Definition of Favourable Conservation Status for upland mixed ashwoods

Defining Favourable Conservation Status Project

Natural England

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Executive summary

This document sets out Natural England's view on favourable conservation status for upland mixed ashwoods in England.

Favourable conservation status is the minimum threshold at which we can be confident that the habitat, and its associated species, are thriving in England and are expected to continue to thrive sustainably in the future.

This definition has been produced following the Natural England approach to defining favourable conservation status described in the guidance document Defining Favourable Conservation Status in England.

Section 1 of this document describes the habitat covered by this definition and its ecosystem context.

Section 2 specifies the units used to describe the three favourable conservation status parameters. These are:

- Natural range and distribution (where the habitat occurs).
- Extent (how much habitat there is).
- The structure and function attributes (habitat quality).

Section 3 outlines the evidence considered when developing the definition. This definition is based on the best available evidence on the ecology of upland mixed ashwoods. The evidence covers the current situation, historical changes and possible future changes.

Section 4 sets out the conclusions on the favourable values, that is the value for each of the three parameters when the habitat has achieved favourable conservation status.

This document does not include any action planning, or describe actions, to achieve or maintain favourable conservation status. These will be presented separately, for example within strategy documents.

Summary definition of favourable conservation status

Upland mixed ashwoods are predominately found on base-rich soils in the north and west of England. Ash is generally the dominant tree species, although locally oak, birch, elm, small-leaved lime, large-leaved lime and even hazel may be more abundant. Yew may form small groves in intimate mosaics with the other major tree species. Many upland mixed ashwoods are associated with gorges or steep rocky slopes and often form mosaics with extensive limestone grassland, limestone pavement and other limestone features. Upland mixed ashwoods are also found on more acid, poorly drained soils where there is flushing of nutrients, often as small fragments of woodland with irregular margins or as narrow strips along flushes, riparian tracts, outcrops and steep banks. Most of these woodlands are found in small, isolated patches.

The extent of upland mixed ashwoods declined during the twentieth century and their quality was adversely affected by excessive grazing by deer and livestock. Ash Dieback disease is now causing widespread damage to, and death of, ash trees.

The natural range of upland mixed ashwoods is largely determined by soils and climate. For favourable status the current range of 147 hectads should be maintained.

The current habitat area is estimated at approximately 32,000 ha and an increase in extent of approximately 21,500 ha. This is needed to address past losses and small patch size and increase resilience to climate change and other pressures. This gives a favourable area of 53,500 ha. This could be achieved by increasing the size of small patches, creating buffer zones around medium sized woods and creating new woods on appropriate sites.

Favourable status would be achieved when 95% of the favourable area of the habitat has achieved favourable structure and function attributes.

All the species associated with the habitat should be Least Concern when assessed using IUCN criteria.

Table 1 Confidence levels for the favourable values

Favourable conservation status parameter	Favourable value	Confidence in the proposed favourable value
Range and distribution	Maintenance of the current range – 147 hectads.	**Moderate**
Area	Create an additional 21,500 ha of upland mixed ashwoods to give a favourable area of 53,500 ha.	**Low**
Structure and function	At least 95% of the favourable area of the habitat meets the structure and function requirements as described above.	**Moderate**

As of December 2021 based on a comparison of the favourable values with the current values, upland mixed ashwoods are not in favourable conservation status. Note, this conclusion is based solely on the information within this document and not on a formal assessment of status nor on focussed and/or comprehensive monitoring of status.

Contents

About the Defining Favourable Conservation Status project

Natural England's Defining Favourable Conservation Status (DFCS) project is defining the minimum threshold at which habitats and species in England can be considered to be thriving. Our Favourable Conservation Status (FCS) definitions are based on ecological evidence and the expertise of specialists.

Through setting our ambition and aspiration for species and habitats, our definitions will inform decision making and actions to achieve and sustain thriving wildlife.

Our FCS definitions will be embedded into delivery of the 25 Year Environment Plan, through the Nature Recovery Network, biodiversity net gain and environmental land management schemes (ELMS).

Conservation bodies will use them to inform their work, including management planning for the land they own. Businesses will have a clear understanding of how their work impacts nature recovery and how they can help contribute to achieving thriving nature.

By considering the evidence for FCS, decisions will be more confident and strategic, with an understanding of their contribution to, or impact on, the national ambition.

1. Habitat definition and ecosystem context

1.1 Habitat definition

Upland mixed ashwoods are predominately found on base-rich soils in the north and west of Britain. Ash is generally the dominant tree species, although locally oak, birch, elm, small-leaved lime, large-leaved lime and even hazel may be more abundant. On the limestones around Morecambe Bay and in the Durham Denes, yew *Taxus baccata* may form small groves in intimate mosaics with the other major tree species. Upland mixed ashwoods are also found on more acid, poorly drained soils where there is flushing of nutrients, often as small fragments of woodland with irregular margins or as narrow strips along flushes, riparian tracts, outcrops and steep banks.

Characteristic species include dog's mercury *Mercurialis perennis*, wood false brome *Brachypodium sylvaticum*, bluebell *Hyacinthoides non-scripta*, primrose *Primula vulgaris*, wood cranesbill *Geranium sylvaticum*, and wild garlic *Allium ursinum*. In terms of National Vegetation Classification (NVC) plant communities (Rodwell 1991) this habitat is characterised by W9 *Fraxinus excelsior - Sorbus aucuparia - Mercurialis perennis* woodland and W8 *Fraxinus excelsior - Acer campestre - Mercurialis perennis* woodland, mainly sub communities d. *Hedera helix*, e. *Geranium robertianum*, f. *Allium ursinum* and g.*Teucrium scorodonia*, often with small patches of W13 *Taxus baccata* woodland for the yew stands. Less frequently some stands in upland mixed ashwoods fit better in NVC terms to the more southerly and eastern sub-communities of W8 (a-c) and, in strips along streamsides, to the relatively dry alder-ash stands (W7c).

Although this woodland type is very much associated with the uplands, it is not confined to upland areas. Roudsea Wood, Cumbria, for example, is at sea level. There is no single, simple distinction between upland mixed ashwoods and lowland mixed deciduous woodland as, in vegetation composition and landscape context, they merge into each other. However, the following characteristics generally tend to distinguish upland mixed ashwoods from their lowland counterparts:

- They are present in the cooler, wetter parts of Britain.
- Their underlying soils are more often shallow, free draining and less often heavy clays.
- They are more likely to be part of or abut unenclosed landscapes.
- NVC types W9 and W8d-g are more commonly found in upland mixed ashwoods (W8a-c less common).

