Woodland creation guide

WOODLAND
TRUST

Contents

Introduction

The Woodland Trust's approach to woodland creation for people and wildlife

VICTORIA HODSON/WTML

This guide sets out the Woodland Trust's approach to woodland creation. It describes in detail the phases of the process and the principles that we apply when looking to expand woodland and tree cover on an area of land.

Woodland creation is central to the Trust's vision of **a UK rich in native woods and trees, for people and wildlife**. We recognise that to address the challenges facing our society we need to deliver on ambitious targets for increasing the extent of native woods and trees. This is critical to tackling both the **climate and nature crises**. It will also help to provide the natural resources that people need, such as **clean water** and **healthy soils,** as well as **reducing flood risk** and helping communities **adapt to the impacts of climate change**. It will also contribute to people's **health and wellbeing** wherever it enables direct experience of woods and trees or enhances the landscapes in which people live. To deliver the greatest possible benefit – to drive **nature recovery** and to make a difference to people's lives – our woodland creation needs to demonstrate excellence in planning and delivery and remain true to our core **conservation principles**.

Our approach will lead to the creation of new woods and the establishment of trees that are well suited to local site characteristics and the landscape context. Equally important, it will ensure that we embrace the objectives and aspirations of landowners and communities and help to ensure that the Woodland Trust is seen as an excellent delivery partner.

CLAIRE INGLIS

A diversity of native trees and shrubs creates wildlife-rich, resilient habitats.

Willow tit. The decline of this specialist of young, dense wet woodland is representative of the 29% decline of woodland birds since 1970.

1.1 Why we need more native woods and trees

Natural colonisation and succession after the last ice age produced landscapes rich in native woods and trees across the UK. These native trees and shrubs co-evolved for many thousands of years with native wildlife to form characteristic ecologically rich and diverse communities, well-adapted to their local geology, soils and conditions – creating distinctive landscapes. Over the centuries, these landscapes have changed as people have utilised and modified the land. The expansion and intensification of agriculture, along with urban and infrastructure development, has reduced and fragmented the network of woods and trees.

The relatively sparse cover of woods and trees that remains has become ecologically degraded. The impacts of deer populations, pollution, tree pests and diseases, invasive species and historic management have collectively resulted in a simplification of habitat structure and tree species composition, reduced biodiversity and disrupted natural processes. Through our approach to woodland creation, we seek to initiate **nature recovery** across our landscapes. Establishing trees and shrubs provides the essential structure and conditions to support the recovery of dynamic communities of plants, animals and microorganisms.

The aim is not to restore the land to some historic condition, but to support a recovery from historic loss, fragmentation and degradation. As recovery progresses and natural processes become re-established, landscapes will become more ecologically resilient, with the capacity to adapt to future change.

The restoration of naturally functioning ecosystems, rich in native woods, trees and wildlife, provides the essential natural capital from which numerous **benefits to people** are derived, including **mitigating climate change; managing water and air quality; enhancing landscapes; supporting people's health and wellbeing; the sustainable production of food, fuel and wood products; and protecting soils**.

Bechstein's bat – a specialist of ancient woodland that relies on old trees for roost sites. Habitat loss and fragmentation has seen this bat decline to become one of Britain's rarest mammals.

Adaptation and resilience

Newly created woodland has the potential to exist for many centuries, often well beyond the lifetime of the individual trees. Current climate projections indicate that the coming decades and centuries could be a time of great change in weather patterns, temperature extremes, and long-term changes in climatic averages. The knock-on impacts of **climate change** could lead to additional pressures – such as drought, floods, disease and pollution – affecting natural habitats, including woods and trees. Today's new woodlands will, therefore, have to be ready to **adapt and evolve** over time.

Our approach to woodland creation is based on establishing woods and trees in a diverse range of habitat structures, at site and landscape scale. Our approach also emphasises the importance of **locally sourced seed and trees** and the role of **natural colonisation** as a critical process that allows natural selection to build adaptation to site conditions. By creating complex habitat mosaics with trees that are well adapted to site conditions, we aim to build woods and landscapes that are resilient to current and future stresses.

Our native trees can grow in a wide range of climatic conditions and have **high levels of genetic variation** within populations, even at local scales, providing a basis on which to build adaptation. We do not believe that there is the evidence to justify introducing new tree species, or more southerly provenances of our native trees, to support the ecological resilience of our woods and landscapes. Our approach is also based exclusively on seed and trees that are **sourced and grown in the UK and Ireland**. This is a critical measure to improve biosecurity and prevent the introduction of pests and diseases which can arrive with imported tree stock.

Our conservation principles

Our approach to woodland creation is an important expression of the Trust's conservation principles:

Native trees and shrubs have co-evolved with our native wildlife and are the richest and most diverse habitats for wildlife. This is why **we prioritise native woods and trees**. The characteristic communities they form – well adapted to their local geology, soils and conditions – help shape our distinctive landscapes.

Trees and shrubs are the visible architecture of our complex woodland ecosystems. The structural diversity and natural processes associated with woodland ecosystems help to build resilient landscapes and catchments. Healthy woods and trees also provide habitat niches and resources for the many species reliant upon them. For these reasons, **we take account of whole ecosystems, landscapes and catchments** in our woodland creation work.

Our landscapes and the distinctive types of woods and trees we have today are a product of geographical location, development over time and interactions with people. Across the UK, over centuries, native woods and trees have been cleared for agriculture and built development or lost to overgrazing and non-native plantations. We **consider the geographical and historical context** to inform the restoration of the ecology and character of our landscapes.

Creating new woods and trees is crucial to restoring ecological networks and delivering the many benefits that woods and trees provide to people. **We actively create and manage woods and trees** to build the woodland network based on the principles of 'more, bigger, better and joined'.

Our landscapes are changing due to the impacts of tree diseases and pests and the effects of climate change. In creating new woods and trees, we need to act to reduce the risk of damage from pests and diseases; for example, by using locally sourced seed and trees. By promoting natural processes and encouraging natural regeneration, we enable our woods and trees to adapt to a changing climate. In this way **we aim to secure the many values of woods and trees for the long term.**

The available space for woods and trees in our landscapes is increasingly squeezed. The ecological restoration of these landscapes will depend on our ability to engage people with the multiple ways in which nature, trees and woods are essential and add value to their lives. Through this engagement, and by collaborating with partners and communities, we seek to **put people at the heart of conservation**.

Pearl-bordered fritillary. The decline of this specialist of woodland glades is representative of the 41% decline of woodland butterflies since 1990.

1.2 The starting point

Woodland cover in the UK is now around 3.2 million hectares (ha), or 13.2% of the land area. This represents almost triple the meagre remnants of woodland of one hundred years ago. However, the significant increase in extent has been dominated by plantation forestry of non-native trees and has been unevenly distributed, with almost two thirds occurring in Scotland. The rate of expansion has also slowed dramatically, with an increase of only around 1% in the last twenty years [1].

Woodland creation has largely been driven by publicly funded incentive schemes. In the earlier half of the twentieth century, the focus of these schemes was almost exclusively on rebuilding the UK's strategic timber reserve. From the 1980s onwards, strategic priorities shifted and began to place a greater emphasis on nature conservation and the other benefits that woodlands provide to people, including public access and recreation. More recently, the role of trees within farming systems – via ***agroforestry*** – has been highlighted, to help achieve more sustainable food production and protect water, air and soils. And, most recently, the strategic focus has been on the sequestration and storage of carbon to help mitigate climate change, with the woodland carbon code becoming an important mechanism to support woodland creation. Mechanisms and incentives have always interacted with land values and the economics of other land uses. Changes to farming subsidies, increasing input costs and land taxation arrangements are all significant factors in shaping how and where woodland creation has occurred over the last century.

Our current woodland cover is almost evenly split between broadleaf (49%) and conifer (51%) [1]. Although these figures include native Scots pine woodland in Scotland, and areas of non-native broadleaved plantations, it is estimated that around half of all woodland is native. Northern Ireland, parts of Scotland and areas of northern England are particularly low in native woodland cover.

In addition, there are a further 742,000ha of **tree canopy cover** beyond that recognised as woodland (small woods below half a hectare, hedgerow trees, river and roadside trees) and 452,000km of hedgerows in Great Britain (no equivalent measure exists for Northern Ireland). This represents almost 20% of the total tree canopy cover and a further 3.2% of land area [2].

These trees and hedgerows in the wider landscape – vital to wildlife, landscape character and sustainable farming – have been largely overlooked by policy, regulations and incentives. As woodland cover increased through the twentieth century, the extent of tree cover in the wider landscape has significantly reduced. Tree disease and the intensification of agriculture and infrastructure developments have reduced tree cover, and without proactive intervention these trees will not be replaced.

The **wildlife associated with our woods and trees** has suffered catastrophic declines in the last fifty years. The network of native woods and trees has become fragmented and degraded, the expansion of woodland cover has been dominated by non-native tree species, and established native woodland management practices have been abandoned. The result has been a simplification of the composition and structure of woods and trees, reducing the habitats available for wildlife. Woodland butterfly species have declined by 41% on average since 1990, and woodland birds by 29% since 1970 [3].

Woods and trees are increasingly impacted by **pests and diseases.** A significant increase in the rate of occurrence of newly imported pests and diseases is associated with a rapid increase in global trade, including tree and horticultural plant imports over the last 30 years. **Herbivore damage** is increasing due to the growing populations of deer and grey squirrel impacting woodland structure and species composition and reducing opportunities for regeneration. These factors all reduce tree survival and result in loss of habitat for wildlife.

Climate change is acting on woods, trees and landscapes, amplifying the challenges created by ecological degradation, with increasingly frequent drought, fire, storm and flood events. Woods and trees are also impacted by **atmospheric pollution**. Although the acid rain deposition of sulphur dioxide from power generation and vehicle emissions has dropped significantly in the UK since the early 1990s, nearly all (92–98%) of woods are receiving damaging levels of nitrogen deposition from predominantly agricultural sources [4]. The effects of nitrogen deposition include observable species loss, changes in soil chemistry and habitat degradation resulting from nutrient enrichment, acidification, or direct damage (toxicity).

