter's-Nightshade	0	
Elymus caninus	Bearded Couch grass	5	8.06
Epipactis helleborine	Broad-leaved Helleborine	5	8.06
Equisetum sylvaticum	Wood Horsetail	6	9.68
Euonymus europaeus	Spindle	0	
Festuca altissima	Wood Fescue	0	
*Gagea lutea	Yellow Star-of-Bethlehem	1	1.61
Galium odoratum.	Woodruff	35	56.45
*Goodyera repens	Creeping Ladies-tresses	0	
Gymnocarpium Dryopteris	Oak Fern	0	
*Hordelymus europaeus	Wood Barley	0	
Hyacinthoides non-scripta	Bluebell	48	77.42%
Juniperus communis	Juniper	0	
Lathraea squamaria	Toothwort	3	4.84
Luzula Pilosa	Hairy Wood—Rush	24	38.71
Melampyrum pratense	Common Cow-wheat	3	3.23
Melica nutans	Mountain Melick	0	
Melica uniflora	Wood Melick	12	19.35
Mercurialis perennis.	Dog's Mercury	44	70.97%
Milium effusium.	Wood Millet	8	12.9
Myosotis sylvatica	Wood Forget-me-not	21	33.87
Neottia nidus-avis	Bird's Nest Orchid	1	1.61
Oxalis acetosella.	Wood Sorrel	55	88.71%
Paris quadrifolia	Herb Paris	3	3.23
Phegopteris connectilis	Beech Fern	0	
Poa nemoralis.	Wood Meadow-grass	8	12.9
Polystichum aculeatum.	Hard Shield-Fern	6	9.68
*Polystichum setiferum	Soft Shield-Fern	0	
Ranunculus auricomus.	Goldilocks Buttercup	12	19.35
Ribes spicatum	Downy Currant	0	
Sanicula europaea	Sanicle	30	48.39
Stellaria nemorum	Wood Stitchwort	5	8.06
Schedonorus giganteus	Giant Fescue	6	9.68
*Tilia cordata	Small-leaved lime	0	
Veronica montana	Wood Speedwell	40	64.52%
Viburnum opulus	Guelder-rose	12	19.35
Vicia sylvatica	Wood Vetch	10	16.13
*species unlikely to be found			

Appendix 2

Faithfulness of species to old and ancient woods using the LNWI weightings.

Table A2. Faithfulness of species to old and ancient woods using the LNWI weightings.

	Species list					
Species	English name	AWI	LNWI weight	Weighting Score	Faithfulness to W3-4	To W 4
Moehringia trinervia	Three-nerved Sandwort		5	6.0	100%	50%
Paris quadrifolia	Herb Paris	AWI	5	5.0	100%	33%
Milium effusum	Wood Millet	AWI	4	4.9	88%	38%
Scrophularia nodosa	Common Figwort		4	4.8	80%	40%
Polypodium vulgare	Common Polypody		4	4.5	50%	50%
Epipactis helleborine	Broad-leaved Helleborine	AWI	4	4.2	60%	40%
Poa nemoralis	Wood Meadow-grass	AWI	4	4.1	88%	25%
Elymus caninus	Bearded Couch Grass	AWI	4	4.0	100%	17%
Campanula latifolia	Giant Bellflower	AWI	3	3.8	75%	25%

(*Continued*)

Table A2. Continued.