- Rowan and wood-sorrel tend to be more common and southern species such as lords-and-ladies, spindle, dogwood and field maple less so.
- Bryophyte and fern diversity tends to be significantly greater.

Many upland mixed ashwoods are ancient (that is they have been continuously wooded since at least 1600), but ash is a vigorous colonist of open ground, and in some important areas, such as the Derbyshire Dales, there are often mixtures of ancient and more recent (secondary) woodland. Many woods have been treated as coppice in the past, others have been wood pasture, but most now are high forest.

The core of the upland mixed ashwoods habitat type is the Habitats Directive Annex 1 type 9180 *Tilio-Acerion* forests of slopes, screes and ravines. The Annex 1 type represents the best developed and most natural forms of upland mixed ashwoods. However, the upland mixed ashwoods type is broader and includes more recent and fragmentary examples of woodland and some where there is no association with rocky slopes and ravines that tend to characterise the Annex 1 type.

Other minor components of upland mixed ashwoods include:

- Annex 1 type 91J0 *Taxus baccata* woods of the British Isles. This includes principally the NVC community W13 *(Taxus baccata* woodland) and corresponds to the European Nature Information System (EUNIS) code T3-C11.
- Annex 1 type H8240 Limestone pavements. This includes principally the NVC community W9 *(Fraxinus excelsior - Sorbus aucuparia - Mercurialis perennis* woodland). This habitat often exists as fragmentary areas especially on northern limestone areas.
- Also of note, but not corresponding to any Annex 1 habitat, there are small patches of alder woodland sometimes found within upland mixed ashwoods. This mostly corresponds to the NVC community W7c (*Alnus glutinosa – Fraxinus excelsior – Lysimachia nemorum* woodland - *Deschampsia cespitosa* sub-community). In turn this corresponds to EUNIS code T1-211.

Table 2 Relationship between Annex I, EUNIS and NVC upland mixed ashwoods classifications

Woodland type	**NVC types**	**Habitats Directive Annex 1 type**	**EUNIS codes (2017 revision)**
Upland mixed ashwoods	W8d-g W9 W8a-c	*Tilio-Acerion* ravine forests (9180)	T1-F (G1.A4 in 2012 code)

Woodland type	NVC types	Habitats Directive Annex 1 type	EUNIS codes (2017 revision)
Yew stands embedded in upland mixed ashwoods	W13	*Taxus baccata* woods (91J0)	T3-C11 (G3-971 in 2012 code)
Embedded limestone pavement	Usually W9	Limestone Pavement (H8240)	H3.511 Limestone pavements
Small alder patches	W7c	N/A	T1-211

The majority of the threats and issues affecting upland mixed ashwoods are the same for all the Annex 1 types and the habitat type more generally.

1.2 Habitat status

Upland mixed ashwoods are identified as a Habitat of Principal Importance in England under Section 41 (S41) of the Natural Environment and Rural Communities (NERC) Act 2006.

In the European Red List of Habitats, Ravine Woodland (roughly equivalent to upland mixed ashwoods) is classed as Near Threatened in the EU28, although of Least Concern in geographical Europe. The Near Threatened status recognises a decline in extent and quality over the last 50 years. Yew woodland was assessed as Least Concern. In addition, as a consequence of Ash Dieback and potentially other pests, ash as a tree species is now classed as Near Threatened, both in Europe and globally.

1.3 Ecosystem context

Ashwoods are widespread across Britain and Europe. Ash-dominant woodland tends to be confined to the moister and more calcareous ends of the soil spectra, hence its association with shady ravines. Upland mixed ashwoods occur in two broad situations (Rodwell 1991), termed ‘streamside ashwoods’ and ‘limestone ashwoods’ in this definition for convenience.

In Britain, many of the strong shade-casting and shade-bearing tree species found in Europe are absent or restricted to lowland sites; ash-dominated woodland is thus relatively more common than on the Continent. Rodwell and Dring (2001) noted a particular similarity between many of our upland mixed ashwoods and those found in southern Scandinavian river valleys.

Based on National Forest Inventory figures (Forest Research 2020), almost 60% of Great Britain's upland mixed ashwoods are found in England. Much of this woodland is likely to be in semi-natural stands as ash has not been as commonly planted as oak or beech.

Streamside ashwoods

In upland landscapes with predominantly acid soils, oak and birch tend to dominate the woodland canopy, but narrow strips of ash and elm, sometimes with small-leaved lime occur along streamsides or at the bottom of slopes where more nutrient-rich soil conditions occur. Ash woodland here may include elements of wetter woodland (often NVC type W7) usually in a very fragmentary form – a few alder trees, with patches of opposite-leaved golden-saxifrage *Chrysosplenium oppositifolium,* creeping buttercup *Ranunculus repens* and remote sedge *Carex remota* immediately by a streamside. While the ash woodland may be only a small part of the total area of these woods it may contain twice as many species of woodland vascular plant as the acid oak areas and thus contribute disproportionately to the species richness for the site.

The boundaries between the woodland types may be fairly distinctive. The ashwood patches are naturally often small and isolated across the slope by the very different soil conditions and woodland type in between (usually acid oakwoods W11, W17 in NVC terms). There may be some continuity of ash woodland down the streamside, but this is often truncated because the lowest ground in the valley bottoms has usually been cleared of woodland. Scattered ash trees along stream sides or hedges in the lower, often enclosed ground, may support some ashwood species on or around them but not the whole assemblage.

The transition to unenclosed land, often moorland, above the wood is also generally distinctive. This may be due to a stone wall or fence with grazing or fire preventing spread of ash onto the moor. The conditions where ash might spread along the streams are also often favoured by grazing livestock, although the odd tree may establish and survive where it grows from rock crevices out of reach of sheep. Some of the ash woodland flora – primrose and anemones for example - may occur in a bitten-down state amongst the grasses and rushes above the woodland wall.

Where there is a change of substrate, particularly at the tops of limestone dales, there are often transitions to W10/W11 oak and birch woodlands (Rodwell 1991).

Limestone ashwoods

Upland mixed ashwoods often form mosaics with extensive limestone grassland, limestone pavement and other karst features, such as on the top of Whitbarrow in Cumbria or in the Derbyshire Dales. They are also associated with enclosed hay meadows as in the Yorkshire Dales. These latter are, in a sense, upland mixed ashwoods lacking trees (Rodwell 1991). Woodland-grassland mosaics can be difficult to maintain - on various Sites of Special Scientific Interest (SSSIs) parts of the sites are noted as having woodland in unfavourable condition because of the stock grazing, whereas on other SSSIs the problem is woodland encroachment on to species-rich grassland patches.