Despite all the pressures on our degraded habitat network of woods and trees, we understand more each year about the importance of native woods and trees, for people and wildlife. They have an important role to play in helping to mitigate climate change, through **carbon sequestration and storage**. Woodlands in Great Britain together hold 213 million tonnes of carbon (in their living trees)[1] and woodland creation has an important role to play in delivering the Committee on Climate Change's recommendations, and government policy for net zero by 2050. In addition, **sustainably growing the nation's timber production** will reduce our huge dependency on imports and ensure good environmental standards of production.

Woods and trees can also help with **adaptation** to changes in the weather and climate; for example, in flood-risk reduction, pollution control and temperature regulation in towns and cities where 80% of the UK population lives. **Agroforestry** can help with adaptation on farmland, ensuring continuity of food production on soils under pressure.

The importance of access to natural green space for **recreation and wellbeing** is well recognised. However, we know that many people do not have easy access to woodland, with just 16.2% of people in the UK having access to a wood of at least 2ha within 500 metres of their homes [3]. Woodland creation is often the only way that local accessible woodland can be provided for communities across the UK.

Woodland creation means establishing native woods and trees by a range of methods, and in all contexts, both rural and urban.

1.3 Scope of the guidance

This guide is intended to cover all our woodland creation work. Although titled 'woodland creation', our approach covers **trees** in a range of **non-woodland contexts**. This includes hedgerows, groups of trees, scrub and individual open grown trees. Sometimes we revert to the shorthand of **woodland creation** by which we mean **the establishment of native woods and trees** by **any means** and **in all contexts** – from the **largest sites to single trees,** through **planting, seeding** or **natural colonisation,** in **urban** or **rural settings.**

The guide has been produced for use by a broad **professional audience**. It describes the approach that we will follow **on our own estate** and where we are **directly managing woodland creation** on behalf of others. We hope that this is an approach which others will be inspired to apply and that this guide will provide a framework for woodland creation that can be used by conservation organisations, forestry and ecological consultants, tree officers, land managers, contractors, etc.

Our approach to woodland creation assumes **nature recovery** as an **overarching and priority objective,** and for this reason is built on the use of **native tree species**. We recognise that well designed, non-native woodland (such as commercial conifer and mixed plantations) can also contribute to nature recovery, alongside priorities such as timber production and carbon sequestration. We hope that those creating woodland for primarily commercial objectives will find this guide an informative and useful resource for planning and delivering woodland creation.

Much of our woodland creation work is not directly managed, but based on a mix of **advice, financial support** or the **supply of subsidised trees**. For these projects, this guide is intended to communicate to landowners, organisations and partnerships the **process** and **principles** which form our approach, and which we would expect to see reflected wherever the Trust is supporting woodland creation projects.

The guide describes our approach at **site scale** – on land which has become available for woodland creation, across the whole of the UK. In practice, site scale can mean anything from a single stretch of hedgerow or individual street trees to hundreds of hectares of complex mosaic woodland habitats.

Evidence-based guidance

This guide is based on a thorough review of the available **scientific evidence** and grey literature, including a series of structured evidence reviews that underpin key aspects. Evidence was assessed for inclusion in terms of **strength and relevance** to the topic based on the knowledge and experience of the editorial team, supported by colleagues and a community of expert stakeholders. We have tried to present and interpret evidence in an **objective and unbiased** way.

The guide covers a broad suite of topics and issues, and the strength of evidence is not consistent across every aspect. Where relevant, the strength of the evidence behind recommendations has been considered. In circumstances where scientific evidence is lacking or partial, guidance is based on the collective experience of advisers, site managers and other contributors, first principles or theory. We have sought to make the basis for guidance clear throughout the guide.

Important gaps in the scientific evidence have been revealed through the development of this guide and we will make every effort to address these through our research programme and partnerships.

The UK Forestry Standard

Our approach complies with all legal requirements and advisory guidelines of the **UK Forestry Standard (UKFS).** The core 'elements of sustainable forest management' are reflected in the structure of this guide, and a short summary of the relevant UKFS requirements and recommendations is included within each section of the site assessment, design and initiate chapters. However, our approach goes beyond this baseline forestry standard in many areas, and not everything contained in this guide is currently well supported by regulation and incentives across the four countries of the UK. To this extent, the guide will also inform our work to influence **government policies**, **regulations** and **funding schemes** to ensure that woodland creation delivers the best possible outcomes for people and wildlife.

1.4 How to use the guide

The chapters of the guide follow an approach to woodland creation through five phases: Objectives, Assessment, Design, Initiation and Establishment. They provide the detail of what we mean when we use the phrase **'right tree, right place, for the right reason, in the right way'**. Applying this approach will ensure a consistent narrative that flows from a sound understanding of the characteristics, features, landscape context and constraints of a site to realising a long-term vision delivered on a suite of clearly defined objectives.

The approach is not intended to be prescriptive, but aims to ensure a consistent approach in the delivery of a woodland creation project at any scale. Nor is it intended to be used as a manual by a non-professional audience, but rather provides a framework on which advisers and consultants can build, based on their own knowledge and experience.

We want to encourage creativity and imagination in designing and establishing new woods and trees, and the observation and response to natural processes as a site develops. This will ensure that we avoid generic prescriptions. Instead, we will work to create new woods and trees and restore landscapes with a strong sense of place: well adapted to local conditions and resilient to the impacts of climate change, pests and diseases.

There are no forms or templates provided in the guide; the approach being to describe the **key phases of the process** and provide a series of **design principles**. These can be applied at any scale and will be relevant to any mechanism, project or management planning system, grant funding or regulatory requirement of a woodland creation project.

The guide has been structured to enable the process to be followed chronologically from beginning to end, but is also intended to be used as a reference document and a signpost to further useful resources.

It is organised around the five stages of woodland creation:

1. Vision

The approach starts by ensuring that the **right reason** for woodland creation has been considered and clearly articulated through a **vision** and **objectives**. Developing the purpose and objectives for woodland creation on the site will draw on the **views and motivations** of **landowners** and **key stakeholders**. The site objectives are likely to develop as the site assessment phase progresses, evolving from broad aspirations to more specific objectives.

2. Assess

The second section describes how we carry out site assessment, including understanding the **site characteristics** and their potential to support woods and trees, assessing existing **features** (habitats, species, historic environment and public access), as well as appraising the **landscape context**. It also describes the assessment of practical **constraints** to woodland creation, including built infrastructure and herbivore browsing impacts.

3. Design

The design process builds on the site assessment to produce a design that reflects the objectives for the project. This phase requires the **synthesis** of all the information gathered and the **balancing of priorities** based on combining the **design principles** for different objectives. The design phase progresses from concept to finalised designs. These are set out using the building blocks of **woodland** (groves, open wooded habitats and glades) and of **resilient landscapes** (woodland, open habitats, hedgerows and trees) as the basis of a spatial plan that puts trees in the **right place**.

4. Initiate

Building on the design plan, this section addresses **species** and **provenance choice** to ensure that our woodland creation is based on the **right tree** species. The initiate section also considers the options for **natural colonisation**, **direct seeding** and **planting** to achieve the target composition and structure; supporting decisions on the **right way** to establish trees on the site.

5. Establish

This final section recognises that establishing naturally functioning, wildlife-rich woods and trees is the work of years, not days. It considers the further interventions required to successfully establish trees and promote the development of **quality woodland habitats** and **naturally functioning woodland ecosystems** over approximately twenty years. It also sets out a framework for **monitoring** the delivery of the site objectives and the quality of the developing habitats.

Vision

RICHARD BECKER/WTML

Vision → Assess → Design → Initiate → Establish

- **Vision**
- **Objectives**
- **Stakeholder engagement and consultation**

2: Vision

Establishing new woods and trees is a long-term process. Many of the benefits of native woods and trees, for people and wildlife, may take years or decades to be realised. Developing a clear **vision** and associated **objectives** for the project is a great way to ensure that the long-term outcomes inform your plans and management as the site develops. For larger sites, complex projects or those with large numbers of stakeholders – such as in urban woodland creation – developing a vision and objectives can be an important part of your stakeholder consultation.

Defining clear **objectives** will ensure that your project delivers the intended outcomes, and that these can be measured and demonstrated. The site assessment will provide you with a good understanding of the site. How you build on this understanding through the design phase and the establishment of new woods and trees will depend on the outcomes that you want to achieve.

2.1 Vision

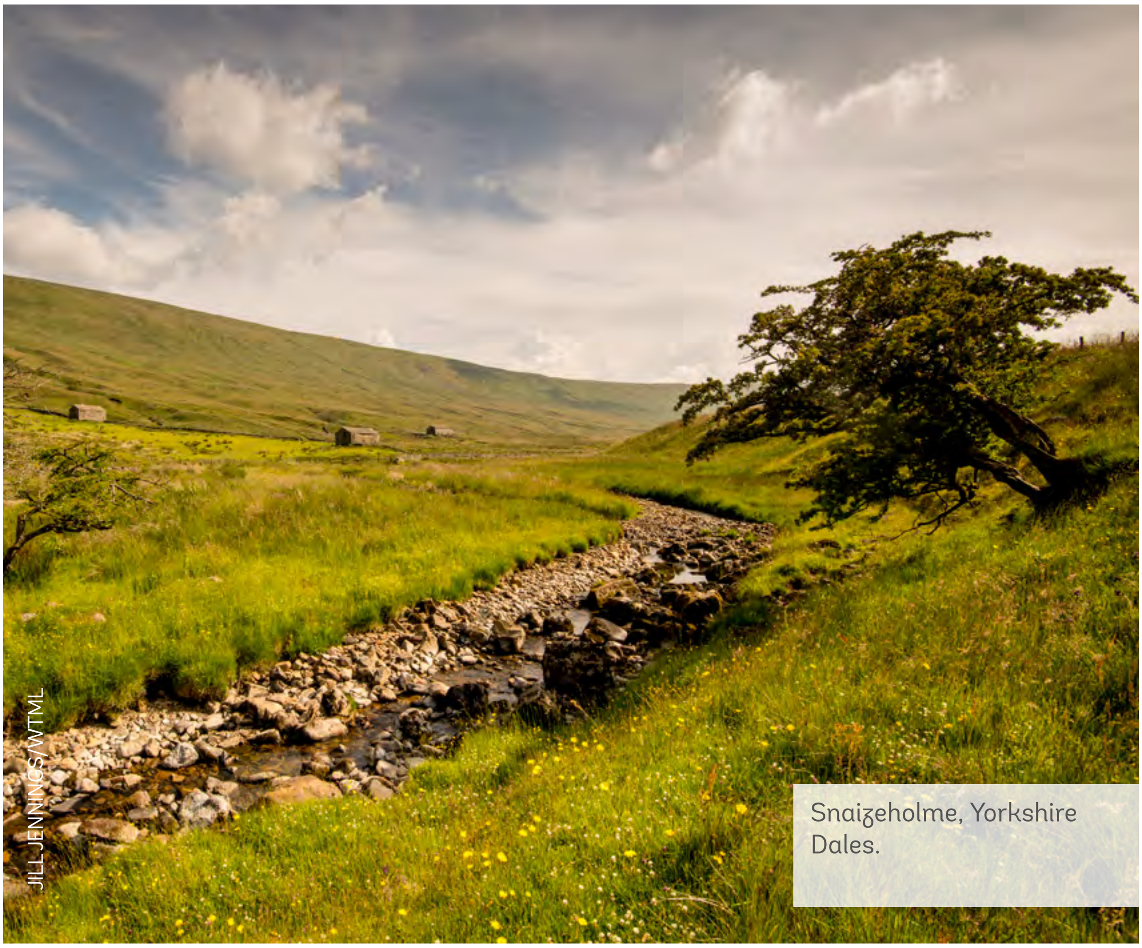
Producing a clear **long-term vision (say, 50 years)** for your project can be a powerful way to capture the aspirations that you have for your woodland creation project and communicate these in an accessible and inspiring way. A strong vision provides a guiding framework for objective setting and helps to keep your project decision making focused and on track throughout implementation.

