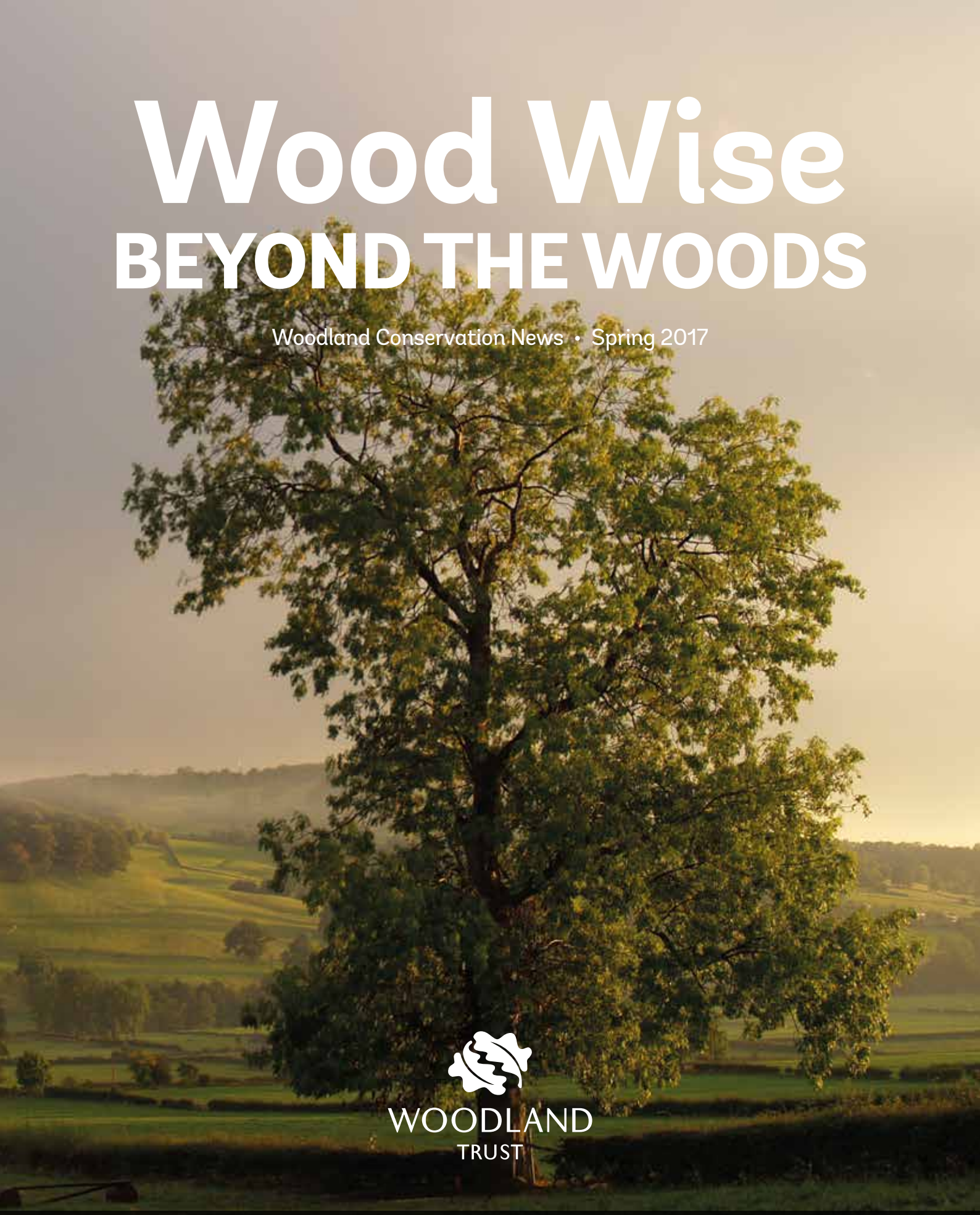
Wood Wise
BEYOND THE WOODS

Woodland Conservation News • Spring 2017



WOODLAND TRUST

HOW PEOPLE HAVE SHAPED OUR TREESCAPES

WILDLIFE BENEFITS FROM TREES OUTSIDE WOODS

DISEASE THREATENS SCATTERED TREES

THE LANDSCAPES WE WANT TO SEE

CONTENTS

Editors: Kay Haw and Karen Hornigold

Contributors: Job Aben, Nick Atkinson, Ruth Feber, Roslyn Henry, Marc Metzger, Steve Palmer, Duncan Ray, Louise Sing, Jon Stokes, Nick Synes, Justin Travis, Kevin Watts, and Tom Williamson.

Designer: Emma Jolly (Woodland Trust)
Cover photo: iStock

To subscribe to Wood Wise online please email **conservation@woodlandtrust.org.uk**

Why it's vital to stand up for trees outside woods

Woodlands are widely regarded as providers of multiple ecosystem services. But trees outside woods are also incredibly important in today's human dominated and fragmented landscapes.

The UK has a long history of trees outside woods. We're all familiar with the hedgerows that stitch together the patchwork of fields in our countryside, the avenues of trees embellishing our roads and the magnificent trees adorning our parks. But have you ever considered their importance for people, wildlife and the environment?

Many individual trees have unique cultural and heritage value, while others are retained for practical reasons such as enclosing livestock or reducing flood risk. In urban areas trees can cool the air, reduce pollution and improve people's mental wellbeing.

Trees outside woods are also extremely important for wildlife. Over the past decade in particular there has been huge research focus on the role that trees outside woods play in the ecological functioning and connectivity of landscapes. For effective wildlife conservation, however, we still require a greater understanding of which trees are needed where, and in what configuration.

Concern for trees and hedgerows

There is mounting concern about individual trees in the landscape. For example, ash dieback is likely to have greater impact on the landscape through loss of individual trees in fields and hedgerows, than from the loss of ash in mixed woodlands, where it will be replaced by recruits from other tree species. Trees outside woods that are lost to disease must be replaced with a diversity of species to ensure resilience in the landscape.

Add to this the attrition of trees outside woods from development and clearance for agriculture – since most individual trees do not have the same level of protection as woodland – and the future is very uncertain for what are often keystone structures in ecosystems.

Poor management is also a cause for concern, particularly with relation to hedgerows, which are a valuable wildlife resource. For hedgerows to have 'favourable condition', gaps must be kept to 10% or less of the total length (or per 30m section); they must be trimmed regularly to prevent conversion to scrub and trees; and non-native species must be controlled. Historical declines in hedgerows mean that proper management, restoration and creation of new hedgerows is vitally important.