The boundary between woodland and grassland has tended to vary over time, largely in response to changing grazing intensity, so woods may be mixtures of ancient core areas with areas of more recent woodland round the edge. While some of the specialist woodland plants such as small-leaved lime are largely confined to the ancient cores, others such as dog's mercury rapidly spread into the new developing woodland on these sites (Merton 1970; Pigott 1969).

Associations with other features

Many upland mixed ashwoods are associated with gorges or steep rocky slopes, some of which are of geological interest. The rivers and streams at the bottom of the slopes may be of value for freshwater species. In a few places the ashwoods on limestone knolls form mosaics with raised mires. At Roudsea Wood the transition zone between limestone and mire is a stronghold for yellow sedge *Carex flava*, otherwise only known from Malham Tarn (Preston and others 2002; Ian Taylor unpublished). In ravine woods on the Continent there can be a clear zonation of vegetation influenced by moisture, slope and substrate. This can also be seen to a certain extent in UK woodlands, where the moister base of ravines on deeper soils is preferred by species such as willows, alder and ash, maples, the drier slopes and screes by lime and elm and the more acidic ravine brows by oaks, rowan, and birch. This clear zonation has been obscured by the proliferation of ash, following the removal or demise of elm, oak and lime.

Mitchell and others (2014a) have highlighted the distinctive character of ash in comparison to most other native species – an open canopy, base-rich bark, easily decomposed leaves and endo- rather than ecto-mycorrhizal roots. In turn these lead to a distinctive associated flora and fauna in both lowland and upland ash woodlands. In total, 1,058 species have been identified as being associated with ash (ash-associated species): 12 birds, 55 mammals, 78 vascular plants, 58 bryophytes, 68 fungi, 239 invertebrates, and 548 lichens. Of the 55 mammals, 28 use the ash trees and the remainder use the ash woodland habitat; the vascular plants use the ash woodland habitat rather than the trees themselves.

2. Units and attributes

2.1 Natural range and distribution

Hectad (10 km grid square)

This is the appropriate woodland metric given the relatively patchy distribution of the habitat across England.

2.2 Extent

Hectare.

2.3 Structure and function attributes

The value of an upland mixed ashwood in supporting biodiversity and associated ecosystem services is determined by several attributes including its age, composition, spatial area, shrub and ground species composition, position in the landscape, adjacent land use, hydrology and the impact of non-native species and disease.

Structure attributes

Attributes used to describe habitat quality and woodland condition at the site level are discussed in Kirby and others (2002). A related set of features can be considered for woodland at a national scale. As well as extent (considered elsewhere), the key attributes are (i) structural variations, (ii) woody layer composition, and (iii) ground flora composition.

The following are the structure attributes that determine quality of upland mixed ashwoods:

- A mix of both open spaces and dense shade to support a variety of different flora and fauna.
- A variety of age/size classes of trees.
- A variety of heights and cover of vegetation layers.
- Presence of characteristic species including characteristic vegetation community composition based on the NVC (Rodwell 1991).
- Absence of invasive and introduced non-native species.
- Presence of fallen and standing dead and decaying wood in at least some areas.

- A graduated woodland edge into adjacent associated habitats, for example, semi-natural open habitats, other woodland or wood-pasture types or scrub. Habitat transitions are important for many species.

- Connectivity. Many species depend on a mosaic of habitats, or woodland patches may be too small to be sustainable. By connecting upland mixed ashwoods to other habitats or other areas of woodland it may be possible to improve the conditions for the characteristic species.

Function attributes

The structure of a wood and the wildlife it can support depend on the natural and cultural processes that generate disturbance and patterns of variation across a site. The following are the functional attributes that determine the quality of upland mixed ashwoods:

- The properties of the underlying soil types, including structure, bulk density, total carbon, pH, soil nutrient status and the fungal:bacterial ratio.

- Hydrological function. This determines the extent and quality of the wetter types of upland mixed ashwoods.

- Water chemistry and water nutrient status. These are important determinants of the vegetation composition of the wetter types of upland mixed ashwoods.

- Air quality characteristics. Higher concentrations and deposition of air pollutants, in particular atmospheric deposition of nitrogen, can result in undesired vegetation changes.

- Vegetation management. Levels of grazing by large herbivores determines regeneration and the balance of tree cover and lower vegetation layers.

- Functional connectivity with other woods and habitats in the wider landscape. Connectivity will ensure opportunity for recruitment and genetic exchange.

3. Evidence

All blocks of evidence are assigned one of three confidence levels (High, Moderate, Low), based on the quality of the evidence, its applicability and the level of agreement.

The matrix in Figure 1 is used to assess the confidence level assigned to blocks of evidence. White = High confidence; Light blue = Moderate confidence and Dark blue = Low confidence.

Limited evidence Strong agreement	Medium evidence Strong agreement	Robust evidence Strong agreement
Limited evidence Medium agreement	Medium evidence Medium agreement	Robust evidence Medium agreement
Limited evidence Weak agreement	Medium evidence Weak agreement	Robust evidence Weak agreement

Figure 1 Matrix used to assign confidence to blocks of evidence (after IPCC 2010).

Quality of evidence is defined as follows:

- Robust evidence is that which has been reported in peer-reviewed literature, or other reputable literature, from well-designed experiments, surveys or inventories that shows signs of being applicable generally.
- Medium evidence is that reported from well-designed experiments, surveys or inventories but from only one or a small number of sites, with uncertainty over its more general applicability, or is correlational or circumstantial evidence.
- Limited evidence includes ‘expert opinion’, based on knowledge of ecological factors that plausibly suggest an effect, but there is no circumstantial or direct evidence available.

Agreement is defined as follows:

- Strong agreement is consensus across the literature and amongst those with expertise on the habitat or species.
- Medium agreement is common consensus across the literature and amongst experts but there are some differing papers or reports and/or some differences of opinion.

- Weak agreement is little consensus across the literature and amongst experts and, possibly, many different findings and/or opinions.

3.1 Current situation

Natural range and distribution

The natural range of upland mixed ashwoods at a national level is largely determined by soils and climate. Figure 2 shows the National Forest Inventory (NFI) sample squares where upland mixed ashwoods were identified as present. The NFI (Forest Research 2020) uses a combination of earth observation and surveys of approximately 6,200 one-hectare sample squares that partially or entirely contain woodland (including clear-felled areas). Upland mixed ashwoods (strictly, NVC W9) were identified within 147 hectads. There are a few outliers in the dataset and it is possible that these would be better described as lowland mixed broadleaved woodland. Also, the sampling method, and the scattered occurrence of this woodland type, may have under-stated the distribution of this habitat. However, overall, this dataset gives a good proxy for habitat range and extent.