A vision is a realistic yet stretching expression of motivations, values and ambition. It should address the question of why you are doing the project, i.e. **your rationale**. This could include leaving a legacy, making an income, restoring nature, providing a community resource or service, tackling a problem in a local or wider context, and so on. It can be written as a physical description of how the site will look and feel, along with a description of the benefits or functions that it will deliver in its landscape context. Even the smallest and simplest of woodland creation projects – such as the planting of a few trees in the grounds of a school – will benefit from taking the time to produce a simple vision.

Developing a vision is an excellent way to **engage and consult** relevant stakeholders (see section 2.4), generate discussion and support, and ensure that all those involved in the project have a shared understanding of the core purpose. This could range from ensuring that the aspirations of a landowner are clearly understood by advisers and contractors, to providing a framework for a diverse group of stakeholders to reach a consensus on what they want and can expect from a woodland creation project.

The development of your vision can be an **interactive process** as you learn more about your site, others' interests in it, and what is feasible. Ideally, your vision should be as **future-proofed** as you can make it, based on any evidence and potential scenarios around projections of climate change and socio-economic and environmental drivers that you have available to consider.

VISION EXAMPLE



JILL JENNINGS/WTML

Snaizeholme, Yorkshire Dales.

Snaizeholme, Yorkshire Dales

Over 50 years, Snaizeholme has developed into a vibrant mosaic of native woodland, upland blanket bog, acid grassland, limestone pavement and riparian meadows. This has re-created a valley rich in the habitats and species that thrived before human activities like farming became dominant. This naturally functioning ecosystem has become a cherished landscape, valued by everyone for the contribution it makes to tempering flood risk, locking away carbon and improving drinking water quality, as well as its outstanding natural beauty.

Iconic species, such as curlew, black grouse and red squirrel, have grown in numbers and spread to neighbouring valleys – connecting with other landscape recovery projects which together are spearheading a revival of nature in the National Park. Partnerships of organisations, landowners and communities are demonstrating a transformation in upland land management, focused on the needs of the future, with large-scale action for climate change, nature recovery and benefits to people.

VISION EXAMPLE


CLAIRE INGLIS

Victory Wood, Kent

Victory Wood, Kent

Fifty years from now, Victory Wood will have become a resilient haven for wildlife. The diverse new woodland (an intricate blend of natural regeneration and planted trees) merges seamlessly with the remaining pockets of ancient woodland. A varied woodland structure of groves, glades, coppice and wood pasture is knitted together by wide, sunny rides with species-rich grassland. These dynamic habitats sustain growing populations of once rare and declining woodland and grassland wildlife species, as well as preserving historical features and enabling stunning views from the ridge of the coastline and across the ancient Blean woodland.

The provision of safe and informal public access is increasingly important, and the site continues to educate visitors on the significance of the Battle of Trafalgar. Landscape-wide partnerships mean that the protection, restoration, and enhancement of an ancient wooded landscape has been secured for people and wildlife, with Victory Wood at its heart.

VISION EXAMPLE


CHRIS MATTS/BEN HARROWER

Brynau Farm, Neath

Brynau Farm, South Wales

An ecologically resilient and picturesque treed landscape is valued and enjoyed by the local community. A rich mosaic of wooded and open habitats has been sensitively created, incorporating ancient woods and wood pasture to provide continuity with the historic landscape. The network of rides, paths and glades connects the landscape, providing exceptional recreation and education opportunities for a large urban population in South Wales. The community also values the site because it plays a key role in preventing flooding of their homes as extreme rainfall events intensify.

Wildlife, such as barn owls and bats, have benefitted from the insect-rich habitats, and the range of the very rare and previously isolated blue ground beetle has been extended. The site supports a thriving community wood-fuel business from woodland management thinnings – replacing fossil fuel use in the local secondary school whose students help to manage the site.

VISION EXAMPLE

RICHARD FAULKS/WTML

Taw Valley, Devon

Taw Valley, Devon

In fifty years' time, this tiny new woodland will be as beautiful as it is useful. The tree canopy of the groves will have closed and the grass sward that the trees were planted into will have given way to woodland specialist plants, such as bluebell and dog's mercury – speeded on by the connectivity with the adjacent long-established woodland. The heavy clays on site which made farming hard work, now support English oak and downy birch, while the wetter patches suit willows and alder and their associated flora. Native flowering shrubs line the species-rich meadow, attracting many different species of butterfly and other insects, birds and bats. Occasional open grown nut trees will reach over the sunny grassland borders, providing a productive harvest each year. From the chestnut tree fencing posts which will supply the farm, to some decorative and structural timber from elsewhere in the woods, this will be a truly wildlife-rich, multipurpose estate in miniature!

2.2 Objectives

New woods and trees can deliver multiple benefits for people and wildlife. Defining the **objectives** for your project is a key step, and the rest of this guide is structured around how to achieve your objectives and intended outcomes through the design, initiation and establishment of new woods and trees.

We set out eight broad **themes for woodland creation** which your objectives can help to achieve. It is possible that a native woodland creation project could achieve results against all these themes; however, we advise **prioritising the themes** that will help most in **delivering your vision,** selecting around three priority themes per project. Larger and more complex projects may wish to identify further secondary themes. This will help to keep your project on track and avoid tensions between priorities which could derail your project.

The next step is to **set objectives** against your chosen priority themes. You should aim for *one or more specific objectives for each priority theme*. Again, engaging project stakeholders in this process can help you in determining priorities and developing clear objectives that work for everyone involved. Some examples of possible objectives are included under the description of each theme. Try to make your objectives quite high level (this is not your management plan), yet specific, so that anyone reading them would have a good understanding of what your project will achieve, how success will be measured, and how long (roughly) it might take to see results.

Table 2.1: Themes and outcomes

Select from the eight themes:	Terms to describe the natural capital and ecosystem service outcomes (see below)
Nature recovery – habitat creation and adaptation	**Biodiversity**
Climate change – climate change mitigation	**Regulating**
Water – water quality and flood management	**Regulating**
Air – air quality	**Regulating**
Landscape – landscape character and **historic** environment	**Cultural**
People – access, recreation, health, skills and learning, community involvement and employment	**Cultural**
Wood products and food production – forestry and agricultural productivity	**Provisioning**
Soils – soil formation and nutrient cycling/soil conservation and restoration	**Supporting**

All woodland creation projects should contribute to **nature recovery**: increasing the area of core woodland, reducing fragmentation of the habitat network of woods and trees, and supporting the ecological restoration of natural processes and the recovery of wildlife populations. In the great majority of cases, this should include setting specific objectives for nature recovery.

The benefits of new native woods and trees to **people and communities** (ecosystem services) should also be reflected in your site objectives. These may be **direct benefits,** such as improving public access to woods or enhancing the landscapes in which people live, or the **wider benefits** that people and society gain from native woodland, like reduced flood risk and cleaner water, healthier soils, carbon storage, cleaner air or the sustainable production of food and wood products.

Your objectives should be concise and clear statements of the intended outcomes of the project for each prioritised theme. It is important to be able to measure the successful achievement of the objectives, and the more specific the objective, the easier this is. Where possible, include a desired state, threshold value or amount of change, as well as a timescale for achieving the objective where possible.

Explained: natural capital, ecosystem services, and nature-based solutions

The eight broad themes for woodland creation used in this guide can be divided between four recognised categories of **ecosystem services: regulating, cultural, provisioning** and **support** services. This categorisation is a way of describing and valuing the **benefits that people derive from nature,** including woods and trees. Sometimes, ecosystem services are quantified and valued financially – which may help decide between options for any parcel of land, and is increasingly being used to inform policy and planning at national and local scales.

Table 2.2: The four categories of ecosystem services

Ecosystem services	Benefits provided
Regulating services	These are the benefits obtained from natural processes and functions. They include the reduction in flood risk and the water purification that occurs when trees intercept rainfall and increase infiltration into the soil, slowing surface water flow, as well as regulating climate by sequestering and storing carbon.
Cultural services	These are the non-material benefits obtained from natural ecosystems, including recreation, health and wellbeing, spiritual enrichment, a sense of place, the historic environment and aesthetic values.
Provisioning services	This term describes the ability of people to obtain products from natural ecosystems, such as food, timber, water and resources, including fuel, oils and medicines.
Supporting services	Those natural processes that underpin all ecosystem functions and the other services. These include fundamental natural processes such as soil formation, nutrient and water cycling, pollination and the production of biomass through photosynthesis.

These benefits are derived from our stock of **natural capital**. This means the resources that nature holds in its **biodiversity** and the **natural functioning** of ecosystems.