A balancing act

The recent focus on trees outside woods by researchers and non-governmental organisations, such as the Tree Council and the Woodland Trust, is establishing a strong evidence base for why we need trees outside woods. This is invaluable for informing policy and persuading landowners to retain and increase the number of trees on their land. But we need to increase our knowledge further to be able to balance the interests of landowners, society and the environment.

The following articles provide a history of trees outside woods in the UK, introduce the amazing variety in types and configurations of trees and their ecological value, and discuss the impacts from pests and diseases such as ash dieback. Some current research projects are presented that are trying to answer questions such as, 'where is it best to plant trees outside woods for ecological functioning', and, 'what is the public's preference for tree and woodland cover in the landscape?'

iStock

Trees in the countryside: historical perspectives

Tom Williamson

We often think of the trees growing in our fields and hedges as part of a natural, timeless landscape, but most were deliberately planted for practical, economic reasons, and changes in their numbers and management over the past few centuries have been profound.

In most parts of Britain, there were far more farmland trees in the past than there are today. Before the 19th century, old-enclosed districts in counties like Hertfordshire, Norfolk or Essex commonly boasted 20 trees per hectare, often more than 30, and sometimes even greater densities. The majority (usually between 70 and 90%) were managed as pollards, cropped to produce a regular supply of 'poles' every 10 or 12 years (Figure 1).

Such high densities of trees, and the remarkably dense mesh of hedges in which they grew (for field sizes were generally small), had adverse effects on the crops growing in the adjacent fields. Back in 1742, a Suffolk land agent bemoaned the fact that a farm at Thorndon, where there were over 72 trees per hectare, was, "very much encumbered" with pollards, and noted that, "if a good deal more were cut down, it would be much better for the land."

Trees as a fuel source

Vast numbers of pollards were tolerated because of the pressing need for firewood at a time before improvements in transport made coal the main domestic fuel. Indeed, hedges were themselves managed as a fuel source; Arthur Young in 1804 memorably described them as 'the collieries of a country'.

Of course, not all districts boasted such vast numbers of farmland trees. In many northern areas there were far fewer, largely because alternative sources of fuel were available in the form of moorland peat or coal. And across large swathes of the Midlands most of the farmland lay in 'open fields', comprising the intermingled strips of farmers, and much of the landscape lay open, without hedges.

Even here, however, trees were more numerous than we often assume. They were tightly packed in the closes and yards in the villages (one 14th-century farmer at Ravensthorpe in Northamptonshire built a new house entirely from the timber growing on his village toft). Trees were also scattered across the surrounding landscape on patches of waste, on roadsides, and in particular on the meadows occupying river floodplains, where vast numbers of willows could be found.

In all districts, farmland trees managed as timber were felled young, almost always before they were 70 years old, usually before they were 40, and often younger still. At a time when sawing was an arduous business, trees were felled at a size suitable for the purpose at hand, rather than allowed to grow to maturity. Much of the value of oak timber, moreover, came from the bark, used in tanning, and this was more valuable, and more easily peeled, from young trees. The countryside before the 19th century was thus filled with young timber, or with pollards that were constantly rejuvenated by cropping: there were few truly senescent (old) trees.

Not surprisingly, as England industrialised and canals then railways allowed coal to become the main domestic and industrial fuel throughout the country, the numbers of farmland trees fell rapidly, more than halving in the course of the 19th century. Their numbers then more than halved again, firstly as the economic management of farmland timber declined, and secondly as trees and hedges were swept away in the period of post-war agricultural 'modernisation'. Dutch elm disease later removed vast numbers of elms.

Species composition

Oak, ash and elm generally accounted for between 80 and 100% of farmland trees before the 20th century, although their rank order displayed marked variations from region to region. Oak, for example, was usually the most common tree in Norfolk, but the second or third most numerous recorded in Northamptonshire. The species composition of farmland trees was thus usually different from that of the timber growing in coppiced woods, which largely consisted of oak. It was also often different from that of the trees growing on commons or in deer parks where (in southern and eastern England at least) beech and hornbeam, both rare as farmland trees, were often prominent.

Of particular interest is the composition of 'minority' trees (other than oak, ash and elm) found in fields and hedges, for these again displayed marked regional variations. On

the flanks of the Chiltern Hills in west Hertfordshire and Buckinghamshire, for example, early surveys suggest that apple, cherry and aspen were common, and in rare cases actually exceeded the numbers of the more 'normal' hedgerow trees (Figure 2). In contrast, on the boulder clays in the east of the county and extending into Essex, maple and hornbeam, sometimes accompanied by black poplar and small-leaved lime, were important.

The dominance of oak, ash and elm in the pre-industrial landscape was largely, if not entirely, due to the fact that other species were choosier in their requirements, had fewer uses, could offer little that these could not provide, or were (like maple) thought to be better managed as coppice in woods or hedges. Today, we have lost elm as a tree, leaving in many areas a landscape dominated by oak and ash, a vulnerable landscape, given that ash is in decline due to dieback (Chalara), and that oak faces challenges of an uncertain scale.

Figure 1. An extract from a map of Beeston in central Norfolk, surveyed 1761, showing the kind of density of farmland trees common in enclosed districts of lowland England in the 17th and 18th centuries. The features resembling palm trees are pollards; the other symbols represent oak, ash and elm timber.

Planting for the future

The countryside is in urgent need of replanting, and with a more diverse range of trees. Some argue that we should now plant species from southern Europe, in anticipation of the effects of global warming. But many of our indigenous trees are anyway found growing far south into Europe, and diversification might be better achieved by focusing on those 'minority' trees which were, and to some extent still are, characteristic of particular districts and regions. These are the 'tried and the true',

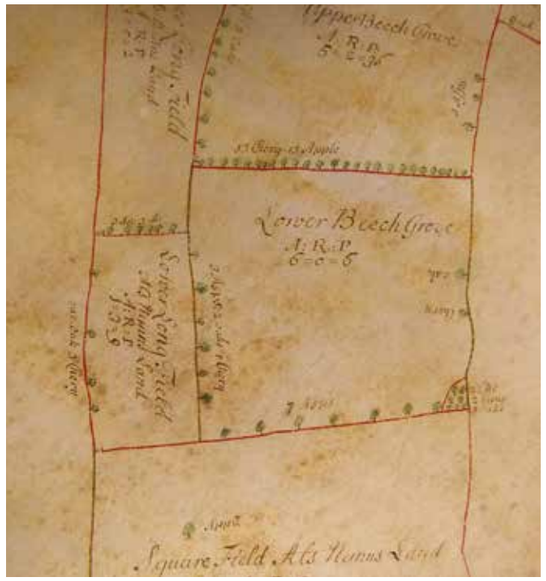


Figure 2. Extract from an undated survey of c.1700 of a farm in Flaunden, west Hertfordshire. Fruit trees and aspen were common in the hedges of the district, but on this farm they actually exceeded the numbers of oak, ash and elm.

and increasing their representation would help sustain a sense of place and a regional distinctiveness more effectively than the indiscriminate planting of an undifferentiated 'diversity mix'.