Areas of upland mixed ashwoods along stream sides are particularly a feature of woods in the following National Character Areas (NCA): 5 Border Moors and Forests, 8 Cumbria High Fells, 9 Eden Valley, 10 North Pennines, 19 South Cumbria Low Fells, 25 North Yorkshire Moors and Cleveland Hills, 50 Derbyshire Peak Fringe and Lower Derwent, 98 Clun and North West Herefordshire Hills, 103 Malvern Hills, 105 Forest of Dean and Lower Wye Valley, 144 Quantock Hills, 145 Exmoor.

The more extensive areas of upland mixed ashwoods, on the limestones of northern England and in the Welsh Borders, are mainly in the following NCAs: 15 Durham Magnesian Limestone Plateau, 20 Morecambe Bay Limestones, 21 Yorkshire Dales, 30 Southern Magnesian Limestone, 52 White Peak, 118 Bristol, Avon Valleys and Ridges, 141 Mendip Hills.

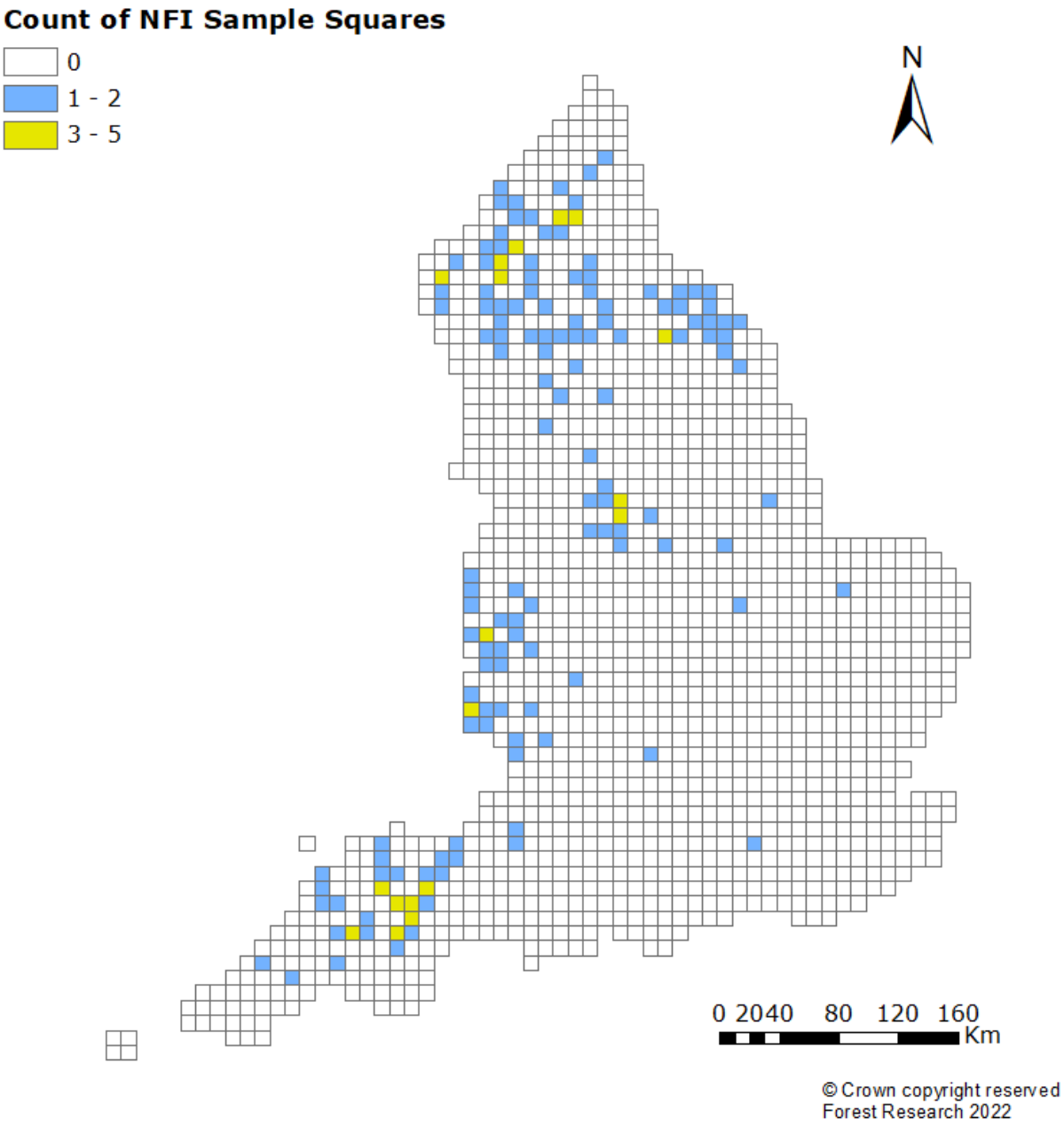

Figure 2 Map of distribution of 10 km grid squares with upland mixed ashwoods identified in National Forest Inventory sample squares. © Crown copyright reserved.

Confidence: Moderate.

Extent

The National Forest Inventory (NFI; Forest Research 2020) estimates there to be around 32,000 ha of upland mixed ashwood in England. As the NFI is based on sampling, the figure is likely to be the right order of magnitude, but not precise. However, it is the best current estimate available.

Confidence: Moderate.

Patch size and connectivity

Most upland ash woodlands occur in small patches. Data from the NFI indicates that the largest proportion of upland mixed ashwoods in England, just over 10,000 ha (33% of the total), occurs in parcels smaller than 5 ha.

Table 3 Proportion of upland mixed ashwoods within different woodland size categories

Under 5 ha	>=5 ha and <10 ha	>=10 ha and <15 ha	>=15 ha and <20 ha	>=20 ha and <25 ha	>=25 ha and <50 ha	>=50 ha and <100 ha	>=100 ha and <150 ha	>=150 ha and <200 ha	Over 200 ha
33%	10%	8%	5%	3%	12%	10%	7%	4%	8%

Confidence: Moderate.

Quality of habitat patches

Just over one third (36%) of upland mixed ashwoods are within SSSIs. Data on Natural England's Designated Sites View shows that the condition of approximately three quarters of this woodland has been assessed, although some of these assessments were completed several years ago. Over half (56%) of the assessed woodland was in favourable condition and a further 35% in Unfavourable Recovering condition. The most commonly mentioned reasons for unfavourable condition were a lack of natural regeneration, high levels of grazing, a uniform age structure and the presence of non-native species such as sycamore, beech and conifers.