Woods and trees are a critical component of our natural environment and can provide multiple benefits essential to support our survival, wellbeing and economic prosperity. With woodland creation, there is potential to **enhance the stocks of natural capital** and/or **improve the quantity and quality of ecosystem services** flowing from the land, to increase the benefits and value for people.

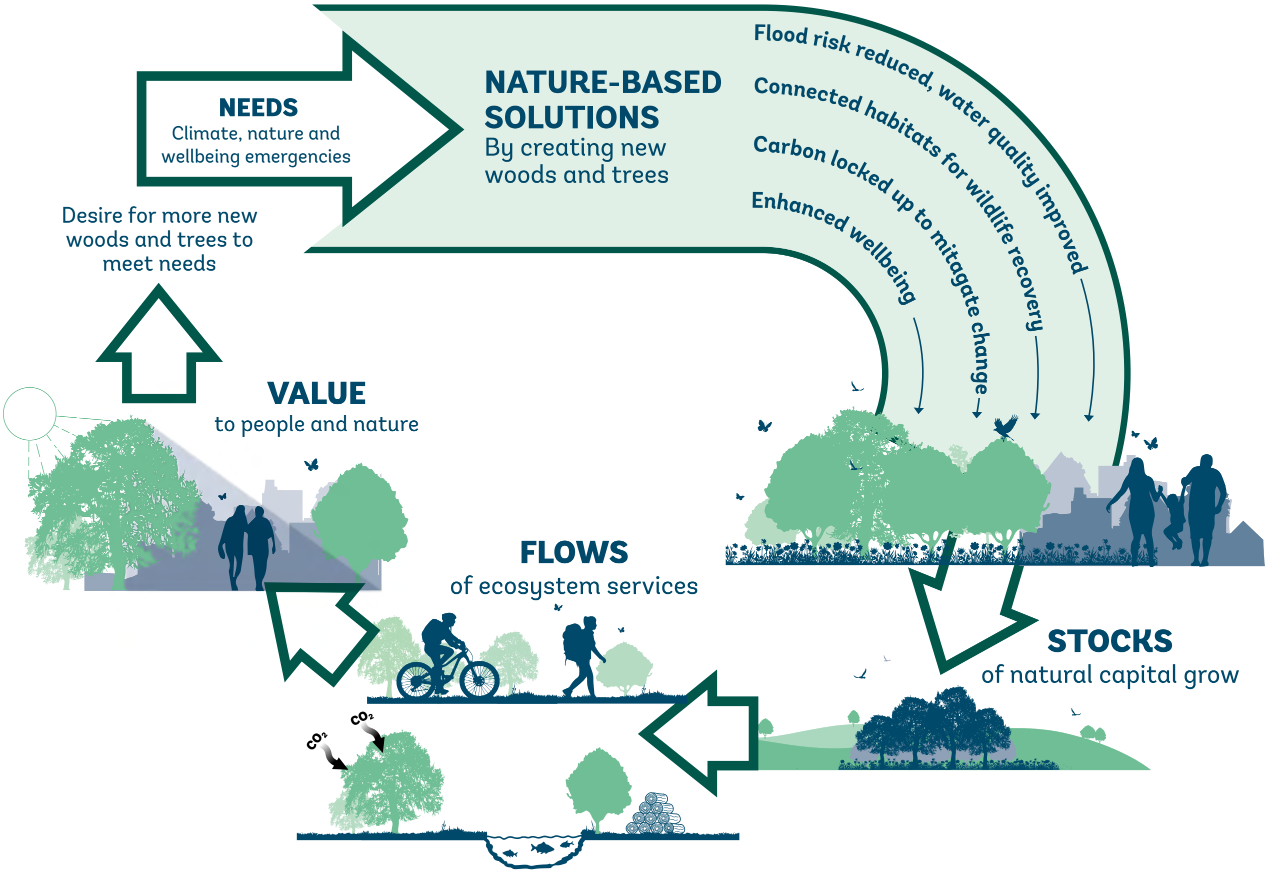


Figure 2.1: Woodland creation as a 'nature-based solution'

Biodiversity: Defined as the richness of habitats, abundance of wildlife and genetic diversity in nature that drives the functioning of natural ecosystems **(natural capital)** from which the other services flow.

Direct benefits: Some of the services provided by woodland creation are experienced directly. An enhanced landscape, access to nature and wildlife, a supply of firewood, or even the shade of street trees on a hot day – these are direct benefits that might be enjoyed by landowners, communities and visitors.

Wider benefits: People also benefit from woodland creation more remotely. For example, woods and trees sequester and store carbon, helping to mitigate climate change. Similarly, woodland creation well located in a catchment can reduce flood risk in towns many miles away. These indirect benefits to society are often the target of government support for private landowners through grant schemes or other initiatives (e.g. tax breaks).

Whether you use the language of natural capital and ecosystem services will depend on the audience. It may seem abstract to many individual landowners, but will be an essential consideration for utility companies, planning authorities and policy makers.

The capacity of the natural environment to provide ecosystem services is threatened by habitat loss, climate change, pollution, invasive species and plant diseases, and inappropriate land management. In addition, society is facing other challenges such as declining health and wellbeing and widening inequalities. Well-designed and delivered woodland creation that drives nature recovery and restores natural processes can deliver ecosystem services that are of immense value to people. To this extent, new woodland can be seen as a **nature-based solution** to these environmental and societal challenges.

2.3 Setting objectives

To set objectives, it is important to have a sound **understanding of the potential benefits** that could result from your proposals. The following sections provide a summary of the rationale for native woods and trees for each of the eight themes. This will help to inform and guide the development of relevant objectives and your stakeholder engagement [5,6].

Biodiversity

2.3.1 Nature recovery

Trees provide the structure and framework of natural systems in many UK landscapes. Woodland creation can support nature recovery and play a critical role in reversing ongoing declines in the diversity and abundance of wildlife in these landscapes.

Selecting objectives: nature recovery

Your woodland creation project should deliver a conservation outcome and contribute to nature recovery. There are several ways in which you might frame a nature recovery objective:

- The creation of **native woodland as habitat** for wildlife. This places a particular focus on habitat quality and providing habitat mosaics with a variety of niches and resources to support a range of species of woodlands and open habitats.
- **Buffering and extending** existing native and ancient woodland and isolated ancient trees. Increasing the size of native woodlands, reducing negative edge effects and increasing the core area of habitat patches is especially beneficial.
- Contributing to **landscape-scale connectivity**. Species (meta)populations[1] often occupy several habitat patches and need to be able to move across the landscape. Increasing native tree-canopy cover by establishing trees and increasing the amount of core woodland habitat within a landscape will increase this functional connectivity.

- Addressing the **specific requirements of species**, assemblages or communities. You may choose to set objectives with a species focus, either as an indicator of wider habitat quality and biodiversity, or because they are of particular conservation concern in the locality, or because of their iconic nature or wide appeal.
- Your nature recovery objectives will generally focus on wildlife associated with woods and trees, but on many sites you may also choose to set objectives for **other features of conservation value** on the site. This could be to protect, restore or enhance other semi-natural habitats and associated wildlife, such as populations of rare and scarce plants or ground-nesting birds of wetlands, grassland, heathland or scrub.

The **size and location** of a site will strongly influence its potential contribution to nature recovery, and consideration of the **landscape context** is important in establishing objectives and more detailed long-term management. Site-level conservation objectives should be set to ensure that the site contributes in the best possible way to achieving wider landscape or regional objectives for conservation, such as Nature Recovery Networks or strategies.

Individual species or species groups may be of importance or concern at a landscape or regional level. Often, sites can contribute best when you consider how they fit into wider plans for conservation of species as part of habitat networks. This may include modifying woodland creation plans where rare or threatened species associated with open habitats might be negatively impacted, such as ground-nesting waders which could suffer from predation if trees are too close.

Scale and connectivity are important, and the diversity and abundance of wildlife will be higher in larger and better-connected woodland habitats. For example, while small woodlands in lowland arable landscapes provide breeding habitat for some of the more common woodland birds, the likelihood of the

Heath fritillary, recovered from the brink of extinction as a result of habitat management and creation in the south of England.

presence of breeding pairs increases significantly in woods above 10ha. For some of the most specialist species, larger woodlands are needed as woods usually only provide the range of resources required to support breeding marsh tits and nuthatches when they exceed 25ha [5].

The importance of smaller patches of quality woodland habitat and individual trees shouldn't be underestimated, however, as these can provide vital feeding habitat or form part of a network between larger sites for woodland birds or bats, for example.

Taking into consideration existing landscape-wide plans for species conservation, the size and location of the site and the practicalities of management, it may be that there are specific tree species or woodland structures that would allow the site to contribute to broader aims. This might include temporary or permanent open ground as well as closed-canopy woodland.

There may be **species-specific objectives** for woodland creation. **Categorising species** can help with setting clear objectives for species and will fall into one or more of the following categories:

Flagship: species which act as an ambassador or symbol for the site or project. Flagship species are usually relatively charismatic and are useful in engaging people and telling the story of the project (examples would be black grouse, dormouse or red squirrel).

Keystone: species that play an essential role in the structure, functioning or productivity of a wooded ecosystem. Sometimes known as ecosystem engineers, the loss or absence of a keystone species can lead to significant ecosystem change or dysfunction. Keystone species are most often the object of species-reintroduction programmes (examples would be beaver, pine marten or even mycorrhizal fungi!).

Indicator: species which provide an indicator of, or proxy for, the quality or condition of a wooded ecosystem or processes within it. Conservation actions are not directed towards management of that species, instead they provide a measure of the value of the site to a wider community or assemblage of wildlife (examples would be species of lichen, bats [Bechstein's, Barbastelle, lesser horseshoe], woodcock, redstart, hedgehog), while many plants will be useful indicators for the condition of different structural components (groves, open wooded habitats and glades).

Target: species with small or declining populations that face local extinction risk without intervention. These are the targets of conservation action, and work to support them is not directly intended to help other species. Any action for target species should aim to re-establish viable populations that are sustainable in the long term (examples would be pearl-bordered fritillary and adder).