Professor Tom Williamson heads up the Landscape Group within the University of East Anglia's School of History.

Over the next 10 years the Woodland Trust is aiming to plant 64 million trees and we can't do it without you. Whatever you want to plant, whether it's a whole wood or just one tree in your garden, we can help.

www.woodlandtrust.org.uk/plant

WTML

Joined up thinking

Ruth Feber

Viewed from the air, lowland farmland is often likened to a patchwork quilt, with arable or grass fields joined together by a network of hedgerows, and interspersed with scattered trees and small copses.

The patches of the quilt – the productive fields - are not very hospitable to wildlife. Arable land is characterised by disturbances such as cultivation, pesticide application and harvest, while grass fields are often intensively grazed or mown for silage. In these environments, trees outside woods can offer a much-needed continuity of resources for wildlife, such as food, shelter and places to breed. Put simply, they play a vital role in helping farmland species to survive.

Benefits of trees outside woods for wildlife

Trees outside woods, and the species they support, deliver a range of key ecosystem services on farmland, such as soil protection, carbon sequestration, and pollination services, as well as having aesthetic and cultural importance. For farmland biodiversity, hedgerows are the most ubiquitous and, arguably, the most important of the trees outside woods, essential for many plants and animals. In excess of 600 plant, 1,500 insect, 65 bird and 20 mammal species have been recorded at some time living or feeding in hedgerows.

Many different aspects of hedgerows are important for wildlife. Species-rich hedges provide a variety of foods at different times of year, with flowers supplying nectar and pollen for insects in spring and summer, and fruits and berries sustaining birds and mammals over winter. Hedges and hedge base vegetation provide nesting sites, cover from predators and refuge from farming operations such as ploughing and harvest. Bats use hedgerows for foraging, and as corridors to commute between feeding and roosting areas.

The value of hedgerows for wildlife varies depending on their structure and arrangement; for example, taller hedgerows are better for bats, and less gappy hedgerows have been shown to support more small mammals.

Other trees outside woods that are important for farmland biodiversity include hedgerow trees and in-field trees. Hedgerow trees are solitary trees emergent from hedgerows. Once abundant in the landscape, where they

Hedges and scattered trees amongst a patchwork of fields

Small tortoiseshell on goat willow.

Buff arches *Habrosyne pyritoides.*

Large emerald *Geometra papilionaria* on a light trap.

served as sources of timber, their numbers have fallen, largely due to mechanical hedge trimming and field enlargements. In-field trees, such as solitary mature oaks or old pollards, can also be found within arable or grassland areas. Often, these may be remnants from former hedgerows, long since destroyed.
Both hedgerow trees and in-field trees are of great importance for wildlife, supporting diverse lichen, fungal and invertebrate communities, and providing nesting sites and song posts for birds. They also offer food and shelter for a range of species that depend on them for all or part of their lifecycles.

Trees outside woodland can also take the form of scrub. This vegetation stage, intermediate between open ground and woodland, comprises scattered shrubs, young trees, or thickets. Common scrub species on farmland include hawthorn, blackthorn, willow and bramble. Scrub of varied age, species and structure can support great wildlife diversity, and may also help to buffer woodland, hedgerows and ditches from farm operations.

Over the last half century there have been great changes in habitats for farmland wildlife due to agricultural intensification. Many uncropped or semi-natural areas have been lost, and the land in between habitat patches is generally more hostile to wildlife than it used to be, with fewer (or poorer quality) habitats such as ditches, hedgerows and field margins. This habitat fragmentation has reduced the availability of resources for wildlife, led to isolation and vulnerability of populations, and contributed to the severe declines of many farmland species. One of the most important potential contributions of trees outside woods is to increase habitat connectivity, reducing the effects of habitat fragmentation.

Hedgerow trees, moths and the landscape

Research on the impact of hedgerow trees on moths provides compelling evidence of the important ecological role of trees outside woods in the farmed landscape. Moths are a diverse and species-rich group – sensitive indicators of the health of the ecosystems they occupy – and are major prey for many bats and birds. Hedgerow trees (solitary emergent trees within hedgerows) have declined in the landscape, yet their benefits to wildlife had hitherto been little-studied. In a landscape-scale study in the Upper Thames region, a team of researchers at Oxford University's Wildlife Conservation Research Unit investigated, first, whether the presence of hedgerow trees affected the abundance and diversity of moths and, second, whether the impacts on moths of hedgerow trees differed depending on the type of landscape in which the trees were located .

Using light-trapping (where moths are captured at night, then identified and released unharmed), the team surveyed 48 farmland sites with or without hedgerow trees, over four years. Of these sites, half were located in 'joined-up' landscapes, where farmers had been targeted to join agri-environment schemes, leading to the creation and better management of habitats such as hedgerows. The remaining sites were located in ordinary landscapes with no such targeting of farmers to join schemes.

During the project, the researchers captured over 70,000 moths from 311 moth species, many stunningly beautiful. There were also some unexpectedly rare finds. When the data were analysed, the results revealed that, where hedgerow trees were present, there was a strong increase in both moth abundance and the numbers of moth species. These findings demonstrated clearly the importance of hedgerow trees in the conservation of wider-countryside moths.

But why did the presence of hedgerow trees increase moth numbers? The researchers discovered that, as well as increasing the numbers of moths dependent on trees for egg-laying sites and larval food, many moths whose larvae were grass or herb feeders were also recorded in greater numbers at sites where hedgerow trees were present. From mark-recapture studies (where individual moths are harmlessly marked to enable their movements to be followed), the team also found that the trees were particularly important for less mobile species.

The results suggested that hedgerow trees were not merely providing food, they were also providing important shelter and roosting places for moths in exposed agricultural landscapes. The team concluded that hedgerow trees may act as 'stepping stones', helping moths, especially less mobile ones, to cross open, often inhospitable, farm landscapes.

Hedgerow re-establishment.

While hedgerow trees were found to benefit moths, further analysis of the data revealed that the best results were obtained in landscapes where farmers had been targeted to join agri-environment schemes. Here, moth abundance was 60% greater where a hedgerow tree was present, compared to a 20% increase in the ordinary landscapes.

The researchers attributed this striking result to the better connectivity of habitats such as hedgerows and field margins in the targeted landscapes due to the higher proportion of land covered by agri-environment scheme agreements. When hedgerow trees were embedded in these more connected landscapes they became even more effective in delivering benefits for biodiversity. So both the presence of hedgerow trees and their landscape context are important for conservation.