Reporting under Article 17 of the Habitats Directive (JNCC 2019) identified approximately 11% of upland mixed ashwoods as Annex 1 type 9180 *Tilio-Acerion* forests of slopes, screes and ravines. The latest report (JNCC 2019) also found approximately 56% of this type to be in favourable condition and approximately 37% in Unfavourable-Recovering condition.

The National Forest Inventory (Forest Research 2020) collected data on the ecological condition of woodland. The following indicators were assessed:

- Age distribution of trees
- Wild, domestic and feral herbivore damage
- Invasive plant species
- Number of native tree species
- Occupancy of native trees - The percentage area of native tree species in the uppermost canopy relative to total uppermost canopy area
- Open space within woodland

- Proportion of favourable land cover around woodland
- Woodland regeneration
- Tree health
- Vegetation and ground flora
- Woodland vertical structure
- Veteran trees
- Volume of deadwood

The results for upland mixed ashwoods suggest that the main issues are:

1. A lack of open space within woodland

   For woods under 10 ha (43% of the total area of upland mixed ashwoods) only 14% had favourable levels of open space. By contrast, a quarter of upland mixed ashwoods 10 ha and over in extent were found to have favourable levels of open space.

2. Low volume of deadwood

   Less than 10% of the sampled upland mixed ashwoods had levels of dead wood present considered favourable.

3. A lack of older trees

   National Forest Inventory data show that approximately 72% of the estimated area of upland mixed ashwoods in England consists of a mix of young and intermediate aged trees (22,963 ha). Woodlands with a mixture of young, intermediate, and old trees make up 5,810 ha, approximately 18%, of the total habitat area in England.

   This is likely to be applicable to many woodlands, and particularly upland woods where trees grow more slowly and take longer to reach larger size classes. The lack of older trees in upland mixed ashwoods, is likely to get markedly worse as the effects of ash dieback are realised.

4. Low numbers of veteran trees

   99% of sampled upland mixed ashwoods had no veteran trees (though note that the sampling method may have led to some under-estimation of their number). This indicator is universal to all woodlands and is an artefact of past management: over-mature and veteran trees are not retained in woodlands generally, and where they are found within woodlands, they usually occur as boundary or marker trees.

The NFI Woodland Ecological Condition (WEC) report collected data in a specific scaled way, useful for drawing out patterns at a country and regional scale but less useful at a local or site scale focusing on specific areas.

Information on damage caused by herbivores within the WEC report is limited to visible impacts on seedlings, saplings and young trees, and doesn’t take account of other aspects

of the woodland structure. Where stands comprise tree species/structure classes that are not vulnerable to damage, this will appear favourable, although the area may be visibly over-grazed. Information on regeneration is similarly limited: there is no unfavourable category, and the indicator is based only on presence of seedlings, saplings or young trees, with no information on the species or quantity of regeneration. Information on vegetation & ground flora is yet more limited, as no species information was collected during the surveys for the report. This indicator simply considers whether the percent cover is appropriate for the NVC community recorded in each square.

Information on the impact of air pollution on upland mixed ashwoods is not available but Rowe and others (2022) found that 61.3% of the area of broadleaved and mixed woodland in England exceeded the acidity critical load in the period 2018-2020. However, a greater area of broadleaved woodland in England exceeded the nutrient nitrogen critical load over the same period – 99.9%. Figures for exceedance of ammonia critical levels are only given for the UK (for the period 2017-2019). 86.4% of the area of broadleaved woodland exceeded the critical level for lichens and bryophytes and 8% of the area exceeded the critical level for vascular plants. Broadleaved woodland is one of the habitats with the highest Average Accumulated Exceedance for both acidity and nitrogen deposition.

Confidence: Moderate.

Threatened species

Upland mixed ashwoods may contain rare, endemic and threatened species. Vascular plant examples include whitebeams (*Sorbus* spp.), whorled Solomon's seal *Polygonatum verticillatum* (Regionally Extinct), Lady's slipper *Cypripedium calceolus* (Critically Endangered) and Northern hawk's-beard *Crepis mollis* (Vulnerable) (Stroh and others 2014).

The alkaline bark of old ash (and elm where it still survives) supports important lichen species, particularly the *Lobarion* community. Two lichen species are obligate on ash: *Lithothelium phaeosporum* (Near Threatened) and *Thelenella modesta* (Critically Endangered); and several have a high level of association with ash: *Bacidia auerswaldii* (Data Deficient), *Caloplaca flavorubescens* (Endangered), *Catapyrenium psoromoides* (Critically Endangered), *Collema nigrescens* (Near Threatened), *Fuscopannaria ignobilis* (Vulnerable), *Leptogium cochleatum* (Vulnerable), *Leptogium saturninum* (Vulnerable), *Vezdaea stipitata* (Near Threatened), and *Wadeana dendrographa* (Near Threatened) (Mitchell and others 2015).

Upland mixed ash woods harbour a rich invertebrate fauna, which may include uncommon or declining species. Standing and fallen dead wood provides habitat for rare beetles, flies and other invertebrates. The dense and varied shrub layer found in many ash woods can, in the southern part of their range, provide suitable habitat conditions for dormouse *Muscardinus avellanarius*, assessed as Vulnerable in England.

Lepidoptera species which are obligate on ash are *Atethmia centrago* (Centre-barred Sallow) and *Pammene suspectana*. The former is regarded as Vulnerable due to an

estimated 74% UK population decline between 1968 and 2002 (Fox and others 2006), whilst the latter is a rare species in the UK with few records.

3.2 Historical variation in the above parameters

It is likely that upland mixed ashwoods would once have been found throughout the uplands wherever there were base-rich soils. Few areas within the overall range, except for coastal strips, high altitude blanket bog or raised mires, would have lacked the type completely, even if it were present only as thin strips along a stream.

During the 20th century there was a substantial decline in the area of ancient semi-natural woodland in England, including upland mixed ashwoods, through clearance and conversion to plantations. Between about 1935 and 1985 approximately 6% of the extent of ancient woodland (greater than 2 ha in extent) present in 1935 was lost through clearance and approximately 41% was converted to plantation (Spencer & Kirby 1992) (based on counties in north and west regions only). The extent of loss of upland mixed ashwoods is not quantifiable because the ancient woodland inventory does not record woodland type.

Because of their geology, upland mixed ashwoods were particularly threatened by limestone quarrying and the removal of limestone pavement for gardens. The introduction of Limestone Pavement Orders greatly reduced the rates of such loss and damage.

There was an abandonment of traditional management, particularly coppicing, during the first half of the 20th century, large-scale felling during the Second World War and a general decline in broadleaved woodland management thereafter. As a result, most trees in ash woodlands are less than 80 years old and the woodlands tend to have dense canopies, little understorey and a rather uniform ground flora. This general uniformity of age structure has probably contributed to the decline of many woodland species in recent decades. Woodlands may become more varied over time, as the trees within them grow at different rates, and conditions are generally less uniform in upland woods, because of the more irregular topography creating more gaps.