	Species list					
Species	English name	AWI	LNWI weight	Weighting Score	Faithfulness to W3-4	To W 4
Rubus idaeus	Raspberry		3	3.7	78%	22%
Festuca gigantea	Giant Fescue	AWI	3	3.5	83%	17%
Equisetum sylvaticum	Wood Horsetail	AWI	3	3.5	50%	33%
Prunus padus	Bird Cherry		3	3.4	70%	22%
Ulmus glabra	Wych Elm		3	3.4	63%	25%
Dryopteris dilatata	Broad Buckler Fern		3	3.3	62%	24%
Carex pendula	Pendulous Sedge		3	3.3	73%	18%
Arum maculatum	Lords and Ladies	AWI	3	3.3	75%	17%
Melica uniflora	Wood Melick	AWI	3	3.3	75%	17%
Carex remota	Remote Sedge	AWI	3	3.1	67%	19%
Blechnum spicant	Hard Fern		3	3.0	62%	19%
Gagea lutea	Yellow Star-of-Bethlehem	AWI	3	3.0	100%	0%
Glechoma hederacea	Ground-ivy		3	3.0	78%	11%
Lathraea squamaria	Toothwort	AWI	3	3.0	100%	0%
Myosotis sylvatica	Wood Forget-me-not	AWI	3	3.0	71%	14%
Phyllitis scolopendrium	Hart's-tongue Fern		3	3.0	50%	25%
Stellaria nemorum	Wood Stitchwort	AWI	3	3.0	60%	20%
Polystichum aculeatum	Hard Shield Fern	AWI	3	3.0	67%	17%
Taxus baccata	Yew		3	3.0	67%	17%
Mercurialis perennis	Dog's Mercury	AWI	2	2.7	61%	14%
Adoxa moschatellina	Townhall Clock	AWI	2	2.7	65%	12%
Allium ursinum	Ramsons	AWI	2	2.7	60%	14%
Veronica montana	Wood Speedwell	AWI	2	2.6	63%	13%
Anemone nemorosa	Wood Anemone	AWI	2	2.6	58%	14%
Galium odoratum	Woodruff	AWI	2	2.6	69%	9%
Luzula pilosa	Hairy Wood-rush	AWI	2	2.5	67%	8%
Viburnum opulus	Guelder-rose	AWI	2	2.5	67%	8%
Carex sylvatica	Wood Sedge	AWI	2	2.5	59%	12%
Vicia sylvatica	Wood Vetch	AWI	2	2.4	60%	10%
Bromopsis ramosa	Wood/Hairy Brome	AWI	2	2.4	50%	14%
Hyacinthoides non-scripta	Bluebell	AWI	2	2.3	58%	8%
Brachypodium sylvaticum	False Brome	AWI	2	2.3	50%	13%
Oxalis acetocella	Wood Sorrel	AWI	2	2.2	55%	9%
Sanicula europaea	Sanicle	AWI	2	2.1	57%	7%
Ranunculus auricomus	Goldilocks Buttercup	AWI	1	2.0	67%	0%
Acer campestre	Field Maple	AWI	1	1.5	50%	0%
Carex paniculata	Greater Tussock Sedge	AWI	1	1.5	50%	0%
Melampyrum pratense	Common Cow-wheat	AWI	1	1.5	50%	0%
Polystichum setiferum	Soft Shield Fern	AWI	1	1.5	50%	0%
Chrysosplenium alternifolium	Alternate-leaved Golden Saxifrage	AWI	1	1.2	40%	0%
Neottia nidus-avis	Bird's-nest Orchid	AWI	1	0.0	0%	0%

Appendix 3

The results of the analysis using all data; total age weighting for each woodland, the species richness (SR), the total number of species recorded, and indicator species (SR-AWI)

Table A3. Summary of results of species richness in all woodlands.

Woodland Name	GRID. REF.	ABBR.	DESIG.	Cons.	Total Age Weight	Total Species Richness	SR-AWI
Abshields	NZ147902	ABS	ASNW		6	74	10
Beggar's Bush	NZ125951	BGB			4	59	4
Blubbery/Blackdean	NZ209908	BLB	BOTH		6	53	9

(*Continued*)

Table A3. Continued.