Restoring trees to farmland

A range of studies within and outside the UK has shown that trees outside woods make vital contributions to the ecological functioning of farm landscapes. The picture that emerges, though, is complex. For example, the importance of trees to a species can depend on the ecological attributes of the species, such as its mobility. Species require connectivity at different scales: the more mobile bats and birds may need habitat patches to be connected at much larger landscape scales, while ground-dwelling beetles may be more sensitive to hedgerow connections across two or three fields.

The contribution of trees outside woods to landscape functioning also depends on their quality and the quality of the wider landscape. For example, the species or age of a single tree, size of a copse, or gappiness of a hedgerow, and how degraded the landscape is in which the trees are situated, will all have an influence.

Overall, there is a wealth of evidence that, to help foster farmland wildlife, habitat diversity needs to be strengthened and increased at a landscape scale. With ever-increasing pressures on land, such measures are needed to protect wildlife populations and increase their resilience, especially in the face of a changing climate. Through agri-environment schemes or other means, the restoration, management and conservation of trees outside woods, from scattered trees and hedgerow trees to copses, patches of scrub and connecting hedgerows, will play a crucial role in helping to achieve this.

Dr Ruth Feber is a Zoology Research Fellow with the Wildlife Conservation Research Unit at the University of Oxford.

Pests and diseases

Jon Stokes

Britain's non-woodland trees face a series of serious threats, both new and old.

The arrival of ash dieback has increased the risks to the UK's non-woodland treescape in a way not seen since Dutch elm disease in the 1960s and 70s.

For over 40 years the Tree Council has campaigned for non-woodland trees, and particularly hedge trees, with the help of its 8,000 tree wardens and more than 180 member organisations. New threats throw a spotlight on the importance of these trees, and the need for a concerted national effort if we are to continue to benefit from them.

Our rich and varied heritage

The UK's non-woodland tree landscapes cover a spectrum that includes managed hedges of shrubby species with a few larger hedge trees; tree lines developed from overgrown hedges; parkland and garden trees; orchards; urban and roadside trees; and even formal avenues.

Many of these features are such a familiar sight in the landscape of England and Wales that one might think they are present everywhere, but elsewhere in Europe hedges are by no means universal and hedged landscapes are widely found only in parts of France, north Italy, the Austrian Alps, Greece, the Republic of Ireland, north Spain and Romania. The UK has an international responsibility to protect its non-woodland trees and the habitats they create.

Throughout history, land managers have used non-woodland trees to supplement much-needed wood supplies, provide winter fodder for stock and produce food from the boundaries of their land. These multi-purpose trees were considered of great importance, and farmers managed them with as much care and thought as the rest of their land.

Then and now, these trees and hedges provide shade and shelter for livestock; act as boundary markers; create living fences to contain stock; protect crops and stock from wind; provide wildlife habitat and link other habitats; provide visual screening; act as a visual feature to enhance a roadside or house; and help to control soil erosion from wind or leaching due to rain.

Non-woodland trees today

The current status of non-woodland trees is hard to pin down. Figures are few and not necessarily comparable. One survey undertaken by the National Trust revealed 500 formal avenues on its holdings around the UK, but details

Derek McGinn

Ash tree


Ana Perez Sierra

Leaf dieback, most easily seen throughout summer.

do not exist for the numbers of formal avenues in private holdings.

The Countryside Survey 2000 (CS 2000) showed in 1998 there were an estimated 1.8 million individual trees or trees in tree lines in Great Britain, 98 % of which were found in England and Wales. This figure is about 3% lower than in the previous survey of 1990, but is within the margins of sampling error, and therefore may not be significant. However, in the eastern lowlands of England an 8% decline was significant and appeared to be at the expense of elms.

Overall, ash at 26% was the most common tree, with oak and field maple, *Acer campestre*, next at 15% each. In the CS2000 survey, the majority of the trees recorded were over 20 years old, most falling into the '20 to 100 year' age category. The number of trees in the one to four-year-old category had also declined significantly by about 40 % since 1990.

Available data therefore suggest non-woodland tree populations are declining. This can be attributed to specific causes such as Dutch elm disease (which killed 30 million largely non-woodland trees across Britain), changes in management techniques and agricultural needs.

The rise of pests and diseases

The invasive fungus that causes ash dieback, *Hymenoscyphus fraxineus*, arrived in Europe from Asia in the 1990s. It poses a deadly threat to common ash, *Fraxinus excelsior*, and other Fraxinus species. Ash dieback was first recognised in the UK in 2012 and by January 2017 had been identified in 40% of all the 10 kilometre squares throughout the UK. As part of our ongoing work on ash dieback, The Tree Council estimates there are 30-60 million non-woodland ash throughout the UK with a stem diameter at breast height greater than 4cm, plus over 400 million seedlings and saplings.

The potential loss of so many trees in a wide range of habitats would lead to landscape changes at both the macro and micro level. From individual gardens and streetscapes, to the loss of swathes of hedgerow trees or small copses, the impact of the disease will be visible. Non-woodland ash, hedgerow trees and parkland are defining features of the landscape in 40% of the 159 National Character Area descriptions of England.

Research suggests large trees are important in hedges for their structural presence, microclimate, shelter and shade. Particular species also provide a specific food source. As ash is the commonest hedgerow tree, many of which are mature, wide scale loss of ash would severely impact the ecological value of UK landscape.

Along with ash dieback, there are many other threats to Britain's non-woodland trees. Dutch elm disease still threatens elm trees that become large enough for the *Scolytus* elm bark beetles to colonise the tree and carry the fungus to a new host. Newer threats, such as Asian longhorn beetle (a serious tree pest which when found in Kent recently resulted in the removal of 2,166 trees to stop its spread) and sweet chestnut blight (a fungal disease recently discovered in Kent and Devon, which can kill sweet chestnut) need control measures and vigilance to ensure that they don't spread.

However, there is a long list of pests and diseases that are currently not found in the UK, which we need to ensure do not reach our shores, such as the bacteria *Xylella fastidiosa*, which damages and kills a wide range or trees and shrubs. (For details on all tree pests - see the UK's Plant Health Risk Register, https://secure.fera.defra.gov.uk/phiw/riskRegister).

Concerted effort by all those interested in trees is required to ensure new pests and diseases do not devastate our non-woodland tree stock any further. We all need to take the threats of pests and diseases very seriously. For our part, The Tree Council has always informed our tree wardens about current and potential tree threats – indeed, it was a Norfolk tree warden who first spotted and reported ash dieback in the 'wild'. However, it is increasingly important that everyone involved with trees is well informed of the symptoms of tree diseases and is constantly vigilant, reporting anything 'suspicious' to the Forestry Commission via the Tree Alert website (https://treealert.forestry.gov.uk/).

