# Definition of Favourable Conservation Status for lowland mixed deciduous woodland

Defining Favourable Conservation Status Project

Natural England

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# Acknowledgements

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# Executive summary

This document sets out Natural England's view on favourable conservation status for lowland mixed deciduous woodland in England.

Favourable conservation status is the situation when the habitat can be regarded as thriving in England and is expected to continue to thrive sustainably in the future. The definition is based on the available evidence on the ecology of lowland mixed deciduous woodland. Favourable conservation status is defined in terms of three parameters: natural range and distribution; extent; structure and function attributes (habitat quality).

A summary definition of favourable conservation status in England follows. Section 1 of this document describes the habitat and its ecosystem context, Section 2 the units used to define favourable conservation status and Section 3 describes the evidence considered when defining favourable conservation status for each of the three parameters. Section 4 sets out the conclusions on favourable values for each of the three parameters.

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.

The guidance document Defining Favourable Conservation Status in England describes the Natural England approach to defining favourable conservation status.

## Summary definition of favourable conservation status

The range of lowland mixed deciduous woodland is determined largely by soils and climate and is more or less fixed. Favourable conservation status would require maintenance of the current distribution of 1,027 hectads (10 km grid squares).

The habitat area is of the order of 748,000 ha and an increase of approximately 12% is needed to give a favourable area of 839,000 ha. This is achievable by the removal of conifers from ancient woodlands and the creation of new lowland mixed deciduous woodlands.

Favourable status would be achieved when 95% of the habitat (including the new 12%) has achieved favourable structure and function attributes. Various aspects of structure and function require attention for favourable status:

- Most broadleaved woods are small, especially ancient woodland in the lowlands, and may be isolated in landscapes which have lost woodland and other tree features such as hedges.
- There is little open space in woodland.
- There is a lot of uniformity of age structure.

- Veteran trees are scarce and under threat from shading by young growth.
- Vertical structure has been simplified by increased deer browsing.
- Levels of dead wood are generally still well below what might be found in natural woodland.
- The number of tree and shrub species present has been reduced by historic and recent management, for example, the focus on hazel in lowland coppices and oak as the main timber tree.
- Regeneration of key woody species is often lacking, particularly where there are high deer numbers.
- Tree pests and diseases are having an increasing impact, particularly ash dieback.
- Locally the ground flora is being changed through factors such as grazing and air pollution.

When lowland mixed deciduous woodland is in favourable conservation status 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 favourable value |
|---|---|---|
| Range and distribution | Maintenance of the current range and distribution of 1,027 hectads (10 km grid squares) with the habitat. | High |
| Extent | Create an additional 91,000 ha of lowland mixed deciduous woodland to give a favourable area of 839,000 ha. | High |
| Structure and function | 95% of the habitat meets the structure and function requirements.<br><br>All species are Least Concern. | High |

As of November 2022, based on a comparison of the favourable values with the current values, lowland mixed deciduous woodland is 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.

We are doing this so we can say what good looks like and to set our aspiration for species and habitats in England, which will inform decision making and actions to achieve and sustain thriving wildlife.

We are publishing FCS definitions so that you, our partners and decision-makers can do your bit for nature, better.

As we publish more of our work, the format of our definitions may evolve, however the content will remain largely the same.

This definition has been prepared using current data and evidence. It represents Natural England's view of favourable conservation status based on the best available information at the time of production.

# 1. Habitat definition and ecosystem context

## 1.1 Habitat definition

Woodland habitats can be classified in several ways, the most useful being dependent on the context and species being considered. This definition adopts the botanical composition approach. However, conservation value is not always strongly linked to the botanical classification of a woodland in the way that, for example, some grassland or heathland National Vegetation Classification (NVC) types are, as much value depends on woodland structure and management history.

Lowland mixed deciduous woodland is a broad classification of woodland developed for the UK Biodiversity Action Plan (BAP) during the 1990s. It embraces woodlands growing on a range of soils, from very acidic to base-rich, and takes in most semi-natural woodland in southern and eastern England. It thus complements, but also partially overlaps, the ranges of upland oak and upland ash woodland UK BAP types. Woodlands dominated by beech and yews and wet woodlands are also excluded, being covered by separate definitions of favourable conservation status.

There is great variety in the species composition of both the canopy layer and the ground flora, and this is reflected in the range of associated NVC and Stand Types, more than one of which can co-occur within a single site. There may be independent variation in the distribution of the main canopy species and main ground flora species within these types. For example, NVC W8 community is usually ash-dominated, but examples with lime, oak, elm or field maple dominance can have high conservation value.

Pedunculate oak *Quercus robur* is generally the commoner oak (although sessile oak *Quercus petraea* may be abundant locally) and may occur with virtually all combinations of other locally native tree species.

The canopy variations as represented by the Stand Type system (Peterken 1993) include most of the field maple (Group 2), lime (Groups 4, 5), suckering elm (Group 10) and hornbeam (Group 9) Stand Groups, and substantial proportions of the wych elm (Group 1), ash (Group 3) and oak (6) Stand Groups. More rarely, birch (Group 12) and some alder stands (Group 7C) occur.