The **Woodland Wildlife Toolkit** provides information on the **woodland specialist species** that are present in the area and factsheets that include information on their habitat requirements. Some species are associated with specific tree species, and many have preferences in terms of woodland structure. The choice of tree species, creation design and long-term management may all be influenced by species-specific requirements.

Examples of nature recovery objectives

Urban site: Create pockets of new native woodland as part of the green infrastructure of the suburb of Fernwood using a diversity of smaller native tree and shrub species. Over time, this will achieve an interconnected network for urban wildlife through provision of shelter, food, and nesting opportunities, that links to the larger wood on the edge of town.

Lowland farmland site: Integrate open grown trees within the five acres of unproductive pastureland, and replace any hedgerow trees lost to ash dieback, to create wildlife-rich habitat for birds and pollinators on the farm.

Big upland site: Recover black grouse populations by transforming the bracken-dominated hillside into structurally diverse native woodland and scrub, with sheltered open glades.

Useful resources

- **Woodland wildlife toolkit.** Interactive map data (regularly updated) showing which rare or declining woodland species are present within the search area, and their habitat and management requirements. Also includes woodland condition assessment method and forms.
- **Devon biodiversity action plan.** Example of a local biodiversity action plan. Provides information on priority habitats and species of importance to the area, and action required to support them.
- **RSPB Futurescapes; Nature Recovery Networks – The Wildlife Trusts; Plantlife – Important plant areas.** Examples of landscape-scale nature-recovery programmes.
- **Butterflies recovery programme** (website, Butterfly Conservation). An example of a species recovery programme. Provides detailed information and maps on priority areas and habitat needs.
- **Priority species in Carmarthenshire** (website with links, Carmarthenshire County Council, 2020). An example of area species action plans. Provides detailed information on local areas of priority and habitat needs.
- **Woodland creation for wildlife** – a guide to creating new woodland for wildlife in Kent and East Sussex. David Blakesley (2006). East Malling Research. Only available in print.
- **Woodland creation for wildlife and people in a changing climate** – principles and practice. David Blakesley and Peter Buckley (2010). Pisces publications. Only available in print.


PHILIP FORMBY/WTML

New native woods and trees on previously intensively farmed mineral soils will maximise carbon sequestration.

Regulating services

2.3.2 Climate change (mitigation)

New native woodland can **capture (sequester) carbon** and develop as a **long-term carbon store** in living woody matter and soils. Increasing the area of the UK covered by woodland is one of four key measures described in the UK's Sixth Carbon Budget to help mitigate dangerous climate change. The budget also recommends a 40% increase in the length of the UK's hedgerow network (including open grown trees) to further sequester and store carbon and help avoid soil loss and build soil carbon.

Intensive agricultural production (arable or intensively managed grassland), especially on organic soils, releases carbon into the atmosphere. **Changing land use** to low-input pasture significantly reduces carbon deficits and, in most cases, can result in carbon being sequestered [7]. The creation of woodland habitats dramatically increases carbon storage. Even the addition of relatively few trees on permanent pasture can increase carbon storage significantly. Ceasing cultivation allows for the buildup of soil carbon, and woody trees and shrubs of all types will begin to sequester carbon in all their living parts – above and below ground. Woodland creation also reduces other carbon-intensive inputs such as inorganic fertilisers [7].

When it comes to carbon storage, **soil type matters!** Woodland created on **mineral-based soils** with low organic matter content has the potential to sequester and store large volumes of carbon. On soils with a **higher organic matter content** (e.g. peaty soils) the balance of carbon loss to gain will be more dependent on the current use and condition of the soils, and how new woods and trees are established. When trees are established on carbon-rich soils, carbon moves from a very stable and long-term pool in the soil to a more mobile and short-lived pool (depending on end use of the timber). Where the opportunity to restore fen or bog habitats exists, this is likely to offer much greater potential for carbon storage and meet other objectives (e.g. nature recovery, water) [8,9].

Although the speed of sequestration in the woody mass of trees is affected by the **tree species and growth rates** at each site, the **long-term storage** at a site is likely to be more affected by the **intrinsic characteristics** of the site itself, and the **management**. Undisturbed sites will continue to accumulate carbon and will generally store more carbon than those subject to regular intervention and removal of timber. While it is true that cut timber can itself act as a carbon store where it remains in long-term use, many of the uses for harvested timber, particularly of lower-grade timbers, is short term and leads to the release of carbon back into the atmosphere relatively quickly.

Significant carbon losses can occur during the initiation phase of woodland creation if soils are disturbed during site preparation and planting. **Minimising soil disturbance** is an important consideration, both in initiation and for long-term management proposals. However, on peats and organo-mineral soils it is possible that any tree establishment (including through natural colonisation) will contribute to soil carbon losses. Felling, forwarding and transport of timber all need to be carefully planned and managed to minimise soil disturbance and carbon loss. The sensitive harvesting of native hardwoods in a continuous cover system, feeding into local supply chains, will often be achievable with minimal impact on climate change mitigation objectives.

Selecting objectives: climate change mitigation

Although most new woodland will sequester and store carbon to a degree, selecting 'mitigate climate change' as a core objective for your native woodland/tree project is entirely appropriate alongside other objectives, particularly where:

- your chosen site will replace a more climate-damaging land use; and/or
- establishing trees and woodland on mineral soils; and/or
- there is good/reasonable potential for tree/shrub growth; and/or
- the site is likely to remain undisturbed over a long period following establishment; and/or

- natural colonisation can be a significant component of the initiation phase; and
- you can meet the requirements of the Woodland Carbon Code (or provide other evidence of claimed carbon benefits, particularly where this is attached to payments)
- you would not be displacing a more appropriate opportunity for nature recovery (e.g. to restore bog or fen).

In many cases, carbon capture and storage is highly compatible with nature conservation aims. However, it can involve compromises, such as where regular intervention has been identified as important for the nature conservation value of the site (e.g. retaining early stage woodland for bird species or woodland plants). Any carbon objectives will need to consider these.

Examples of climate mitigation objectives

Big upland site: Create 143ha of native woodland in the remote northwest highlands of Scotland to capture approximately 49,000 tCO_2e over the next 100 years, while protecting and enhancing peatlands as existing carbon-and nature-rich habitats.

Small lowland site: To assist mitigation of climate change, establish approximately 15ha of new native woodland as part of a move from a mainly arable farm to a mix of woodland, cattle pasture, wetland, and wood pasture. Through the new planting and natural regeneration of trees, increase carbon sequestration as well as future adaptation through shade provision for cattle, reduced soil runoff and improved water quality.

Useful resources

- **POST research briefing: woodland creation** (UK Parliament, 2021). Summary of creation for carbon and the key factors influencing how much carbon is taken up.
- **Sixth Carbon Budget** (Climate Change Committee, 2020). UK targets for woodland, peatland and trees outside woods to mitigate climate impacts.
- **Carbon storage and sequestration by habitat** (Natural England, NERR094 2021). Provides a comparison of carbon qualities by habitat.
- **Climate change factsheet: Climate change and forests** (Forest Research, 2021). Summary of key evidence.
- **Trees and carbon position statement** (The Woodland Trust).

- **Forestry statistics 2020, chapter 4, carbon** (Forest Research). Carbon facts and figures for the UK, and **here** for carbon data sources for forestry statistics.
- **UK Woodland Carbon Code** (WCC) (website). The quality assurance standard for woodland creation projects in the UK. Includes tool to generate independently verified carbon units under a range of scenarios.
- **Carbon, trees and forests – resources for Wales** (website, Natural Resources Wales, 2019). A range of climate change and carbon resources relevant to Wales.

DANIEL ROMANI/WTML

Well-placed woods and trees can help reduce flood peaks, reducing risk to properties.

2.3.3 Water – water quality and flood management

Storm and flood events, and their severity, are increasing, and so is their economic, social and environmental impact across the UK. Water use is also increasing, and good quality untreated water is incredibly important to reduce overall costs of water treatment and supply to people, as well as being critical for healthy wildlife. Geographical location, altitude, topography and geology, are the primary determinants of the volume of water reaching the ground and how quickly it runs off. Soils, land use and management, and the surfaces of the built environment are also significant for water flow rates, infiltration and runoff, and water quality. Trees can rapidly **increase water infiltration** and **reduce the rate of surface water runoff**, **reducing peak flows** during flood events and **improving water quality**. The distribution of woods and trees within a catchment can greatly influence the impact on water quantity and water quality.

Different tree species have different rooting depths, and physical structure (leaves/needles, etc.), as well as varying tolerances of waterlogging, for example. Conifer species (often non-natives) can result in increased acidification of water in catchments with already acidic soils. Generally, the **location** of woodland in relation to intended water benefits, as well as any **management** or harvesting regime and associated soil disturbance levels (e.g. clearfell relative to continuous-cover approaches), are more significant than tree species. Evidence is limited on the water benefits of different tree species or woodland types [10].

Selecting objectives: water quality and flood management

Choosing to create woods and trees for water quality and management as one of your primary objectives is particularly significant in the following situations:

- **Opportunity mapping for new woodland creation to reduce flood risk and/or increase water quality** has been undertaken in various places around the UK. If your woodland creation site lies within a **high priority area,** then strong consideration should be given to prioritising this objective.
- In **upper catchment** areas, woods and trees can increase water infiltration and reduce the rate of surface water runoff, reducing peak flows and soil erosion during heavy rainfall. In these areas, it may be possible to realise local benefits from woodland creation which reduces local flash flooding and erosion and contributes to mitigating flooding at lower levels in the catchment. Woodland creation should be combined with other **measures to slow the flow**, such as woody debris dams/leaky wood structures and blocking field drains, to reinstate more natural hydrology and help attenuate peak flows. There are certain risks when installing leaky wood structures which should be considered and mitigated for.
- Further down the catchment, **floodplain woodland** can also slow floodwater flows and reduce the risk of downstream flooding. Since flooding in the lower catchment is generally affected by numerous smaller catchments feeding into a river system, woodland planned for flood mitigation will have most impact where it is part of a wider plan for flood alleviation which considers the implications of slowing flows in different parts of the catchment.
- In **urban areas**, surface water flooding is a major problem. Tree canopy cover intercepts rainfall and can reduce and slow throughfall, while tree roots increase infiltration, helping to reduce surface water flooding. Surface water maps are available for the UK which identify areas at greatest risk. Woods and trees in urban areas can contribute to Sustainable Urban Drainage systems (SUDs).
- Woodlands are generally associated with very low or no inputs of fertiliser and pesticides, and only occasional periods of soil disturbance, linked, for example, to initial planting, thinning works and harvesting. Consequently, woodland cover can be effective for protecting **water quality** by, for example, reducing sediment loads in runoff compared to pasture or arable land. Riparian tree planting can provide a barrier to capture organic and inorganic pollutants and prevent them entering water courses. This includes animal faecal matter, inorganic fertilisers and pesticide residues, as well as providing a physical barrier to reduce pesticide spray drift. Shade provided by riparian trees can also reduce water temperature – important for aquatic wildlife in the face of climate change.