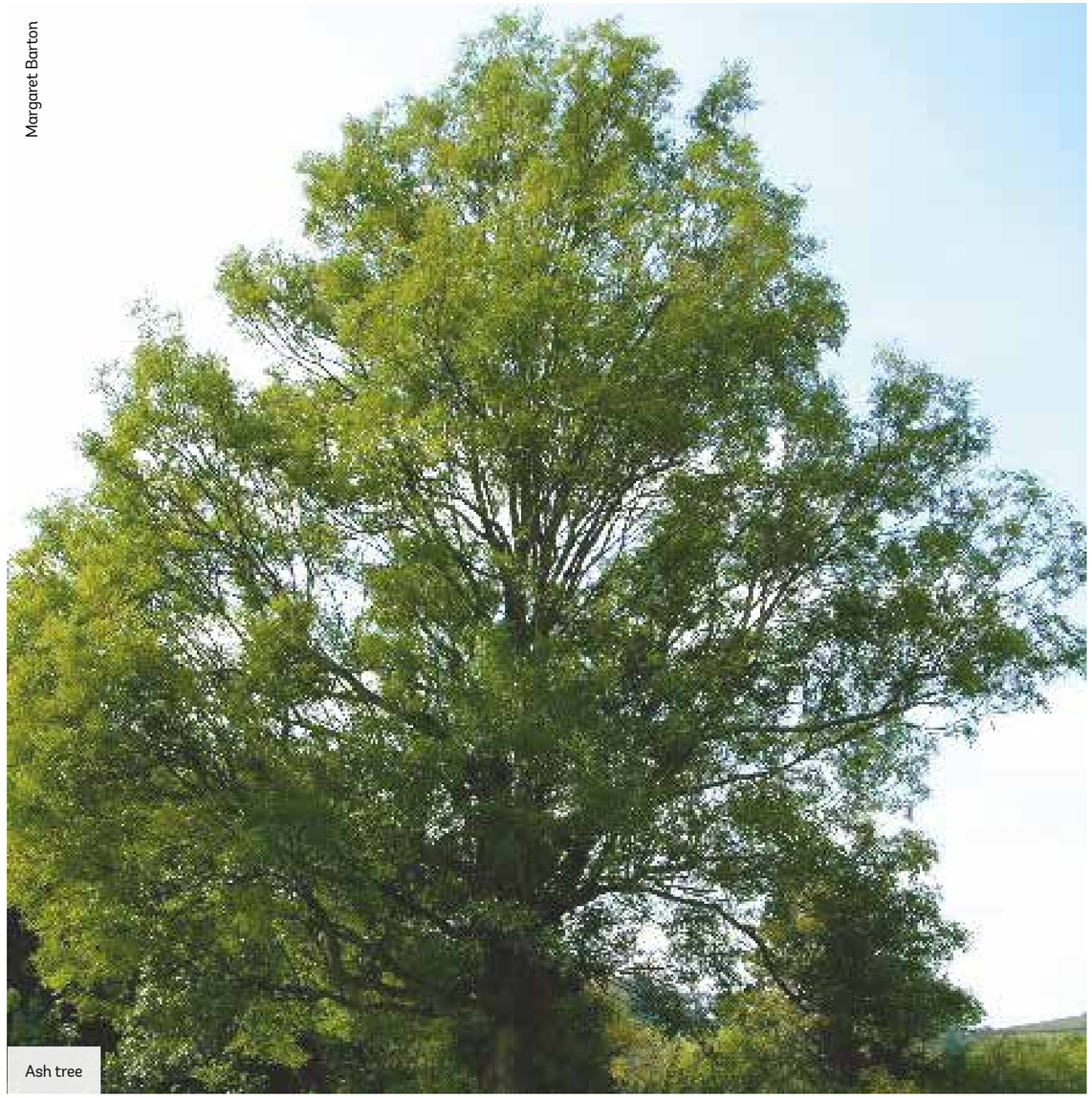
Looking to the future

Future planning with a focus on 'resilience' of the landscape also needs to be factored in to any tree replacement strategy following ash dieback (or any other disease outbreak). New strategies must be developed to ensure that no single species becomes over-dominant in our non-woodland tree populations. In the US, during the 1990s, a rule was introduced for resilient urban tree planting, which stated that in an urban tree population there should be, 'No more than 10% of a species, no more than 20% of a genus, no more than 30% of a family'. Would this be suitable in the UK for non-woodland tree planting? Possibly not, but we will need to develop strategies and practices to ensure that any restoration of the landscape does not risk creating further problems, either from inappropriate species mixes or from the introduction of new pests or diseases. Imagine for a moment the appalling consequences of replanting trees to replace ash and introducing a new threat to oak!

The future for Britain's non-woodland trees depends on this generation valuing such trees for their contribution to the environment and to the continuing life of this country. It will also require an understanding of the practices used to create and manage a landscape with non-woodland trees in it, as well as re-valuing the role that trees play.

Without such a shift in awareness of these trees' place in British life, the survival of non-woodland trees through the third millennium may not be achieved. However, The Tree Council believes that with appreciation, better care, and a concerted national landscape-scale restoration programme, we can continue to benefit from our non-woodland tree heritage, while shaping a new landscape for the future.

Jon Stokes is programme director of The Tree Council and currently researching impacts of ash dieback in the UK and mainland Europe


Margaret Barton

Ash tree

Computer-aided landscape design

Justin Travis, Kevin Watts, Steve Palmer, Job Aben,
Roslyn Henry, Nick Synes & Nick Atkinson

Computer-aided design is heavily used by engineers, architects and landscape planners. It can be used to explore the aesthetics of a design and to establish its functionality. With the recent and ongoing development of new computer models that simulate ecological processes with improved realism, there is an emerging opportunity to make much greater use of computer-aided design to enhance our management of woodlands and trees outside woods for ecological functioning.

What is the best way to invest finite resources on planting trees outside woodland? This is a challenging question, and the answer depends, of course, on the objective. Is the aim, for example, to maintain or improve the aesthetic characteristics of a landscape, reduce soil erosion, provide habitat for invertebrates or enhance connectivity for birds?

Even when the objectives are clear, it can still be challenging to know how best to invest resources. For instance, if the objective is to enhance the dispersal of species between woodland patches to improve the chances that they can respond effectively to climate change by shifting their ranges, would it be better to plant individual trees, regularly spaced as linear features linking woodlands? Or would it be better to have small clumps of trees that form larger stepping-stones? Should certain areas (e.g. counties) within a focal region (e.g. Great Britain) be prioritised over others? Is the answer likely to be the same across species? A group of ecologists would probably all agree that the answer to the last question is 'no'! However, it would be equally certain that reaching consensus on the other questions, even when one particular species was being considered, would be very difficult.