In terms of the NVC (Rodwell 1991), most woods can be categorised as W8 *Fraxinus excelsior – Acer campestre – Mercurialis perennis* woodland (mainly of the a to c *Primula vulgaris – Glechoma hederacea, Anemone nemorosa* and *Deschampsia cespitosa* sub-communities in ancient or recent woods, with, in the lowlands, W8d *Hedera helix* sub-community mostly in recent woodland) and W10 *Quercus robur – Pteridium aquilinum – Rubus fruticosus* woodland (sub-communities a to d) with lesser amounts of W16 *Quercus*

*spp. – Betula spp. – Deschampsia flexuosa* woodland (mainly W16a *Quercus robur* sub-community).

Lowland mixed deciduous woodland is equivalent to the following European Nature Information System (EUNIS) habitats:

- T1-B1 Atlantic *Quercus robur* - *Betula* forest (within T1-B Acidophilous *Quercus* forest)
- T1–E1 *Quercus* - *Fraxinus* - *Carpinus betulus* forest on eutrophic and mesotrophic soils
- T1-E2 Non-riverine *Fraxinus* forest (both within T1-E *Carpinus* and *Quercus* mesic deciduous forest)

Most lowland mixed deciduous woodland falls outside the scope of the Habitats Directive but two types, with limited distribution and abundance in Britain, come within it as well as part of a third (Rodwell & Dring 2001):

- 9190 Old acidophilous oakwoods with *Quercus robur* on sandy plains: the key sites selected for this type as SACs have almost all been managed as wood-pastures.
- 9160 Stellario-Carpinetum oak-hornbeam forests (most of our hornbeam woods fall into the Atlantic type, which is not covered by the Habitats Directive).
- It is convenient to treat the small outlying stands of 9180 Tilio-Acerion that occur in Sussex/Hampshire as part of lowland mixed deciduous woodland rather than as upland ashwoods.

Since the majority of the type is not covered by the Directive, examples of the Annex 1 habitats often occur in mixtures with non-Annex 1 elements, and as the conservation issues and solutions are similar it would not make sense to separate out the Annex 1 habitats, even if the data were available to do so.

**Other sources:** JNCC website; Peterken 1977; Rackham 2003.

## 1.2 Habitat status

Lowland mixed deciduous woodland is listed as a Habitat of Principal Importance for the conservation of biodiversity in England under Section 41 (S41) of the Natural Environment and Rural Communities (NERC) Act 2006.

Within the European Red List of Habitats (Janssen and others 2016) Acidophilous *Quercus* forest was assessed as Vulnerable and *Carpinus* and *Quercus* mesic deciduous woodland as Near Threatened.

## 1.3 Ecosystem context

Lowland mixed deciduous woodland is found throughout England but is concentrated in the south and east. It occurs on a wide range of soil types, from acid sands to heavy, base-rich clays. It is found also in Wales and southern Scotland but there, and in northern England and the south-west peninsula, it overlaps with upland oak and ash woods. The bulk of the UK resource (just over four fifths) is in England. The type is the north-western extension of the lime-oak-hornbeam woods found across Europe where beech is not dominant, but with increased representation of Atlantic species such as bluebell (Ellenberg 1988). Shade-bearing tree species, such as Norway maple, sycamore, hornbeam and small-leaved lime are absent or generally scarce compared to Continental examples. This allows a higher representation of more shade-intolerant trees such as oak and ash.

Lowland mixed deciduous woodland occurs largely within enclosed landscapes, usually within well-defined boundaries, at relatively low altitudes (though altitude is not a defining feature). Many are ancient woods, and they include the classic examples of ancient woodland studied by Rackham (2003) and Peterken (1993) in East Anglia and the East Midlands. While some individual woods may be all ancient or all recent, it is not uncommon for woods to consist of patches of both ancient and recent origin. Ancient woodland (believed continuity of woodland since at least AD 1600 (Peterken 1977)) are generally biologically richer and more valuable for some groups of species and conservation features than woodland that has developed within the last 300-400 years on previously open ground. The distinction between the woods of ancient and recent origin tends to be more pronounced for this type compared to most other woodland types in terms of the associated species, particularly amongst the ground flora (Peterken 1993; Rackham 2003).

There is no consistent and regular pattern of other habitats being associated with these woods: it depends on local landscape history. They may form a mosaic with other woodland types, including patches of beech woodland, small wet areas, and types more commonly found in western Britain. They may be associated with mesotrophic grassland (less often calcareous grassland) or open wetland and those on the most acidic soils may be associated with lowland heath. Woodland rides and edges may also grade into grassland and scrub. For example, the fields in Monks Wood are significant as grassland habitat in Cambridgeshire; the rides in Lineage Wood in Suffolk are important areas of neutral grassland.

# 2. Units and attributes

## 2.1 Natural range and distribution

Hectad (10 km grid square).

## 2.2 Extent

Hectares.

## 2.3 Structure and function attributes

The following list of woodland attributes is largely derived from the condition monitoring approach developed for woodland at the site level (Kirby and others 2002).

### Structure attributes

- Woodland structure including:
    - the number and degree of layers of vegetation;
    - the variation in the age of trees;
    - the amount of dead wood; and
    - the availability of temporary and permanent open spaces.

Attributes concerning these characteristics are used in part as an indication of the likely value of a woodland for fauna that cannot be assessed easily by other means.