- In some locations, however, **woodlands can reduce water quality** by enhancing the capture of pollutants such as acid deposition and ammonia, and from the air (particularly true of conifer needles), exceeding the capacity of the soil and bedrock to cope with them. These and related issues are addressed by good forest design and management practices.
- Creating extensive areas of woodland in water-deficient ground-water catchments and surface-water catchments subject to low flows can have a **negative impact on water availability**. This generally is an issue with conifer woodland and short-rotation coppice/forestry (as indicated by UKFS), but native broadleaf woodland can use more water than other land uses, and this may be a consideration in your design.

Examples of water objectives

Lowland site: Create a mosaic of native woodland and wet grassland within the water catchment and undertake river restoration by installing leaky woody dams to restore natural hydrology, improve water management and reduce sediment entering the river.

Urban site: Achieve a final canopy cover of 30% across the suburban development. Include woods and trees located to intercept surface water flows and increase infiltration of surface water and filter pollutants, as a key component of the Sustainable Urban Drainage system (SUDs).

Useful resources

- **Opportunity mapping woodland creation for water.** National maps for England, Wales, Northern Ireland and catchment-scale maps for parts of Scotland and other locations across UK. Also part of **MAGIC (defra.gov.uk)** for England and Wales.
- **Working with natural processes to reduce flood risk.** The evidence base for working with natural processes to reduce flood risk. Contains useful diagrams and maps, and the catchment woodland chapter has some good evidence about role and type of woodland in reducing flood risk (2021). Flood and Coastal Erosion Risk Management Research and Development Programme and Environment Agency.
- **Assessing risk of using leaky woody structures in flood mitigation** (Forestry Commission, Environment Agency, 2019). How to assess and mitigate risk of installing leaky wood structures.
- **Forestry and water quality** (website with links, Forestry Focus). Irish website, useful on effect of conifers and acidification.
- **Sustainable urban drainage** (website with links, Forest Research). Introduction to evidence and practice of SUDs, with case studies.
- **Keeping rivers cool** (The Woodland Trust, 2016). Creating riparian shade for
- climate adaptation.

PHILIP FORMBY/WTML

Well-placed trees and hedgerows can intercept and disperse pollution from vehicles.

2.3.4 Air quality

All vegetation which photosynthesises produces oxygen as a by-product – maintaining the balance of the atmosphere and promoting air quality overall. Across the UK, urban air pollution causes between 28,000 and 36,000 deaths each year, and many more illnesses[11]. Atmospheric ammonia pollution from intensive livestock housing and slurry-spreading causes damaging impacts on wildlife habitats, with over 80% of UK woodland affected [4].

Taller vegetation like trees and shrubs can also be useful in **blocking, diverting, dispersing** and even **removing** air pollution (both particulates and gaseous) from sources such as agricultural ammonia emissions, industrial emissions and/or vehicle emissions in urban areas, where such vegetation is known as 'green infrastructure'. This can help to improve air quality for people (e.g. pedestrians, cyclists, in school playgrounds or in parks and gardens), to protect livestock, or to buffer sensitive habitats, such as ancient woodland or species-rich grassland. The value of new woods and trees for wildlife may be reduced where they are exposed to high levels of ammonia or other pollutants.

The choice and mix of tree species, their structure and location, can greatly affect the impact of woods and trees on air quality. Often, trees and shrubs located to improve air quality will have the additional benefits of reducing noise pollution (e.g. from vehicles, quarries and industrial sites), regulating local temperatures by providing shade and evaporative cooling in hot weather, protection and shelter in cold weather, and as components of sustainable urban drainage systems regulating peak water flows in high rainfall events[12].

Selecting objectives: improving air quality

- Identifying **improving air quality** as one objective of your woodland creation project can make an important contribution to the lives of people, livestock, wildlife and habitats if your site is **located in an area with air pollution impact issues**. Such areas might include urban streets, school playgrounds, hospital grounds, city car parks, city parks and green space, around industrial sites, intensive livestock units (pigs, poultry, dairy), and around sensitive habitats where there is a pollution source in the vicinity.
- Individual and groups of trees, hedges, shelterbelts, and woodland can all be appropriate, depending on the circumstances. The **use of green infrastructure to reduce exposure to air pollutants** is a relatively new and fast-evolving area of research, but a broad principle in improving air quality overall is to reduce pollutants at source as well as implementing measures to limit exposure to the pollutants (such as woodland creation). Using native tree species is recommended for their additional contribution to wildlife objectives, but they need to be species which can tolerate the often specific and challenging conditions in polluted and/or urban areas. In some challenging conditions, certain non-native trees may be more suitable.

Examples of air quality objectives

Urban site: Improve air quality, so the walk to school is safer and more pleasant, by dispersing fumes from traffic with the creation of a hedgerow buffer between the footpath and the road.

Rural site: Reduce deposition of quarry dust onto the adjacent ancient woodland by creating a 100-metre buffer of native trees and shrubs.

Useful resources

- **UK emissions interactive map** (Government department BEIS). A searchable map with UK emissions risk of a long list of potential pollutants. Updated annually for a range of air pollutants, including ammonia.
- **Role of trees and other green infrastructure in urban air quality** (Institute of Environmental Sciences, 2019). Helpful diagrams for tree placement for pollution management in urban situations.

- **Using green infrastructure to protect people from air pollution** (Mayor of London, 2019). Practical advice, useful diagrams and an evidence review.
- **Improving air quality – Forest Research.** (Website with links). Summary, with links to other resources.
- **Using trees in free-range poultry farming** (The Woodland Trust). Advice on preventing ammonia-pollution impacts using trees.

Cultural services

2.3.5 Landscape and the historic environment

Landscape is an overarching concept which comprises **natural components** (topography, habitats, hydrology)**, human influences** (field pattern, land use and management, access), **aesthetic qualities** (visual and sensory perceptions), **and cultural values** (historic environment and social and personal associations). As such, **landscape** and the **historic environment** are **integrating themes** which should inform all stages of woodland creation. However, there may be circumstances where you wish to select them as specific objectives of your project.

Woods and trees provide the framework for many of our landscapes and, for some, are their defining feature. Scattered pines in the Scottish Highlands, coastal oak woods hugging the hillsides of the UK's Atlantic fringe, intricate networks of hedgerows and scattered woods across pastoral lowland landscapes, extensive wood pastures with their distinctive ancient trees – surviving remnants of medieval hunting forests – and woodlands carpeted with bluebells and other flowers in spring, to name just a few. In our towns and cities, street trees create leafy avenues and meeting points in city centres, while groves and mature trees bring wildlife, colour and shade to our urban parks and gardens.

As land use has intensified, landscapes have become increasingly **structurally and visually simplified**. The cover of native woods and trees has also reduced, resulting in landscapes that are ecologically and aesthetically degraded. Their character can be used to help people understand **past and current landscape change** and should not be seen as a constraint on the opportunities for restoration and enhancement. In some degraded landscapes, there is great potential to create new, distinctive and high-quality landscape character that people will come to value.

The **historic environment** contributes everywhere to our **sense of place**. Better understanding of how landscapes have evolved will help inform and manage change and enable carefully designed place-making, including woodland creation. Historic landscape characterisation and landscape character assessment begin from the premise that all landscapes have **layers of history**, all is of interest, and all can be managed appropriately, including enabling their evolution. **Historic**

features within landscapes are, by definition, irreplaceable, although their rarity and/or value to society may vary significantly. Often, it is not the feature itself that is particularly remarkable, but its context in a landscape setting, and the stories it can reveal of past lives and livelihoods when taken together with its surroundings. History is constantly being created and new woods and trees can play an important role in valuing, enhancing and protecting past landscapes, while creating new landscapes for future generations to be proud of[13].

Many of the **National Parks, Areas of Outstanding Natural Beauty and National Scenic Areas** (the statutorily protected landscapes in Great Britain which cover up the 25% of England, 15% of Wales and 7.5% of Scotland) aspire to increase the cover of native woodland and trees to restore and enhance landscape character, support nature recovery and tackle climate change [14].

Woodland creation in these **protected landscapes** should give additional attention to **landscape-character enhancement** and consider the impact on existing land uses – primarily farming and tourism. Often, farming is seen as a key component of the cultural landscape in these areas and is intrinsic to it (e.g. the World Heritage status recently awarded to the Lake District National Park based on its cultural landscape). Woods and trees (particularly those which are ancient) are also often an important component of cultural landscapes; however, woodland creation may be seen as conflicting with established land use and landscape aesthetics.

Despite the many positive benefits that woods and trees can bring to landscapes, there may be resistance to change, particularly where creation has a strong visual impact in a landscape. Genuine **engagement and consultation** with local people to build understanding, and engaging local communities in the design process, can lead to successful outcomes. A good way to get people involved in conversations about a project and place is to **look together at how landscape character has evolved** through the natural and human-driven drivers for change that have influenced the place over time, and invite people to contribute their own local knowledge to the evidence and character assessment.

Scattered natural colonisation on a hillfort at Glen Finglas, part of the extensive restoration of the cultural wood-pasture landscape.

Selecting objectives: landscape character

There are many reasons to select enhancing landscape character as an objective of woodland creation.