The value of computer models

Computer models can provide a way to test the likely consequences of alternative management interventions before they are implemented. They can provide answers to challenging questions, such as those posed above, and can help inform and improve landscape management.


Nick Atkinson

Roadside ash such as this are being removed for public safety


Job Aben

Taita Hills study site in Kenya

New computer software is being developed that facilitates this approach, making it increasingly accessible to conservation managers and landscape planners. Computer packages have been developed that enable the assessment of future land-use changes for a broad range of ecosystem services; a popular package, called InVEST, has already been used to assess how alternative forest management options will impact a range of ecosystem services, including hydrology and carbon storage.

Other packages have a particular focus on biodiversity and conservation. RangeShifter is one example that includes sophisticated models for population demography and the dispersal of individuals moving across complex landscapes. There is substantial untapped potential for these computer packages to be used in the context of managing trees outside woodlands. This potential is illustrated by recent work applied to two conservation challenges (see panels).

New functionality is being added rapidly to these ecological modelling platforms. RangeShifter is being extended to incorporate genetics, which will enable a whole range of new questions to be addressed. For example, how well will different management options for trees outside woodlands enable tree species, or tree-dependent species, to adapt to the presence of a new disease or pest species?

Finally, if you are interested in finding out more about the computer-aided approach to managing trees in the landscape, look out for a forthcoming RangeShifter workshop that will focus on this topic.

Modelling management interventions

Example 1: Connectivity between forest fragments in the Eastern Arc Mountains, Africa

In the Taita Hills in Kenya, at the northern end of the Eastern Arc Mountains, only 5% of historic forest cover remains, and several bird species, including the endemic Taita thrush, are threatened. From workshops run with local stakeholders, a suite of plausible alternative management interventions was developed. It is challenging to know how well these alternatives might meet the objective of protecting these threatened species, and this is where testing alternative scenarios, using computer modelling, can be a valuable exercise.

Using excellent data on the demography (e.g. birth rate, death rate) and dispersal of the Cabani's greenbul

songbird, a forest-dependent species, RangeShifter was used to evaluate the likely effectiveness of alternative interventions. The computer simulations suggested that while total population abundance is maximised by restoring patches of native forest, enhancing the wider landscape by planting native trees can have greater benefits in terms of both connectivity and the number of habitat patches inhabited.

Two possible spatial arrangements for planting trees outside forests were trialled. The first simulated trees being planted randomly across small-holdings. In the second, they were planted in diffuse corridors, spread out over a wide area, linking habitat patches. Results suggested that the number of patches occupied by the greenbul is likely to be highest if trees are planted in diffuse corridors, as this aids dispersal. These initial results illustrate the potential of the general approach, and ongoing work is now considering eight bird species across the whole of the Eastern Arc.

Taita thrush, endemic to the Taita Hills

Example 2: Mitigating impacts of ash dieback

Ash dieback is a rapidly spreading threat with many millions of the UK's ash trees projected to be lost to the disease. There is an urgent need to understand the ecological and ecosystem service consequences of the loss of these trees and to develop strategies for mitigating against the worst of these consequences.

Roadside ash trees are landscape features of particular concern as they are most likely to be removed due to perceived risks to public safety. The same logic suggests replanting along roads will be difficult. Given the ecological importance of roadside trees in the UK landscape, it is particularly critical that we gain improved understanding of the likely consequences of these ash trees being removed.

RangeShifter is currently being used to establish how the removal of ash trees outside woodlands will impact on biodiversity that relies on ash as either habitat or to move across the wider landscape. Alternative mitigation options, that can include planting ash, or alternative tree species, along existing linear features including hedgerows and waterways, are being tested in a project funded by the Woodland Trust.

Professor Justin Travis is a spatial ecologist and evolutionary biologist at the University of Aberdeen, focusing on developing and applying computer models in ecology and conservation.

Dr Steve Palmer is a Research Fellow at the University of Aberdeen, working with and supporting RangeShifter.

Dr Kevin Watts is an applied landscape ecologist focussed on understanding the impacts of land use and climate change on the biodiversity and resilience of wooded landscapes.

Dr Job Aben is a researcher in the Travis lab where he works on the application of state-of-the-art mechanistic ecological models.

Nick Synes is a researcher interested in developing and applying spatial models of biodiversity and landscape management to inform conservation decisions.

Dr Roslyn Henry is using a global land use model to investigate the resilience of the UK food system to global shocks.

Dr Nick Atkinson works at the Woodland Trust and is interested in finding ways to mitigate the impact of pests and diseases on non-woodland trees.

Visualising our landscape

Louise Sing, Marc Metzger and Duncan Ray

Understanding people's perceptions of landscape and their preferences for woodland cover can help to inform environmental planning and policy making.

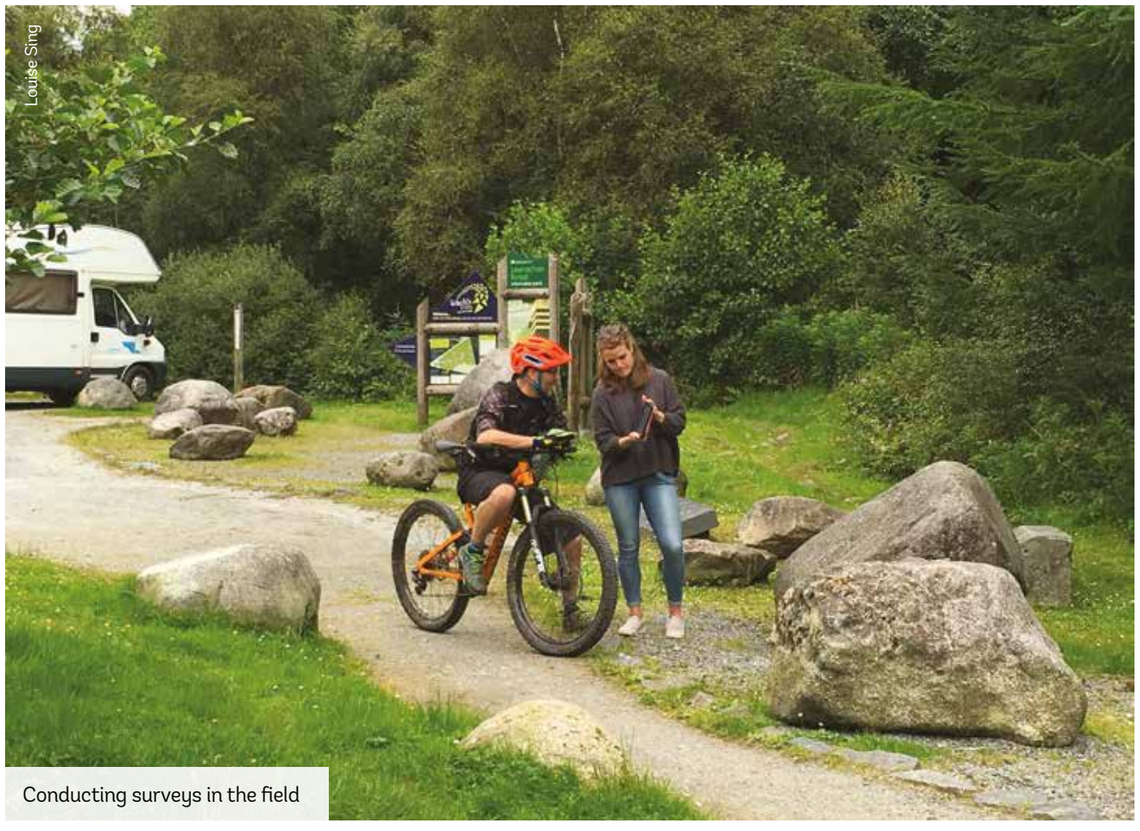
The challenge is to help people understand both the many benefits that result from different types of land use, as well as the way that different land uses interact and are sometimes in competition with each other or are even incompatible.