- Vegetation composition and characteristic species, reflecting the local natural environment and function attributes.
    - Tree and shrub composition. The percentage of native/accepted naturalised trees and shrubs. On some sites there may be a specific need to maintain a particular species (for example, lime trees for lime-dependent invertebrates) but on most sites a variety of species may be present, and their relative abundance may be expected to change over time.
    - The ground flora assemblage gives an indication that most of the woodland floor does have a recognisable woodland community, using NVC as a guide. However, allowance must be made for the stage in the woodland cycle: in gaps (natural or created by felling) non-woodland species and assemblages may dominate the ground flora for several

years; during the thicket stage the ground flora may be virtually absent; in some long-undisturbed stands single species (bramble, dog's mercury, ivy) may come to naturally dominate the ground cover. Conformance to NVC type composition alone is not a measure of value in woodland.

    - The presence of invasive non-native species, pests and diseases may indicate habitat that is in poor condition and less resilient to other pressures.

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

- Presence of natural transitions to, and mosaics with, other habitats reflecting natural variations in abiotic conditions and an appropriate level of grazing or browsing etc.  A mosaic of habitats is important for many species.

## Function attributes

- Woodland composition and structure should vary in relation to environmental conditions, particularly differences in natural soil characteristics across the site.

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

- Natural hydrological function, water chemistry and water nutrient status - particularly in humid woodlands.

- The degree to which the various structural and compositional aspects are maintained by active management or the operation of natural processes. This will be affected by site size: the smaller the site, the less likely it is that the desired conditions can be maintained without some active management.

# 3. Evidence

## 3.1 Current situation

### Natural range and distribution

Figure 1 indicates the range and distribution of lowland mixed deciduous woodland.

It is produced from data from the National Forest Inventory (NFI; Forest Research 2020). The NFI 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). There are 1,027 hectads (69% of all hectads within England) where lowland mixed deciduous woodland was identified within NFI sample squares, which is considered to represent the current distribution. Note, that, although called lowland mixed deciduous woodland, this habitat can occur in the upland fringes and does overlap with upland woodland types.

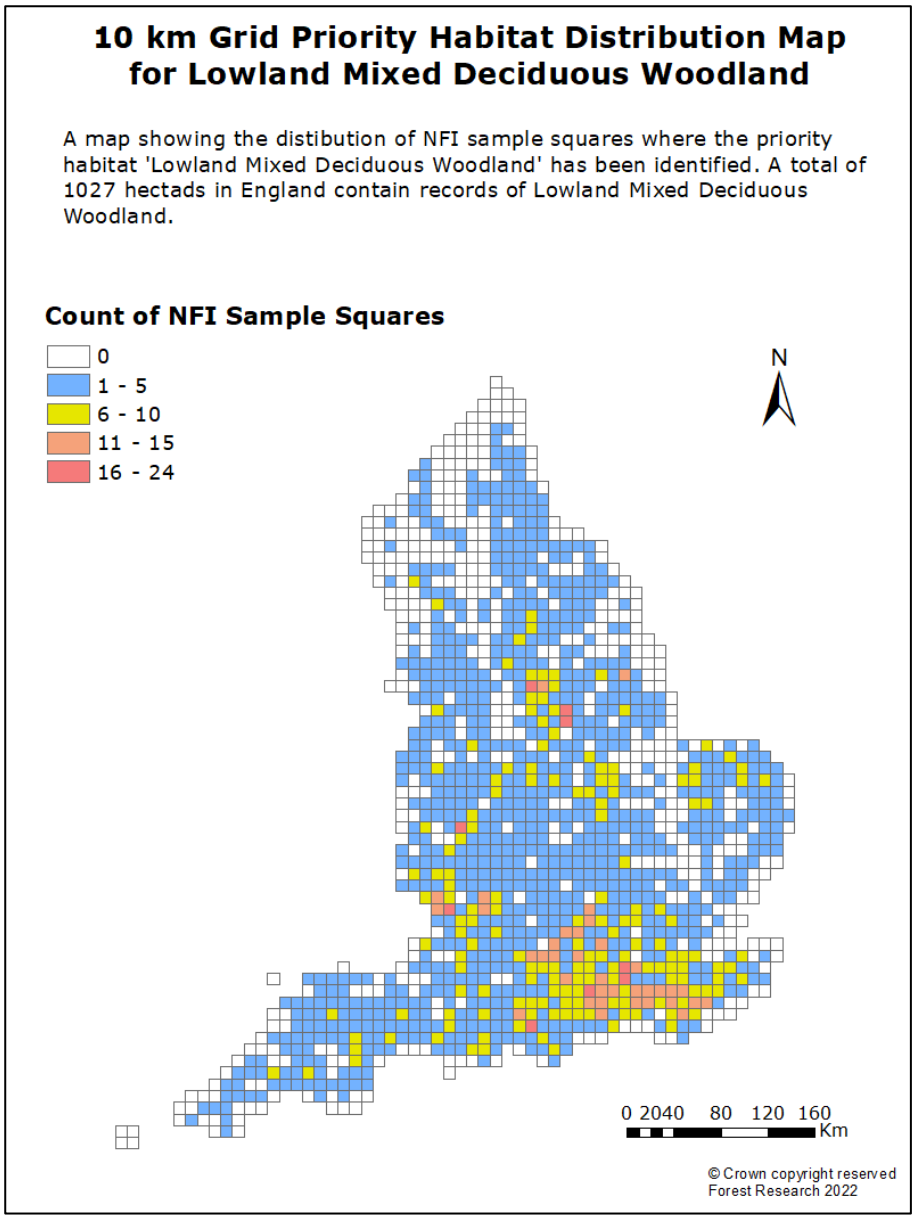


**Figure 1 Distribution of lowland mixed deciduous woodland in England © Crown copyright reserved Forest Research 2022**

**Confidence:** High in terms of overall range outline; moderate for detailed distribution within this boundary.

## Extent

The National Forest Inventory (NFI; Forest Research 2020) estimates there is around 748,000 ha of lowland mixed deciduous woodland in England. The NFI data is based on a combination of earth observation and surveys of approximately 6,200 one-hectare sample squares that partially or entirely contain woodlands (including clear felled areas). Therefore, the figure is likely to be the right order of magnitude, but not precise.