Heavy grazing is generally damaging to the ground flora and limits tree regeneration. An increase in both sheep and deer grazing intensity since the mid-twentieth century was a cause of much damage (Ward 2005) but, in some circumstances, a complete removal of grazing using fencing can be undesirable as well (Sanderson & Lamacraft 2022). Rare lichens have been lost through being overgrown by dense ground flora following fencing out of stock from a site in the Lake District. At Gait Barrows in Lancashire some coppiced blocks were deliberately left open to deer browsing to prolong the period of open conditions needed for key butterflies on the site.

Ash woodland has increased in extent since at least the 1980s; there was 5-10% increase in the area of ash woodland in the ‘upland regions’ between approximately 1998 and 2010, based on comparisons of censuses by the Forestry Commission (Forestry Commission 2001; Forestry Commission 2012). This is likely to have been through natural regeneration

and deliberate ash planting both within existing woods and on to open ground. The virtual elimination of rabbits through myxomatosis in the 1950s allowed the development of new woodland. Locally, changes in farming practice may also have left some areas less grazed than previously, again allowing woodland to develop.

Wych elm *Ulmus glabra* was (in some cases still is) an important, albeit usually minor, component of many upland mixed ashwoods. Many of the mature trees present in the mid-twentieth century died as a result of Dutch Elm Disease although elm often remained alive as a component of the understorey. There is only limited information on the impact of Dutch Elm Disease on woodland biodiversity, but some elm specialist species (white letter hairstreak butterfly, some lichens) declined at least locally.

Ash Dieback, a tree disease caused by an invasive fungus (*Hymenoscyphus fraxineus*) was first recorded in England in 2012, although research has shown that it is likely to have been present since at least 2005. Most parts of the country are now affected. In November 2022 Forest Research recorded Ash Dieback as present in over 78% of 10 km x 10 km grid squares in England. The disease is causing widespread decline and death of ash trees and this is expected to continue. The severity of the disease varies locally determined by local conditions. It is likely that the majority of trees will exhibit symptoms of Ash Dieback, but not all will die.

Natural range and distribution

The broad range of upland mixed ashwoods is largely defined by soils and by climate and has remained largely static. However, there have been local changes in the distribution and extent of upland mixed ashwoods within its overall range.

Confidence: Moderate.

Extent

The available data do not allow a sound appreciation of the change in upland mixed ashwood extent over the time.

An estimate of extent made by Forest Research in previous (unpublished) work for English Nature using the National Inventory of Woodland and Trees (1999-2001) was 76,834 ha. This now seems too high, with inclusion of too much lowland ash woodland. The estimate used in the 2008 UK BAP report was 42,000 ha in England. The lower current estimate of extent of upland mixed ashwoods in England (32,000 ha), compared to previous estimates, is likely due to over sampling of the W9 NVC class (that represents upland mixed ashwoods) in the original 2008 estimates. It could also be that the NFI has allocated more of this habitat into the lowland mixed deciduous woodland category through methodological differences.

Confidence: Low.

Patch size and connectivity

There is no data on changes in patch size for upland mixed ashwoods. From known processes of loss and expansion of such woodland, both increases and decreases are likely to have occurred.

Confidence: Low.

Quality of habitat patches

The figure for conversion of ancient woodland to plantation implies a net loss of ash woodland. The Broadleaves Policy (Forestry Commission 1985) greatly reduced the rates of such loss and damage and since then there has been some restoration of stands through removal of the conifers.

Pigott (1969), Merton (1970) and Rodwell (1991) all suggest that limestone woods were once likely much more diverse with oak and lime occupying much more of the canopy.

Epiphyte communities in mixed ashwoods have been adversely affected by air pollution in the past and they continue to be so, but there is only limited evidence so far for impacts on vascular plant communities. Acid deposition and nutrient nitrogen deposition may have been declining in recent years: the area of broadleaved and mixed woodland in England exceeding the acidity critical load declined by 3.6% in the period 2010-2019 and over the same period, the Average Accumulated Exceedance declined by 16%. The decline in nutrient nitrogen critical load exceedance in 2010-2019 has not been as strong – the area of broadleaved woodland in England exceeding the critical load declined only 0.1% and the Average Accumulated Exceedance declined 4%. Conversely there has been an increase in the area of broadleaved woodland in the UK exceeding the ammonia critical levels in the period 2010-2018 – up 5.9% for the critical level for lichens and bryophytes and 3.1% for the critical level for vascular plants (Rowe and others 2022).

Confidence: Low.

3.3 The future for the habitat and its conservation

The threats and pressures affecting upland mixed ashwoods tend to be those common to a range of woodland types and the actions need to address them should be applied across whole woods and whole landscapes, not simply targeted at one type. The key areas of concern highlighted in in the Article 17 reports for *Tilio-Acerion* woodland and NFI report are:

- Woodland clearance
- Unsympathetic management
- Large herbivores (particularly deer)
- Tree diseases (particularly Ash Dieback)
- Air pollution

- Climate change
- Invasive species
- Habitat fragmentation
- Game management

Woodland clearance

It seems unlikely that there will be a revival of pressure to clear woodland for agriculture. However, locally there may be a continued threat to sites from development and from mineral working.

Unsympathetic woodland management

There seems little likelihood that large-scale conversion of broadleaved stands to conifers will be revived under current forestry policies.

Changes on sites due to lack of management will continue, but upland mixed ashwoods often have a relatively open structure because of varied topography, rock features and past stock grazing. Lack of management is therefore less of an issue for this type than, for example, lowland mixed deciduous woodland.

Large herbivores (particularly deer)

Despite considerable efforts, there is no sign that deer populations are being brought under control. There is a risk that overgrazing by deer will get rapidly worse without action to control their numbers.

Livestock grazing can have similar impacts to that of deer but is more easily controlled.

Tree diseases (particularly Ash Dieback)

Ash Dieback is now widespread throughout the country and is causing damage to, and death of, ash trees. Current estimates are that perhaps 85% of trees may die but this will vary from stand to stand.

The reduction in ash and its replacement by other tree and shrub species will change the character of upland mixed ashwoods and their associated species. In most cases species more strongly associated with ash are likely to decline in abundance. For example, if the replacement tree species cast a heavier shade than ash, or if the shrub layer becomes denser, this could result in a decline in northern hawk's-beard, wood barley *Hordelymus europaeus* and narrow-leaved bitter-cress *Cardamine impatiens* which are all light-loving species. Rare species, strongly associated with ash and present only at a few sites (in the case of some lichens, only on a few trees) are most at risk from the disease.