- The **important qualities** of a landscape can be **conserved and enhanced** through woodland creation; for example, by re-creating areas known to have once been ancient woodland – sometimes known as ghost woods. Understanding the landscape character in which your new woodland or trees will sit is critical.
- Ensuring that the **cultural values** attached to woods and trees in the landscape are reflected in your plans for woodland creation is advisable. The perspectives of local people and visitors are important, in order to understand and reflect the **sense of place** that defines people's experience of the landscape.
- Often, landscapes have been simplified over time – with woodlands and grazed commons being cleared for farming systems which have become progressively less complex – with less mixed arable and livestock farming, a smaller range of crops grown, much increased field sizes (often at the expense of hedgerows and field trees) and greater use of agrichemicals. New diverse and distinctive native woods and trees in such landscapes can massively increase landscape heterogeneity, begin to restore wildlife and **create a more visually complex** and **reconnected landscape** with new mosaics of colours, textures, smells and sounds, which are more engaging for people.

Selecting objectives: historic and cultural environment

- Where your proposed woodland creation site contains **features of historical or cultural interest**, then protecting, enhancing and interpreting these may be a priority objective. Historic environment features at an adjacent site could also be affected by your woodland creation plans, so it will be important to investigate this.
- The establishment of new woods and trees **should not negatively impact** historic environment features. These may include **sub-surface archaeology** which can be damaged by ground preparation and tree roots, carefully designed **landscape vistas** that can be destroyed by inappropriately sited trees, as well as **surface archaeology** and **landform** which can be damaged by vehicles and machinery. **Scheduled Ancient Monuments** need to be kept in an open context and visible, so should generally be kept clear of trees, and the influence of nearby trees should be monitored.

- Well-designed new woods and trees can be used to **enhance the landscape context** of historic features, bolster boundary patterns and reveal and restore nuances within the landscape setting which may have been lost over time. There may also be strong links between historic features and wildlife value. For example, unploughed and unfertilised grassland which has protected ridge and furrow may be botanically rich; wood bank features or burial chambers may hold ancient woodland or grassland indicator plants; historic boundary trees (often pollards) may have become biodiversity-rich ancient trees over time; and lakes or water bodies in designed landscapes may have developed a rich wetland biodiversity.
- In many cases, local communities will have a strong cultural tie to an area of land and this may be historic and/or continuing. It may include **traditional use of the site**, association of **local names** for parts of the site or features, site-specific **folklore** or local historic events associated with the site. Many such **cultural links** are not immediately obvious or lead to any formal or statutory designations yet can be of very significant interest and concern to local people. Some simple discussion with local people and neighbouring landowners can often elicit such connections, which can be accommodated in your objectives.

Examples of landscape, historic and cultural environment objectives

Big lowland site: Undertake large-scale native woodland expansion on former arable land in the Blean complex Special Area of Conservation, re-connecting the ancient Ellenden and Blean Woods. Enhance the spectacular views over the north Kent coastline through sympathetic placement and spacing of trees, wide rides, and management of non-wooded semi-natural habitats.

Upland valley: Clear bracken to recover the charcoal hearths along the valley as part of the re-creation of native woodland which once covered this valley and supported a thriving charcoal industry. Use interpretation to explain to visitors the significance of woodland to the industrial heritage in this area.

Useful resources

- **National Character Areas (NCAs) profiles – data for local decision making.** Natural England guidance on 159 landscape character areas for England.
- **Scottish landscape character types map and descriptions, NatureScot.** Website and interactive map describing the landscape character of Scotland.
- **Natural Resources Wales/National Landscape Character Areas (NLCAs).** Website and interactive map describing the landscape character of Wales.
- **Historic landscape characterisation maps for England (website)**. County or protected area level interactive maps providing a time-depth view of landscapes. If not available on this site, you will need to contact the relevant local Historic Environment Record via your local authority.
- **Historic land-use assessment project for Scotland.** Interactive maps of current and historic land uses, including farming, forestry, recreation, charcoal burning or prehistoric agriculture and settlement.
- **Historic environment resources from Forest Research** (weblinks). Various links to historic environment and landscape resources relating to woodland.
- Protected landscapes: check websites of the relevant AONB or National Park (and equivalents) for the Protected Landscapes Management Plan and their Landscape Character Assessment, along with any helpful resources such as tree and woodland strategies, woodland opportunity studies and maps, woodland sensitivity studies, and locally relevant woodland design guides.

2.3.6 People (access, recreation, skills and learning, community involvement and employment)

Woods and trees are good for our health and wellbeing. Many of us feel this intuitively, and there is a growing body of research to back this up. It shows that access to woodland can make us **physically healthier, improve mental wellbeing and increase quality of life**. The closer our homes are to green spaces, the more likely we are to use them.

We want people to enjoy and value woodland, not only for their own benefit, but for the benefit of our woods and wildlife too. A valued wood is more likely to be looked after and protected for the long term. Established woodland can welcome large numbers of visitors without detracting from the experience. And as they are such rich and diverse natural habitats, they make for **exciting and inspiring places to visit**. Increasingly, woods are becoming more welcoming to people with disabilities. Creating and caring for woods near people's homes can provide new opportunities for recreation and learning in local communities. In many parts of the UK, significant numbers of people do not have any nearby woodland they can visit. The reasons are twofold: many woods are under private ownership and have no legal or permissive access, and/or there is simply insufficient woodland cover.

Selecting objectives: woods for people


Engaging schools and communities in tree planting creates a stronger sense of ownership of new accessible woods.

PAUL GLENDELL/WTML

- Creating new woodland near to people, that's accessible and contains a diverse range of site-suitable native species, will attract wildlife and provide opportunities for public engagement; for example, health improvement activities, recreation, volunteering and learning activities through Forest Schools, college courses and local naturalist societies. New woods with a significant landscape or historic environment element may be particularly attractive as a destination for people.
- Creation of publicly accessible woodland can help to **relieve pressure on existing woodlands** and other sensitive habitats by providing alternative recreation destinations and, as such, should be considered when planning major new housing developments. This is especially important for reducing footfall in ancient woodlands due to their sensitive wildlife, such as ground flora, birds and invertebrates.
- In towns and cities, even **small areas of woodland, trees in clumps and individual trees** can provide significant value to local communities. Benefits of trees in the grounds of schools and hospitals, or street trees, for example, can far outweigh the costs of creating and maintaining them. Such benefits and values, which include everything from the calming effect of natural beauty and bird song to noise reduction, shade in hot weather and pollution abatement, are beginning to be quantified and priced; for example, through i-Tree surveys [15].
- Connection to nature and environmental awareness are associated with positive behaviour and actions. An important element of this is **educating and**

inspiring the environmental guardians and conservationists of the future. Children who learn about woods and trees are much more likely to grow up to be environmentally responsible adults. Planting trees, looking after them and watching their development is a very tangible action people can take to engage with nature. It is always best to include local communities, schools, stakeholders, potential volunteers and partners early on in your plans for your new woodland to help shape the purpose and design and engender a long-term sense of shared responsibility.

- With plans by all UK governments to increase the overall cover of new woods and trees, and increase the level of public funding for this, jobs will be created. By engaging in woodland creation activity, you are potentially **supporting jobs and employment** during all the phases of creating your new woodland. For some new woodlands or groups of woodlands, small businesses or community interest companies have been established; for example, to support forest product and craft industries, deliver recreation and wellbeing experiences, provide educational courses and training opportunities, and establish cooperatives to share machinery or grazing livestock. It will always be worth considering such opportunities during the planning and design phase, particularly where they may require on-site infrastructure.
- For some landowners, providing cover for recreational **game-bird shooting** may be an objective in creating new native woodland. Woods and trees, generally in smaller groves, provide cover and habitat for the released birds, though care needs to be taken to integrate this objective with nature recovery and other objectives.

Example of people objectives

Urban fringe site: Create a new public amenity space for walking, cycling and education (school visits) by establishing new community woodland, hedges, orchard and scattered parkland trees to transform a 95ha, low-grade agricultural landscape, and take recreational pressure off existing fragments of ancient woodland on the edge of the town.

City hospital grounds: Provide peaceful and interesting outdoor space for patients and families and reduce long-term maintenance costs (from regular grass mowing) by transforming the existing grassed areas through the creation of small groves of native trees and open glades connected by wheelchair-accessible paths with benches.

Useful resources

- **Creating a new community woodland – Llais y Goedwig/Community Woodlands.** Advice and resources for creating community woodlands. Welsh-based, with wider applicability.
- **How to set up a forest school – from the roots up!** (Forest Schools Association). Advice on setting up a forest school.
- **Ecological consequences of game-bird releasing and management on lowland shoots in England** (Natural England, 2020). Game-bird impacts and management. Also see **Sustainable game-bird release – guidelines** (GWCT) for downloadable advice.

Provisioning services

2.3.7 Wood products and food production (agroforestry)

(a) Wood products

Splitting chestnut rails on a farm in Kent. Wood products from native trees can reduce hardwood imports and diversify farm businesses.

The UK has an active forestry sector but remains **one of the largest importers of wood products in the world**, second only to China in 2019. That year, wood products imported into the UK were valued at £8.3 billion and included 7.0 million cubic metres of sawn wood, 3.7 million cubic metres of wood-based panels, 8.9 million tonnes of wood pellets and 5.2 million tonnes of paper. The hardwood timbers (the high-value product of native woodlands in the UK) are a relatively small component of these imports, but nonetheless amount to around 100,000 tonnes of imported sawn hardwood products a year. This compares to around 80,000 tonnes per year of domestic production.

Hardwood imports (from broadleaved trees) come primarily from Europe (especially Estonia, Latvia and France) as well as from the USA [1]. Importing timber has an inherent environmental cost related to the distances across which heavy goods are carried. In addition, forestry practices vary between the countries of origin, making it very difficult to evaluate the full environmental impact of imported timber. Where timber is used to **substitute** for other more carbon-intensive building materials like steel or concrete, it's use can contribute to climate change mitigation.

Native woodland in the UK also produces around 700,000 tonnes of **wood fuel** in addition to sawn hardwoods . This can contribute to tackling climate change where its use replaces or reduces the use of fossil fuels. These, along with around 30,000 tonnes of **round fencing material** and other minor products, add up to circa 900,000 tonnes of hardwoods harvested in the UK each year [1].

Native woodland creation can play an important role in growing sustainable hardwood and wood-fuel production in the UK, significantly reducing the environmental impact of domestic resource use. This can provide landowners with an important source of income to support the establishment and management of new woods and trees.