Visualising landscapes

A research project by Forest Research and the University of Edinburgh is being conducted in the Lochaber region of the western Highlands, looking at public preferences for the type and extent of tree and woodland cover in the landscape. It uses a landscape visualisation tool, developed as an app for use on a tablet, within a structured interview. The app uses a virtual landscape onto which participants are able to specify their preference levels for potential land uses on a scale of 0-5.

The land uses to choose from include commercial forestry, native woodland, sheep farming, wind turbines, recreation and habitat for wildlife. There is a carbon sequestration display that indicates the potential storage capacity of the woodlands that the user adds to their landscape. Certain combinations of land uses are restricted to represent the interaction and conflict among particular land uses. The survey method therefore requires participants to make decisions about trade-offs. A set of visual images accompany each land use combination, providing participants with a visual cue as to the landscape implications of managing land for particular benefits.

Landscape visualisation techniques are important in raising awareness of the benefits and challenges around different types of land use amongst different stakeholders. They can act as learning tools in landscape and environmental planning[1], helping to make sense of the complexities in public perceptions of multifunctional landscapes.[2]



Conducting surveys in the field

Public support for increasing woodland cover

Analyses of public preferences for an upland landscape close to Edinburgh from a previous survey using this method showed a strong inclination towards management that is more strongly oriented towards nature-based land uses. More than half of the interview respondents selected management that would maximise biodiversity or woodland enhancement[3].

Through the visualisation tool, participants can see how a landscape looks with varying degrees of native woodland cover (Figures 1 and 2), including that of more scattered trees and shrubs at one end of the spectrum. In landscapes where trade-offs are needed, the scattered cover of trees outside woods, integrated with other land uses, could help to meet people's wish to maximise biodiversity.

Last summer, in the most recent survey for woodland expansion and land use preferences, over 200 participants were interviewed in and around Fort William, with the aid of the landscape visualisation tool. Feedback on the method was generally very positive.

Other public opinion surveys on forestry and woodland show high levels of support for increasing woodland cover. The most recent, carried out by the Forestry Commission in 2015, showed that 80% of people believe that a lot more trees should be planted in response to climate change[4]. In Scotland, 62% of people said they would like to see more woodland in their area[5].

The restrictions on certain land use combinations within the tool were also effective in communicating to a broad audience the trade-offs that result from rural land use decisions. Participants were forced to prioritise the most important benefits according to their beliefs and preferences. The tool can therefore be used in stakeholder engagement events to explore multifunctional land use and woodland expansion.

Figure 1. The virtual landscape with scattered trees

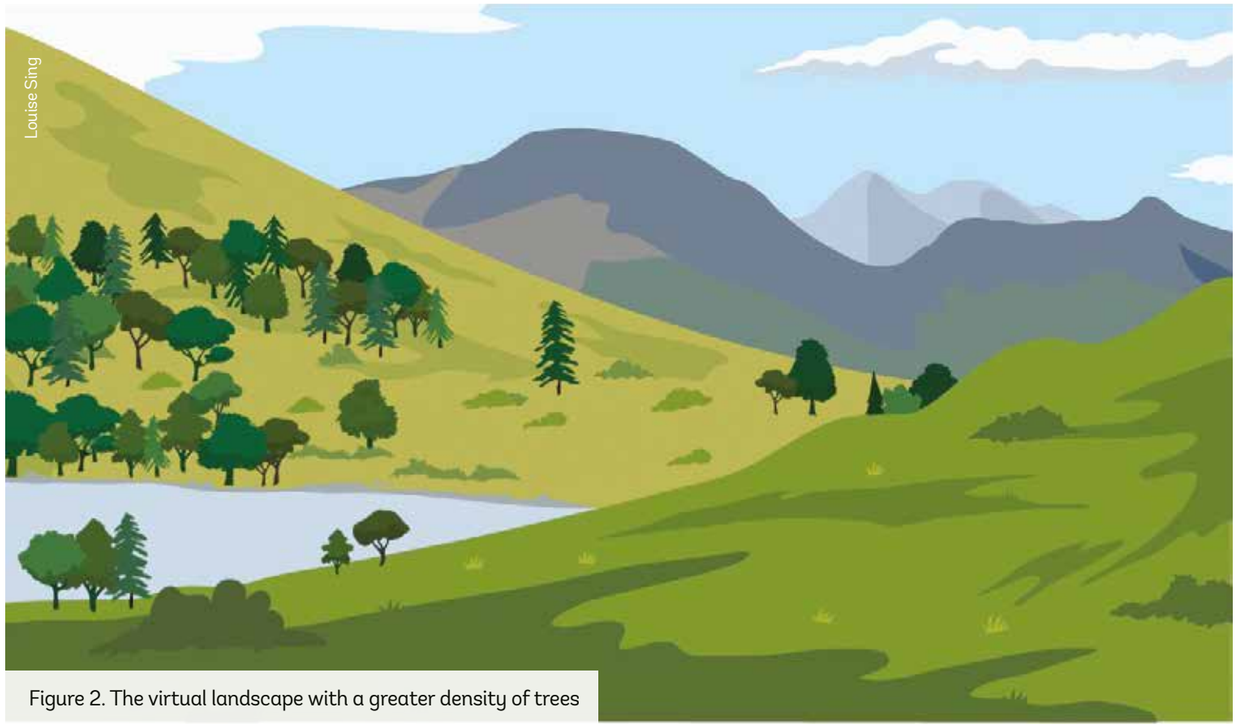


Figure 2. The virtual landscape with a greater density of trees

Benefits of trees in the landscape

Depending on the type and location of planting, as well as the change in land cover that takes place, new trees in the landscape can deliver a wide range of benefits for biodiversity and society. These ecosystem services include climate mitigation through carbon sequestration, habitat for wildlife, opportunities for recreation, physical and mental wellbeing benefits, flood protection, air quality regulation and slope stabilisation. Trees and woodlands in landscapes are also important for a range of cultural values associated with the aesthetic quality of a landscape.