Even if tolerance develops in our ash populations to the current pests and diseases there are others that might arrive in Britain, both ones specific to ash (the Emerald Ash Borer beetle) and those that will impact ash and a range of other species such as the Asian

Gypsy Moth and the bacterium *Xylella fastidiosa*. These could cause further declines in ash abundance.

Most attention is currently focussed on diseases impacting ash, but there are also other diseases present in Britain (or that might spread here) that affect the other woody species in upland mixed ashwoods. These include Acute Oak Decline and Oak Processionary Moth and Alder Dieback. Their impact on the overall upland mixed ashwoods habitat is currently low, but this could change in the future.

Air pollution

While it is to be hoped that emissions may have peaked, the legacy of increased nutrients already in the system means that there may still be future changes in ground flora and epiphytic assemblages.

Climate change

The Climate Change Adaptation manual (Natural England & RSPB 2019) assesses the sensitivity of upland mixed ashwoods to climate change as Medium. It notes that significant changes to the species composition of upland mixed ashwoods are possible as is an increase in their susceptibility to other climate-driven impacts, such as wind throw, and colonisation by non-native invasive species and other pests and pathogens.

The direct effects of climate change on species over the next 50 years may be small compared to indirect effects arising because climate change favours further pest and disease spread, increased survival of deer over winter, or increases the regeneration of other trees to replace ash.

Invasive species

Two tree species have the potential to spread into upland mixed ashwoods: beech and sycamore. Spread of beech in upland mixed ashwoods is likely to cause more change in the associated wildlife than sycamore spread. In particular, beech casts a much deeper shade, has a more acidic bark (thus does not support the same epiphytes), and has more acidic and persistent litter (thus leading to a loss of ground flora). Sycamore casts a deeper shade than ash, the litter is more persistent and nutrient cycling is different, but not to the same degree as beech. In particular, sycamore bark can support many of the same epiphyte species as ash.

Spread of non-native ground flora, such as Himalayan balsam, can raise concerns that they will out compete other species although at present the extent of such invasions in upland mixed ashwoods is limited.

Habitat fragmentation

There is evidence that isolation and poor connectivity affects the spread of species to new woodland; but less that it contributes to preferential loss of species from existing small or isolated woods, although this may be the case. Changes in future connectivity are difficult

to predict – if there are significant shifts towards rewilding and increased woodland cover in the uplands then there is likely to be increased potential connectivity across the landscape.

Improved connectivity is desirable because, as the climate changes so does the potential distribution of species, albeit not in totally predictable ways. Natural England is therefore encouraging habitat networks as a mechanism to increase landscape permeability.

Game management

There is increasing concern about the impact of the release of large numbers of non-native pheasants into woods each year. Gamebird release and management can result in long-term nutrient enrichment of soil, leading to a change in ground flora. The presence of gamebirds can also inhibit tree regeneration, and create bare ground, and disturbance of important features such as deadwood. There may also be impacts upon invertebrates and reptiles (Madden & Sage 2020).

Natural range and distribution

The range of upland mixed ashwoods is largely defined by soils and by climate and is believed to have remained largely static. Therefore, future maintenance of the habitat and its associated species will require maintenance of the current range (147 hectads).

Confidence: Moderate.

Extent

An increase in the extent of upland mixed ashwoods is desirable to address past losses, small patch size and fragmentation of the habitat and to increase resilience to climate change and other pressures. An increase in extent will generally increase the opportunities for a range of growth stages to be represented with their associated species: from open space through to old growth. Since any patch of woodland potentially moves through these stages over time, the distribution of the different stages in a wood, a landscape, or a region, will vary from one decade to the next.

The area of woodland required for favourable conservation status and its disposition will be affected by the management strategies adopted. A much greater area is likely to be needed to cover all growth stages where there is reliance on ‘natural processes’ rather than deliberate intervention because of the greater randomness of variation inherent in the former. Long-term conservation of woodlands and their associated species will require good connectivity between habitat patches for different species groups in order to increase and maintain resilience of the habitat in the event of extreme disturbance.

The increase in extent could be achieved by increasing the size of small patches and creating buffer zones around medium sized woods. Also, to improve connectivity in the landscape, by creating new small woods and groups of trees. More substantial blocks of

new habitat are likely to be needed to provide more sustainable woodland conditions in the longer term.

Doubling the size of all patches under 5 ha would give an increase of approximately 11,000 ha. A buffer of 20 m around all woodlands between 5 ha and 20 ha in extent would require an increase in extent of approximately 8,000 ha, based on the NFI data which indicates there is approximately 7,400 of upland mixed ashwoods under 20 ha in extent and assuming 20 m buffers around circular 10 ha woods. A further 2,500 ha could improve connectivity by creating small woodlands in woodland landscapes and some new large woodland blocks (at least 50 ha). These additions would increase the extent of upland mixed ashwoods by approximately 21,500 ha.

As a result of Ash Dieback woodland expansion may be mainly of species other than ash, with a higher proportion of oak, hazel, aspen and birch than current examples.

Confidence: Low.

Patch size and connectivity

Future median patch-size will depend much on the balance between adding to existing sites and creating new sites.

Because of the number and variety of different associated species it is unlikely that a single woodland patch size will provide benefit for all associated species. Some species and processes can be maintained for long periods in very small sites (or portions of sites, including down to a few individual trees for some lichens); other species and processes require very large areas, tens if not hundreds of hectares, within which the ecological processes necessary for their continued existence (for example, natural gap-dynamics) can operate freely.

However, it is probably a reasonable rule of thumb that individual woods of less than about 5 ha will be unable to support a diverse range of associated species and these will remain vulnerable to stochastic events.

Woods with an area of 5-30 ha will likely support many more species, but not specialists that depend on rare microhabitats, or have large territories (some mammals and birds).

Larger woods will allow populations to survive with increasingly less reliance on management to maintain suitable conditions for them. However, we do not have any examples of large-scale, minimum-intervention woodland that have been in existence long enough to show that they can sustain a full woodland ecosystem without significant management, particularly for the species of the open stage and the old-growth woodland stage which are generally where many high conservation-value species occur (Warren & Key 1991). With current knowledge it would be very risky to assume that specialists that depend on open space and young stages, or those that depend on veteran trees, will survive under minimum intervention sites: mosaic landscapes stretching over several

kilometres may be needed, and these are likely to require management to maintain the mosaic.