Ancient broadleaved woodland of this type makes up less than a fifth of the extent (146,000 ha).

**Confidence:** Moderate

## Patch size and connectivity

Most broadleaved woods are small, especially ancient woodland in the lowlands, and are in landscapes which have lost woodland and other tree features such as hedges. Data from the NFI indicates the half of all lowland mixed deciduous woodland occurs in patches less than 20 ha in extent and one quarter in patches less than 5 ha in extent. Again, the NFI data is derived from sampling and is not precise.

**Table 2 Proportion of lowland mixed deciduous woodland within different woodland size categories.**

| <5ha | >=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 | >200 |
|---|---|---|---|---|---|---|---|---|---|
| **25%** | 12% | 8% | 5% | 4% | 13% | 13% | 6% | 4% | 11% |

**Confidence:** Moderate to High

## Quality of habitat patches

The majority of woodland SSSIs are in Favourable or Unfavourable Recovering condition, but SSSIs form less than 10% of the resource of lowland mixed deciduous woodland.

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 lowland mixed deciduous woodland suggest that the main issues are:

1. A lack of older trees

Just over a quarter of the sampled lowland mixed deciduous woodland had all three age classes of tree. 56% of woodland had only young and intermediate aged trees.

2. A lack of open space within woodland

For lowland mixed deciduous woodland at least 10 ha in extent, only 16% was found to have favourable levels of open space. For woods under 10 ha this figure was 14%.

3. Habitat fragmentation

75% of lowland mixed deciduous woodland had 20% or less woodland cover within 100 $km^2$ circle of the sampled woodland.

4. Low numbers of veteran trees

99% of sampled lowland mixed deciduous woodland had no veteran trees but note that the sampling method may had led to some under-estimation of the number of veteran trees.

5. Low volume of deadwood

Less than 6% of the sampled lowland mixed deciduous woodland had levels of dead wood present considered favourable.

**Confidence:** Moderate to High

## Threatened species

Ancient woods of this type can hold populations of threatened plants such as the following, listed within the vascular plant red list for England (Stroh and others 2014), starved wood-sedge *Carex depauperata* (Endangered), crested cow-wheat *Melampyrum cristatum* (Endangered), red helleborine *Cephalanthera rubra* (Critically Endangered), ghost orchid *Epipogium aphyllum* (Critically Endangered), spreading bellflower *Campanula patula* (Critically Endangered) and yellow bird's nest *Hypopitys monotropa* (Endangered).

Many mammal species can live in this type of woodland, but lowland mixed deciduous woodland is particularly notable for common dormouse *Muscardinus avellanarius*

(Vulnerable (Mathews & Harrower 2020)), bats, and, on the Isle of Wight (and formerly much more widely), red squirrel *Sciurus vulgaris* (Endangered).

Amongst woodland birds, lesser spotted woodpecker (Endangered), willow tit (Endangered), nightingale (Vulnerable), woodcock (Vulnerable), marsh tit (Near Threatened), spotted flycatcher (Near Threatened) and tawny owl (Near Threatened) are often associated with this type of woodland. Many woods also support species more often associated with scrub or the woodland edge, such as cuckoo (Vulnerable) (Stanbury and others 2021).

Reptiles and amphibians may occur within the lowland mixed deciduous woods, particularly along rides or in and around water bodies.

Woodlands contain a very high number of lower plants (fungi, lichens and bryophytes) and invertebrates when compared to other priority habitats. Wood white and black hairstreak (Endangered), white admiral, white-letter and brown hairstreaks (Vulnerable) are all butterfly species associated with lowland mixed deciduous woodland. Open spaces in the woods, both temporary (as after coppicing) and permanent (Warren & Fuller 1993), have been critical for woodland butterflies such as the pearl-bordered and small pearl-bordered fritillaries (Vulnerable) and heath fritillary (Endangered) (Fox and others 2022).

The importance of this type of habitat for lower plants and fungi, although high, tends to be less than, for example, the western oakwoods that are important for Atlantic bryophytes (Ratcliffe 1968), because of the lower humidity. Threatened bryophytes in lowland deciduous woodland in England include *Atrichum angustatum* (Critically Endangered) on bare ground on rides in ancient woodland in the Weald of Kent and Sussex, *Orthodontium gracile* (Critically Endangered) on shaded sandstone rocks in lowland woods, and *Pallavicinia lyellii* (Endangered) on moist shaded sandstone rocks and stream sides in woodland. Poor air quality and their history of coppicing tends to make this habitat of less significance for epiphytic lichens (Rose 1993).