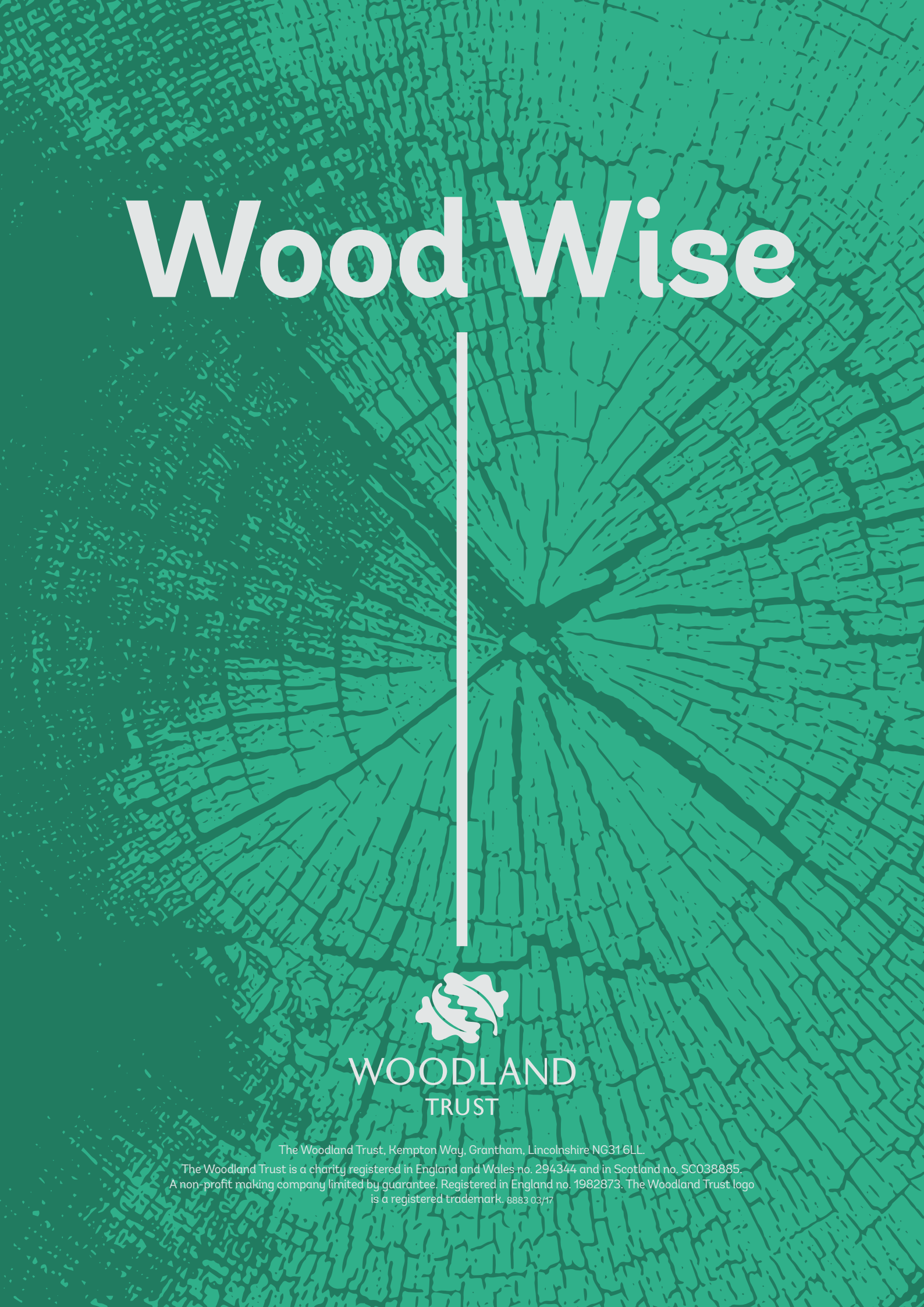
Increasing Britain's tree cover to deliver multiple benefits is a current policy objective for each of the devolved forestry administrations of England, Wales and Scotland, which this work could help to inform. The current tree cover of England (10%), Wales (15%) and Scotland (18%) is much lower than the European average of 38% (46% including the Russian Federation).

A website for the tool is currently in development. For more information on the study please contact Louise Sing (louise.sing@forestry.gsi.gov.uk).

Louise Sing and Duncan Ray work at Forest Research in the Land Use and Ecosystem Services Group. She is currently undertaking a PhD at the University of Edinburgh looking at the effects of forest management on ecosystem services in Lochaber, Scotland. Dr Marc Metzger is reader in Environment and Society within the University of Edinburgh's Research Institute of Geography and the Lived Environment.

1. Pettit, C.J., Raymond, C.M., Bryan, B.A., Lewis, H., 2011. Identifying strengths and weaknesses of landscape visualisation for effective communication of future alternatives. Landsc. Urban Plan. 100, 231–241. doi:10.1016/j.landurbplan.2011.01.001
2. Nijnik, M., Mather, A., 2008. Analyzing public preferences concerning woodland development in rural landscapes in Scotland. Landsc. Urban Plan. 86, 267–275. doi:10.1016/j.landurbplan.2008.03.00
3. Schmidt, K., Walz, A., Jones, I., Metzger, M.J., Schmidt, K., Walz, A., Jones, I., Metzger, M.J., 2016. The Sociocultural Value of Upland Regions in the Vicinity of Cities in Comparison With Urban Green Spaces. Mt. Res. Dev. 36, 465–474.
4. Forestry Commission, 2015a. Public Opinion of Forestry 2015, UK and England.
5. Forestry Commission, 2015b. Public Opinion of Forestry 2015, Scotland.

Wood Wise



WOODLAND
TRUST

The Woodland Trust, Kempton Way, Grantham, Lincolnshire NG31 6LL.
The Woodland Trust is a charity registered in England and Wales no. 294344 and in Scotland no. SC038885.
A non-profit making company limited by guarantee. Registered in England no. 1982873. The Woodland Trust logo
is a registered trademark. 8883 03/17