Quality of habitat patches

There are likely to be changes in habitat quality over time and in the populations of some threatened species and even species assemblages as they respond to the changing balance of growth stages, climate change, eutrophication, the impact of Ash Dieback, variations in deer pressure, etc. Upland mixed ashwoods may end up looking and functioning differently from now.

Any patch of woodland potentially goes through a series of growth stages which differ in terms of their structure and function attributes, from open space through to old growth. Many species are limited to particular types of structure which may be present only during certain growth stages. For a woodland system to be sustainable in the long-term the proportion of stands that might be at any given stage should be proportional to the length of time that that stage lasts as shown in Table 4.

Table 4 Proportion of different growth stages within a landscape

Stage	Age range (years)	Percentage of landscape
Open to young thicket	0-40	10%
Thicket to pole	41-100	15%
Mature	101-300	50%
Old growth	301-400	25%

In order for the full woodland cycle to be represented in a single site, a large part of it (65% or so) has to be of trees in the thicket to mature stages. However, this balance does not necessarily have to be achieved at each site, providing it is found within the wider landscape. There needs to be sufficient area of the growth stage within a given landscape or region, within the effective dispersal distance of the key species, to sustain populations of dependent species in that landscape or region in the long-term. The overall extent of woodland must be sufficient to allow for the full range of these growth stages to be represented. The presence of the different growth stages should ensure adequate representation of the structural attributes to provide suitable conditions for dependent flora and fauna.

Rare or uncommon species may be sensitive to factors, or levels of those factors, which would otherwise be judged to have limited effect on other qualities of the woodland. For example:

- Lichens may be affected by levels air pollution that have little or no impact on other groups.
- Deer grazing in a particular part of a wood may be at a generally acceptable level, except that it happens to impact on the sole population of a rare orchid.
- Game management impacts may be only apparent on the populations of predatory species.
- Minimum intervention management may lead to the loss of gaps that particularly affect pearl-bordered fritillary breeding sites.
- Some appear to be limited by climate such that they currently tend to be found only in the southern part of the upland mixed ashwoods range (south-west England to Welsh Borders), or mainly in the northern part (Peak District northwards).

Trends that will improve the quality of upland mixed ashwoods include:

- An increase in connectivity across the landscape, such as indicated by higher levels of adjacent semi-natural habitat.
- An increase in structural diversity including greater numbers of old trees and larger volumes of dead wood.
- Increasing regeneration within gaps.
- An increasing proportion of native tree species in the woody layers.
- Reduction in invasive ground flora species
- Reductions in the overall levels of deer and livestock impacts.
- Improvements in air quality, indicated by reductions in air pollution indices.
- Emergence of ash-dieback tolerant/resistant trees.

Confidence: Moderate.

3.4 Constraints to expansion or restoration

Given the right soils, climate and time, the extent of woodland of broadly this type can be increased, but its composition will be different to current ancient stands.

Development of new stands of upland mixed ashwoods would be most successful on semi-natural calcareous grassland, for example NVC communities CG8 and CG9 or on MG3 *Anthoxanthum odoratum – Geranium sylvaticum* grassland (upland hay meadows) (Rodwell 1991; Rodwell & Patterson 1994). However, such areas are highly valued as open ground habitat and the loss of these habitats and their associated species would be

detrimental to conservation overall. However, it may be possible to improve woodland connectivity across some areas of these habitats through scattered trees and patches of scrub. Creating or encouraging woodland development on less suitable soils (improved grassland, arable fields) will mean that it takes much longer to develop a rich woodland ground flora, particularly in areas of high nitrogen deposition.

New woodland developed close to existing ancient or long-established will likely accumulate woodland species faster than new woodland patches remote from such sources. There can be potential benefits for many species through the buffering of the older woodland. Woodland creation will also bring short-term benefits to species of scrub and woodland-grassland transitions.

Changes in climate in the next half-century will not rule out development of upland mixed ashwoods on suitable soils. But some component species may be less abundant in the new stands, for example, the northern herbs globeflower *Trollius europaea*, wood cranesbill and melancholy thistle *Cirsium heterophyllum* and fern and bryophyte cover. On the other hand, there is potential (subject to the developing woodland structure) for more favourable conditions for southern species such as some of the fritillary butterflies and dormice.

Confidence: Moderate

4. Conclusions

4.1 Favourable range and distribution

The favourable range is the same as the current range – 147 hectads.

4.2 Favourable extent

Create an additional 21,500 ha of upland mixed ashwoods to give a favourable area of 53,500 ha.

4.3 Favourable structure and function attributes

Structure attributes

- A mix of both more open spaces and dense shade to support a variety of different flora and fauna. Areas of permanent/temporary open space within the woodland typically to cover approximately 10% of the area. Tree canopy cover across the feature typically between 40-90% of the site.
- A variety of age/size classes of trees. At least 3 age classes (pole stage/ medium/ mature) spread across the average life expectancy of the commonest trees present. Undisturbed, mature/old growth stands typically comprising at least 20% of the feature at any one time with assemblages of veteran and/or ancient trees (typically >10 trees per hectare).
- A variety of heights and cover of vegetation layers. Understorey shrubs covering 20 - 60% of the stand area.
- Presence of characteristic species including characteristic vegetation community composition based on the NVC (Rodwell 1991). A canopy and under-storey of which 95% is composed of site native trees and shrubs.
- Absence of invasive and introduced non-native species.
- Presence of fallen and standing dead and decaying wood in at least some areas. Continuity and abundance of standing or fallen dead and decaying wood, typically between 30 - 50 m^3 per hectare of standing or fallen timber or 3-5 fallen trees >30 cm per hectare, and >10 standing dead trees per hectare.
- A graduated woodland edge into adjacent associated habitats, for example, semi-natural open habitats, other woodland or wood-pasture types or scrub. Habitat transitions are important for many species.

- Connectivity. The ashwood is connected to other habitats or other areas of woodland.

Function attributes

- The properties of the underlying soil types reflect natural environmental conditions.
- Natural hydrological function.
- Water chemistry and water nutrient status reflecting the natural environmental conditions.
- Air quality characteristics. The concentrations and deposition of air pollutants at or below the site-relevant Critical Load or Level values given for this feature of the site on the Air Pollution Information System (www.apis.ac.uk).
- Vegetation management. Levels of grazing by large herbivores permit regeneration, typically tree seedlings of characteristic species should be visible within the wood and/or as regrowth.
- Functional connectivity with other woods and habitats in the wider landscape. Connectivity will ensure opportunity for recruitment and genetic exchange.

Quality of habitat patches

At least 95% of the favourable area of the habitat meets the structure and function requirements as described above.

Threatened species

None of the species partially or wholly dependent on this habitat should be categorised as IUCN Threatened.

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