For many species a variety of different structural states within woodlands is important. The structural states of particular importance are:

- Veteran trees with good, spreading structure and abundant dead wood.
- Sheltered glades and rides where woodland habitats interweave with heathland, grassland and wetlands; and
- Closed canopy woodland where the humidity levels are high (Webb, Drewitt & Measures 2009).

Woodland composition and origin (ancient versus recent) tends to be less critical for vertebrates and some invertebrate groups, than is woodland structure. Though in practice, ancient lowland mixed deciduous woods may still be richer for these groups than recent examples, simply because the recent examples have not yet had the time to develop the same variety of tree sizes, forms and microhabitats such as rot-holes; the soil surface will

tend to be more uniform, lacking the irregularities that might produce wet hollows and dry bare mounds; plant diversity may be less, with fewer potential host species.

**Confidence:** High

## 3.2 Historical variation in the above parameters

Lowland mixed deciduous woodland might be expected to be the natural vegetation cover over much of the lowlands (Peterken 1996). However, there is some debate about the predominance of closed canopy woodland, with the theory that most woodland would have been akin to a wood pasture mosaic (although potentially with significant areas of closed canopy high forest), facilitated by the action of large herbivores on shrub and tree cover (Vera 2000). However, human agricultural activity has reduced the proportion of woodland so that lowland mixed deciduous woodland has not been the dominant vegetation for millennia. Rackham's (2003) estimates for woodland in southern England from the Domesday Book are for about 15% cover.

The broad pattern of distribution of ancient woodland has remained the same at regional and national levels over the last few centuries, but at local levels significant changes have occurred as a result of woodland clearance and conversion to coniferous plantations between the 1930s and 1980s. Examples include the loss of most of Ongar Park Wood in Essex, the replanting with conifers of much of Salcey Forest in Northamptonshire, the bisection of sites around London by the M25.

The loss in area of ancient lowland mixed deciduous woodland has been counterbalanced by an increase in the extent of new broadleaved woodland. However, the conservation value of recent woodland, particularly newly created stands, is so much lower than that of ancient woodland that the net result is substantial loss of conservation value.

The development of new lowland woodland since the Second World War has not been separately analysed in detail but is believed to largely mirror the existing woodland pattern (Forestry Commission 2012) at a national level. However, as with woodland loss and damage, there have been some large local scale changes in woodland cover in areas designated as Community Forests, in the Heart of England Forest area near Evesham and in the National Forest in the East Midlands. In the latter area, woodland cover has increased from about 6% in 1991 to over 20% in 2016. Not all of the new planting has been of native broadleaved trees but much is, and hence will develop into new (albeit currently species-poor) lowland mixed deciduous woodland.

Management significantly affects the structure of the vegetation, and so the balance between different species, yet it may not change the way in which a woodland is classified. Some species are strongly associated with one particular type of woodland stage or structure and may have been favoured by a particular type of management, for example fritillary butterflies by management promoting temporary open ground; nightingales by that promoting dense young growth; specialist lichens by the retention of old trees. Other species can survive under multiple management regimes but with widely varying potential

abundance: bramble, for example is in most woods, but it is scarce under dense shade or where there is high grazing pressure and so will not form the thickets used by small mammals and birds, its flowering will be strongly suppressed so its potential for supplying nectar or fruit will be almost non-existent.

In the nineteenth and early twentieth centuries most ancient lowland mixed deciduous woods were actively managed as coppice and so would have had relatively high proportions of open space and dense young growth (but with correspondingly low levels of mature canopy trees and fallen dead wood). Since the Second World War the extent of coppice has plummeted; most ancient woods and virtually all recent lowland mixed deciduous woods have a high forest structure (through management or neglect).

Management also affects the composition of tree and shrub species, in particular, within a woodland. Historic and recent management has tended to reduce the number of tree and shrub species present, for example the focus on hazel in lowland coppices, oak as the main timber tree. Disease may also affect tree composition: in the second half of the twentieth century Dutch Elm disease caused the loss of elms from woodlands.

## Natural range and distribution

The range of lowland mixed deciduous woodland 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 lowland mixed deciduous woodland within its overall range.

**Confidence:** High

## Extent

Across England about 7% of ancient woodland (of all types) present in the 1930s was cleared completely by the late 1980s and about 38% converted to plantations of non-native species (Spencer & Kirby 1992). The loss and damage were spread fairly evenly across the country and, as it is the most extensive type in England, it is reasonable to apply the same loss figures to the whole lowland mixed deciduous woodland resource.

Much of the broadleaved woodland that developed during the last century, either through natural regeneration, for example, on old commons and downland following the decline of grazing, or more recently through new farm plantings is, or will develop into, lowland mixed deciduous woodland.

**Confidence:** High

## Quality of habitat patches

In ancient woods, coppice and wood-pasture systems once maintained a high degree of small-scale structural diversity within sites. Because of the decline in coppicing, these woodlands have tended to become structurally more uniform. They have tended towards young-mature high forest with a decline in the area of temporary glades, rides and post-

coppice stands. Dead wood has increased but open stage and young growth species have declined (Hopkins & Kirby 2007). Consequently, the distinctive invertebrate faunas of both ends of the woodland rotation have declined (Warren & Key 1991). The change has been driven largely by (a) extensive felling during World War II which reduced age diversity; (b) the poor markets for low-quality broadleaved timber which have discouraged woodland owners from managing their woods (Independent Panel on Forestry 2012).