Woodland Name	GRID. REF.	ABBR.	DESIG.	Cons.	Total Age Weight	Total Species Richness	SR-AWI
Bothal Mill	NZ215866	BTN	BOTH		6	89	20
Brinkburn North	NZ121989	BBN			6	41	11
Brinkburn Riverside	NZ113987	BBR		SSSI	5	73	19
Brinkburn South	NZ114989	BBS	ASNW	SSSI	6	58	14
Broadwood Meldon	NZ134885	BML	ASNW		5	31	9
Broadwood Mitford	NZ114872	BMT	ASNW		5	71	17
Buckshaw	NZ127876	BSW			3	36	5
Carr's Island	NZ147997	CRI		SSSI	4	64	14
Chevington	NZ225985	CHV	BOTH		6	17	1
Clark's Bog	NZ215857	CLB		LNR	−2	26	0
Cockshot Brinkburn	NZ117994	CSB	ASNW		5	71	19
Cockshot Meldon	NZ160880	CSP	PAWS		4	69	10
Coltpark	NZ073934	CLP	BOTH		7	68	13
Combhill	NZ070931	CMH	ASNW		4	57	9
Cottingwood	NZ193868	CTW	ASNW	LWS	13	159	23
Duke's Bank	NZ174997	DKB	ASNW	SSSI	4	58	16
Fenceburn	NZ137887	FNB	ASNW		6	40	17
Fenrother	NZ178914	FRT			9	54	7
Forest	NZ206964	FOR	ASNW		5	52	11
Forestburn	NZ059969	FBL			4	58	16
Garrett Lee	NZ113963	GRL			4	63	16
Hag's	NU 102002	HAG			3	35	4
Hangingleaves	NZ194918	HGL			5	86	10
Hardhirst	NZ158871	HDH			4	62	9
Hare Dean	NZ134925	HRD			4	56	8
Harry's	NZ160868	HAR	ASNW		4	57	13
Hartburn	NZ08685	HTB		WT	6	24	9
Hedley	NZ145985	HED	ASNW		6	51	17
Heighley	NZ173883	HEI	BOTH		5	76	12
Hope	NU 092051	HOP	BOTH		6	25	6
Linden	NZ205875	HWB			6	47	13
Howburn	NZ160967	LDN	ASNW		6	86	10
Linn	NU 096024	LIN	PAWS		1	16	0
Longhirst	NZ223095	LHT		LNR	−2	37	4
Longhorsley Moor	NZ160925	LHM		SSSI	0	21	
Longwitton	NZ084872	LWT	BOTH		8	27	10
Lordenshaw	NZ075971	LDS			1	33	3
Maglinburn Lower	NZ105980	MGL			4	53	16
Maglinburn Middle	NZ100973	MGM			4	21	8
Maglinburn Upper	NZ076955	MGU			4	24	0
Nunriding	NZ146886	NNR	ASNW		6	16	2
Oldpark	NZ100953	OLP	PAWS		9	74	17
Paxtonburn	NZ174953	PXB			6	47	16
Pegswood	NZ230878	PGW		LNR	−2	22	0
Posternburn	NZ197885	PSB		LNR	4	43	8
Ritton	NZ064935	RIT	ASNW		6	23	3
Rivergreen	NZ139847	RVG	ASNW		6	46	12
Robinhood	NZ214934	RBH	ASNW		6	45	13
Scotch Gill	NZ182861	SCG	ASNW	LNR	6	128	23
Stobswood Ancient	NZ248948	SWL	ASNW	LNR	13	47	10
Stobswood Grange	NZ242945	SWG	PAWS		13	43	8
Todburn	NZ125976	TOD			3	52	9
Ulgham	NZ236926	ULG		LNR	3	81	19
Weldon to Brinkheugh	NZ120138	WLN			4	21	5
Weldon	NZ140989	WLB	ASNW		4	48	5
West	NZ220923	WST	ASNW	LWS	6	50	11
Wholme	NZ114950	WHM	ASNW		4	71	8
Willy's	NZ160898	WIL			4	36	7
Woodhouse Strip	NZ127883	WHS			2	46	6