The spread of deer (Ward 2005) has generally reduced woodland understorey and regeneration, the loss of low scrubby cover in many woods having consequential effects on other species groups (Fuller & Gill 2001). The woodland ground vegetation has been changed from low bramble dominance to grass dominance, for example Kirby (2001), Kirby & Thomas (2000). The overall species richness may not have changed much but the abundance of many species has changed.

New woodland has largely been created by planting which tends to produce structurally uniform stands over the first 50-100 years of their life. Uniform plantations have also replaced more heterogeneous stands in many ancient woods (Spencer & Kirby 1992). Ancient semi-natural stands converted to plantations of non-native species are now being restored but the restored stands still tend to be more uniform than the semi-natural stands they have replaced.

Fallen dead wood has increased in many woods because they are not being actively managed (Kirby and others 1998), but there has often been a loss of veteran trees and their associated standing dead wood habitats through shading by younger growth.

There have been changes in how woodland species populations are likely to be connected across landscapes. As a result of agricultural intensification many matrix features such as hedges, field trees, streams, old meadows have been lost, reducing potential connectivity (Peterken & Allison 1989) and there has been an increase in negative edge effects from fertilizer and spray drift etc. (Gove and others 2007). However, the new broadleaved woodland that has been created should eventually increase the area of habitat available and increase connectivity between patches (Quine & Watts 2009).

Recent woodland of some 100-200 years old and close to ancient sites may contain many ‘ancient woodland’ plant species’ (Peterken & Game 1984), but younger stands remote from ancient sites usually contain few such species.

**Confidence:** High

## Threatened species

The major changes to the structure of many lowland mixed deciduous woods since the Second World War has been linked to declines in ground flora richness (Kirby and others 2005), specialist woodland butterflies (Hopkins & Kirby 2007) and in specialist woodland birds. The abandonment of grazing in wood pastures has often led to the veteran trees becoming overtopped by young growth, which also shades out the lichens on the lower trunks.

The loss and decline in some species associated with lowland mixed deciduous woodland is often linked to adverse change in the ancient woodland subset of lowland mixed deciduous woodland rather than to change in the overall resource.

**Other sources:** Hewson and others 2007; The National Forest Website

**Confidence:** High

## 3.3 Future maintenance of biological diversity and variation of the species

The current increase in the extent of lowland mixed deciduous woodland seems likely to continue. However, the impacts of new or emerging tree pests and diseases, climate change, air pollution and changes in management are likely to lead to a continuing decline in the quality of lowland mixed deciduous woodland.

After the introduction of the Broadleaves Policy in 1985 (Forestry Commission 1985; 2005) agricultural clearance and conversion to conifers largely stopped and some of the woodlands damaged by under-planting with conifers have been restored, for example Kirby and others (2017). Some lowland mixed deciduous woodland continues to be under threat from development. There will be pressure to re-establish previously open habitats or wood pasture where lowland mixed deciduous woodland is establishing through natural regeneration where grazing has declined.

Various new or emerging tree pests and diseases have been identified affecting important native tree species. Large-scale canopy loss, for example through ash dieback (Mitchell and others 2014, 2016) or acute oak decline (Denman and others 2010), must be considered a significant potential future impact. Increased drought stress from climate change is likely to exacerbate their impact because these dieback diseases often act through blocking water movement/killing vascular tissue in the trees (Denman and others 2014; Mitchell and others 2014,2016).

Non-native grey squirrels already damage and kill young broadleaved trees, altering the structure and composition of woods and threatening the economics of woodland management, for example Mountford (1997). Deer have become more widespread and numerous in lowland England over the last fifty years, changing the structure and functioning and ground flora composition of lowland mixed deciduous woodland, reducing the regeneration of woody species and making management more difficult, if not impossible without expensive fencing and intensive culling (Fuller & Gill 2001; Ward 2005). High deer numbers pose a threat that is interrelated with the threat of disease: disease-resistant saplings are likely to be browsed off.

At the national scale lowland mixed deciduous woodland has been assessed as having low sensitivity with respect to future climate change: woods that are currently of this type are likely to remain so, not least because most of the woody species are present further south and east on the Continent (Natural England & RSPB 2019). The current range and

distribution should allow most associated species potentially to survive at a national level for the next few decades – but changes in the abundance and distribution of individual species and to the composition of individual woods is likely in response to an increase in the frequency and severity of summer drought. There is a high likelihood that there will be impacts on drought-sensitive tree species such as beech, particularly on some soil types (for example shallow, free-draining soils and clay soils), particularly in southern and eastern England.

Acute eutrophication of lowland mixed deciduous woodland can occur close to major pollution sources such as intensively managed livestock units, leading to major changes in the vegetation (Gove and others 2007; Pitcairn and others 2002). Rowe and others (2021) found that all areas of managed broadleaved woodland and unmanaged woodland (which will include lowland mixed deciduous woodland) exceeded nutrient nitrogen critical loads in the period 2016-2018. The area exceeding nutrient nitrogen critical loads had not declined since the period 1995-1997. Nitrogen deposition may already be causing the homogenisation of the flora (Keith and others 2009), there is potential for rapid further change if conditions reach a tipping point (Verheyen and others 2012).

The continued reduction in management may lead to further loss of open space, increased threats to veteran trees through shading by younger growth, increased uniformity of age structure but also an increase in the amount of dead wood.

## Natural range and distribution

Favourable conservation status will require the maintenance of the current distribution of 1,027 hectads.

**Confidence:** Moderate for overall mixed woodland survival; low for any particular species in particular regions in the long term.

## Extent

There is no simple answer to the question of how much woodland is required in order for lowland mixed deciduous woodland and its associated species to thrive, not least because the answer depends on what levels of abundance of different species groups are considered necessary and what level and type of management operates across the resource, including areas left for minimum intervention. Various groups of species, particularly specialists, associated with lowland mixed deciduous woodland have been declining over the last 40-60 years at a time when the area of the woodland habitat has been increasing. Habitat extent overall is therefore less critical for many species than habitat quality.

An increase in the extent of lowland mixed deciduous woodland of the order of 10-20% has been proposed as part of the UK Biodiversity Action Plan and is an ‘order of magnitude’ figure based on a series of assumptions about where and how new woodland could effectively improve the quality of the existing stands of ancient woodland and the ability of woodland species to survive and spread in future landscapes.

The key is to use the new woodland to improve the sustainability of species populations in the ancient woodland (since any new woodland will itself make only a limited contribution to the occurrence of specialist species in the next few decades) through expansion of small blocks and buffering of medium sized woods. Also, to improve connectivity in the landscape through 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.

Expansion might be sought as follows:

- Securing the ancient element of the lowland mixed deciduous woodland resource:
    - Converting 50,000 ha of conifer-dominated Plantations on Ancient Woodland Sites (PAWS) back to native trees appropriate to lowland mixed deciduous woodland. This assumes lowland mixed deciduous woodland potential sites are about half the PAWS resource or approximately 70,000 ha, but some of this already has a strong broadleaf component and work in this would count as improvement of resource rather than new habitat creation. The potential PAWS area has been reduced accordingly.
    - About 4,600 ancient woods of lowland mixed deciduous woodland type are in the 1-5 ha size category (half the number in total); doubling their size would reduce risk of future loss and allow for an increase in the populations present. If we assume a mean size of additional woodland of 2.5 ha, then the total area of new creation needed is 11,500 ha.
    - About 4,300 ancient woods of lowland mixed deciduous woodland type are between 6 and 20 ha; putting a 20 m buffer round these would help reduce impacts of spray drift, drying out etc as well as adding to habitat area and heterogeneity. Based on a circular 10 ha wood, this would require about 9,500 ha.
- Improving the matrix and creating new woodland blocks
    - Allocate 10,000 ha (about 250 ha per county) to small woodland plantings to provide connections and stepping-stones in woodland landscapes.
    - Allocate 10,000 ha to create five large (50 ha) new blocks per county (amalgamating small counties there are about 40 in England).

The combined expansion (50,000 ha from conversion of conifer stands on existing wooded sites and 41,000 of new woodland creation) amounts to 91,000 ha, or about 12% of the current area of lowland mixed deciduous woodland.

**Confidence:** Moderate to Low

## Patch size and connectivity

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.

Various ‘minimum sizes’ have been suggested for different species that vary with the species under consideration and depend on the quality of the woodland, its management and the nature of the surrounding landscape. For example:

- Pearl-bordered fritillaries tend to breed in recently felled areas where violets are surrounded by bare soil. In a wood managed on a 20-year coppice cycle, 25% of the area might be expected to be in stands 5 years old or less and so possibly suitable for the species; new cut areas are almost certainly going to be close to an existing suitable stand. The same area of woodland managed as high forest, would, on a 100-yr rotation, have only 5% of its area with stands of 5 years old or less; new cut areas can be located close to existing suitable stands but the overall population of fritillaries will be lower. In a wood left to minimum intervention with trees growing to about 200 years old, only 2.5% of the wood on average will be as suitable stands, but this will fluctuate over time and may drop to zero at some points; new gaps, for example from windthrow, may be distant from existing suitable stands. The risk of fritillary populations going extinct increases markedly under such management.

- Saproxylic beetle abundance depends on the availability of deadwood, itself associated with number and density of mature and veteran trees. Where such trees are absent, so too will the beetles, irrespective of the size of the wood. At the same time most sites do not actually contain the full range of successor generations of trees for the population to be sustainable on that site in perpetuity, even though they may survive for the next century or so. The minimum size ought to include these younger age classes, even though they will be unsuitable as habitat for the beetles for most of their lives (Kirby 2015). For some species the veteran trees need to be in a relatively open conditions: ‘connecting up’ the patches of old trees with the necessary cohorts of younger trees could paradoxically make the veteran tree patches more isolated.

It is unlikely that a “one size fits all” woodland patch size will work, because of the sheer number and variety of different species for which woodland provides habitat. However, it is probably a reasonable rule of thumb that individual woods less than about 5 ha will be able to support a limited range of species and these will be more vulnerable to accidental loss; but there are plenty of examples of species that have survived for decades in small woods.

From about 5 to 30 ha many species, but not specialists that depend on rare microhabitats or have large territories (some mammals and birds), are likely to be able to survive, given favourable management most of the time.

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 going 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.

**Confidence:** Moderate

## Quality of habitat patches

In general, a diversity of structures at the landscape level and encouragement of 'lighter touch' management is likely to be required to address the problems with current landscapes.

In general, we should be looking for most lowland mixed deciduous woodland to achieve the following attributes in order to be considered in a favourable situation:

**Structure**

A diverse woodland structure, including the following:

- Trees and shrubs of different ages.
- Several vegetation layers.
- Less than 10-25% young growth (dense thicket stands).
- Some old/dead trees present
- Some large branches and trunks on forest floor left as deadwood
- Permanent and temporary open space present.

**Regeneration potential**

- Sufficient natural regeneration to restock canopy, for example, young trees and saplings in gaps.
- Planting used only where regeneration is clearly not likely to be successful.

- No obvious signs of significant grazing/browsing

**Tree and shrub composition**

- Greater than 95% native trees and shrubs reflecting the local natural environmental conditions

**Vegetation**

- Semi-natural woodland ground flora reflecting the local natural environmental conditions widespread
- Cultural boundaries and features retained.
- Micro-habitats such as wetland rock outcrops, etc retained.

**Invasive non-native species, pests and disease**

- No, or low levels, of invasive non-native species.
- Low levels of pests and diseases.
- No signs of rapid dieback for example through disease (greater than 10% cover in a five-year period) of tree and shrub layer.

**Connectivity**

- Area with semi-natural surroundings as opposed to being surrounded by intensive farmland.
- Fragmentation reduced.
- Part of a habitat network.

**Habitat transitions and mosaics**

- Presence of natural transitions to, and mosaics with, other habitats reflecting natural variations in abiotic conditions and an appropriate level of grazing, browsing etc.

**Soil characteristics**

- Natural soil characteristics.

**Air quality**

- Concentrations and deposition of air pollutants at or below the site-relevant Critical Load or Level values.

**Hydrological function**

- Natural hydrological function, water chemistry and water nutrient status.

**Management**

- Woodland structure and composition maintained by natural processes or management.

**Sources:** Natural England (2009)

**Confidence:** Moderate

## 3.4 Constraints to expansion or restoration

The expansion of lowland mixed deciduous woodland has generally been through new woodland creation, but restoration of former ancient woodland sites now dominated by planted conifers can do much to help expand the area and quality of this habitat.

Techniques for restoring plantations on ancient woodland sites to broadleaved woodland are being extensively trialled by the Woodland Trust and Forestry Commission. The results are generally positive, for example, Brown and others (2015), Kirby and others (2017).

Woodland creation – in terms of getting trees established – is also straightforward. However, recent lowland mixed deciduous woodland is likely to remain relatively species poor for at least the next 50-200 years. Care in the siting of new woodland and in its subsequent management can help minimise the period over which its conservation value is limited. For example, new lowland mixed woodland can acquire a more interesting flora (the fauna is little studied) where it is adjacent to ancient woods or hedges, for example the Hayley Wood triangle (Rackham 2003), through deliberate enhancement of its ground flora by planting as at Milton Keynes (Francis & Morton 2001), or through soil translocation as at New Biggin Wood (Buckley and others 2017). Similarly, we are at an early stage of understanding of how to speed up the colonisation of trees approaching maturity by species that are otherwise associated with veteran trees (Lonsdale 2013).

From a woodland conservation perspective new lowland mixed deciduous woodland would best be created on sites with low productivity soils. However, these sites may be occupied by semi-natural open habitats (usually grassland or heathland) (Rodwell & Patterson 1994). Such sites will however normally be ruled out because these habitats are themselves rare and valued. Woodland created on improved farmland, with nutrient-enriched soils, will take longer to develop its full potential. Even so it will be richer in wildlife than the farmland it replaces and may also lead to significant landscape changes, for example, as is happening north-east of Evesham with the creation of the Heart of England Forest in an area traditionally regarded as rather unwooded.

There is evidence and experience that restoration of structure and functions within lowland mixed deciduous woodland can be achieved through increased management of (non-

SSSI) ancient woodland taking account of the recommendations in the Forestry Commission's guidance (Forestry Commission 2010). Plus, the restoration of past management techniques which help achieve specific aims, for example coppice restoration at the Blean for heath fritillary, or for various key butterflies at Gaitbarrows; grazing and pollard restoration in Epping Forest and Burnham Beeches. However, there would also be declines in the species that have increased as a consequence of the shift towards high forest.

Dealing with other forms of site degradation (rhododendron control, excessive (or too little) grazing) are similarly reasonably well understood (Armstrong and others 2014; Edwards 2006).

**Other sources:** Blakesley & Buckley (2010); Quine & Watts (2009).

**Confidence:** Moderate

# 4. Conclusions

## 4.1 Favourable range and distribution

The favourable and current range and distribution are the same – 1,027 hectads.

## 4.2 Favourable extent

Create an additional 91,000 ha of lowland mixed deciduous woodland to give a favourable area of 839,000 ha.

## 4.3 Favourable structure and function attributes

### 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

All species partially or wholly dependent on this habitat should be Least Concern, when assessed using IUCN criteria (or considered to be Least Concern if not formally assessed), as regards to this habitat.

### Monitoring

National/network level monitoring to assess the above might include:

- Collation and integration of individual site assessments on SSSIs and from Forestry Commission grant form feedback.
- National overviews based on data from the National Forest Inventory sample squares which are to be regularly re-assessed.
- Connectivity and size parcel data from remotely sensed data (in future, Lidar might also be used for structural assessments).
- Species trends via the National Biodiversity Network.

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