Selecting objectives: wood products

- If you want to harvest trees for **timber products,** such as furniture, flooring, beams and building timber, and sleepers, you will need to reflect this in the design and establishment of new woods, even though the end product may be decades away. This objective will shape species choice and may require specific or selected seed sources. It will also inform planting/establishment patterns and will require management to thin stands and prune trees to encourage straighter growth forms. While there will be some compromises in terms of structural complexity resulting from this, timber production can be compatible with nature recovery objectives if it is designed and managed according to **continuous cover forestry** principles.
- The **infrastructure** requirements for timber production will need to be considered when setting objectives, and early consideration given to the practicalities and costs of forest roads, stacking areas and access to the site for large vehicles and machinery. In addition, any **browsing impacts** from mammals, such as deer and grey squirrel, will need to be addressed from the start (and continuously), in order to grow quality timber.
- There are small, but often high-value niche markets for small-diameter stems for **craft or coppice products,** such as wooden hurdles, plant frames and baskets. These markets are usually very localised, but where a demand exists, they can add a financial or cultural value arising from management during the establishment phase of new woods and trees.
- **Wood fuel** can be produced from a wide variety of woodland structures through practices that are complementary to nature recovery objectives. Irregular thinning can promote dynamism in the woodland system and coppicing can achieve similar effects as conditions change through growth cycles. Wood-fuel production can be carried out at a range of scales, and the design and installation of infrastructure will need to reflect the objective. This could range from forest roads to enable firewood to be harvested alongside

timber, to unsurfaced access routes for off-road vehicles and trailers to enable the gathering of firewood for one or more households.

- Woodland can also provide a variety of **non-wood products**. These could include foraging of fruits, nuts, seed and fungi; cutting fodder for livestock and horses; and collection of resins and woodland herbs for traditional medicine.

Useful resources

- **Managing ancient woodland and native woodland** (Forestry Commission, 2010). Mainly concerns management practices and the link between nature and timber benefits.
- **Timber production from British woodlands** (Sylva Foundation, 2014).
- **The silviculture of trees used in British forestry.** (Savill, P., 2013). 2nd Ed. CAB International. Available in print only.

(b) Food production – agroforestry

In the UK, agriculture and forestry are often considered separate disciplines and production systems, as both have become more specialist over time. Yet, there is an increasing body of evidence and experience from the UK and overseas which shows that, when combined via **agroforestry**, trees, woods and farming can be mutually beneficial. Agroforestry can, for example, enhance farm productivity, increase wildlife, improve soil health and animal welfare, manage water flow and contribute to climate change mitigation and adaptation[16]. Although 72% of the UK's land is farmed, of this, only 3.3% is officially identified as agroforestry[17]. The Climate Change Committee has recommended that 10% of farmed land should be converted to agroforestry to help the UK meet net zero by 2050[18].

As the demand for new woodland grows, alongside many other demands on land in the UK, it is inevitable that much of the increase in tree and woodland canopy cover will need to be on currently farmed land. Agroforestry, when well-designed, can maintain and enhance food production at the same time as delivering a suite of the benefits (or ecosystem services) associated with increased tree cover. Growing two crops from the same land – such as rows of fruit trees through arable crops or combining livestock and timber trees – can increase total yield from a given area compared to monocropping (producing each item in separate areas). Productivity increase can be significant and, in some cases, up to 40% [19]. Tree products, such as wood fuel, timber, fruit, or nuts, can enable a business to spread risk, provide a smoother, year-round demand on labour, save on the purchase of inputs and add value.

In its broadest sense, agroforestry has been present in the UK for centuries as it includes traditional practices such as hedgerows, wood pasture and parkland, as well as newer innovative systems like silvoarable cropping. The more traditional agroforestry systems have often become redundant, and with that the loss of the subsidiary benefits. For example, where fencing has replaced hedgerows to contain livestock, this has come at the expense of nutrient-rich hedgerow fodder and livestock shelter, and with the loss of the stabilising effect on soils, and the landscape and wildlife benefits of a dense hedgerow network.

What is agroforestry?

Agroforestry describes farming systems that combine trees or shrubs with agricultural crops or livestock. It is a land-management approach with multiple benefits. It can enhance farm productivity, increase wildlife, improve soil health and animal welfare, manage water flow and contribute to climate change mitigation. Agroforestry can be designed in such a way that avoids potential trade-offs between food production and public goods that occur in many modern farming systems.

Table 2.3. Types of UK agroforestry

Agroforestry system	Description	Forest land (official land-use classification)	Agricultural land (official land-use classification)
Silvopasture	Trees in fields	Forest grazing	Wood pasture Orchard grazing Individual trees
Silvoarable	Trees in fields	Forest farming	Alley cropping Alley coppice Orchard intercropping Individual trees
Agrosilvopasture	Trees in fields	Mixtures of forest grazing and forest farming	Alley cropping and/or Alley coppice and/or Orchard intercropping and/or Individual trees
Hedgerows, shelterbelts and riparian buffer strips	Trees between fields	Forest strips	Shelterbelt networks Wooded hedges Riparian strips

16,20

Selecting objectives: food production via agroforestry

Restoring the vital connections between trees, woods and agriculture, and creating innovative ways to solve food and climate sustainability challenges, are great reasons to select agroforestry as an objective for your creation project.

In the following circumstances, food production via agroforestry could be an important objective of your plans:

- Where you need to enhance **farm productivity and business resilience** by delivering a range of services for existing farm enterprises and/or deliver a range of additional products and employment opportunities for the farm business. Practising agroforestry can help farm businesses to be diverse and produce a combination of products from the same area.
- When you have **limited space**, with not enough room for both woodland and farming, creating areas that combine both can be a highly effective use of land.
- Where providing **shade and shelter for livestock** by hedgerows, shelterbelts and in-field trees will reduce impacts of extreme weather and can increase daily live weight gain, reduce neonatal losses and enhance milk yield and fertility. Access to tree cover will also enable livestock to exhibit natural behaviours and reduce animal stress (e.g. for sheep or free-range hens). Provision of tree browse can provide both nutritional and medicinal benefits to ruminant livestock [21,22].
- **Trees as windbreaks in arable fields** will act as natural barriers, reducing soil erosion and improving crop growth and yields through the modification of the crop microclimate by reducing wind speeds and evapotranspiration losses (improving crop water efficiency) [23].
- Arable and horticultural enterprises can benefit from the increased **habitat for pollinators** and beneficial insects that agroforestry will provide [24].
- **For water management,** including trees on farmland, which can help slow the flow of runoff from farms, thereby moderating downstream flood flows and reducing soil erosion. The deep roots of appropriately placed trees can help minimise the leaching of nitrate.
- **To enhance biodiversity**, with two principal benefits for nature conservation from agroforestry systems, particularly where those systems use native tree species:
    - In-situ benefits for species which are supported by those tree species – especially insects, arachnids and other invertebrates, and birds.
    - Increased landscape connectivity – as a result of a less hostile agricultural matrix and the potential of agroforestry to provide 'corridors' for the movement of some species, including some birds, bats and moths, and species associated both with trees and more open vegetation together [25]. This is especially important where there have been heavy losses of trees outside woods (e.g. as a result of Dutch elm disease or ash dieback).

Example objectives – wood products and food production

Estate woodland (wood products): Extend our capacity to grow high value hardwood timber by planting selected seed stock of native oak in several stands of around 0.5ha each across the 20ha of fields we have earmarked for woodland creation – adjacent to our existing managed ancient woodland. We intend to manage this on a continuous cover basis and will take early thinnings of birch and hazel to use for craft products and firewood. (Fencing and deer management infrastructure required, and we are already part of the local deer management group.)

Small farm (food): Plant 2ha of native woodland within the mixed farm to provide wood fuel for the farmhouse through coppicing, and integrate fruit and nut trees in alleys among the arable crops to diversify farm income, generate year-round employment opportunities, and spread risk. The trees will additionally provide windbreaks for the crops, reducing soil erosion and encouraging wildlife and crop pollinators, as well adding capital value to the land.

Useful resources

- **The agroforestry handbook** (Soil Association). The essential guide to agroforestry and how to implement it – practical, economic and marketing advice based on evidence and experience.
- **Role of trees in sheep farming; Tree leaves for livestock; Role of trees in arable farming; Role of trees in poultry farming; Agroforestry for pest and pollinator control** (The Woodland Trust).
- **Advice on managing woodland for pollinators** (Defra).

Young trees can help stabilise eroding soils in areas of high rainfall such as here in the Cumbrian hills.

Supporting services

2.3.8 Soils

Soils underpin all woods and trees – their physical, chemical and biological characteristics largely determining the woodland communities which can develop at any given site. Soils must be **a fundamental consideration of all aspects of woodland creation** design, initiation and establishment. In some circumstances, conservation or restoration of soils and the ecosystem services they support (e.g. carbon storage, water management, pollution abatement, historical archive, vegetation productivity and so on) could become a **core objective** for a particular native woodland creation scheme. Increases in extreme weather (storms, droughts, high-rainfall events, etc.) create an even stronger imperative for soil conservation in woodland creation. Loss of topsoil through erosion is an increasing problem in many parts of the UK due to a combination of changes in cropping – leaving soils exposed to winter rainfall – and an increased frequency of intense rainfall. The soils on your site may be connected to a wider system, such as a catchment, so it is important to consider the implications of your interventions beyond your own site.

Selecting objectives: soils

Choosing soils as a core objective of your woodland creation plans would be appropriate in the following circumstances:

- Agroforestry and hedgerows on cultivated farmland to **reduce topsoil erosion and loss**. For example, in parts of eastern Britain, light sandy or dry peaty arable soils are liable to wind erosion, while heavy rainfall contributes to soil erosion in other areas. Tree belts **reduce wind speeds** and trap blowing soils. Tree shade can also reduce soil temperature, reducing desiccation and supporting better crop growth in extreme heat.

- Planting of tree belts across slopes on **soils liable to water erosion** increases infiltration and reduces the speed (and energy) of runoff. Tree belts and hedges on field margins can also reduce soil running into drainage channels and water courses.
- Upland woodland creation in **high rainfall areas** to increase water infiltration and reduce soil erosion and land slips, reduce down-stream flood risk and enhance water quality. Water infiltration can also be increased by reducing grazing, livestock pressures and compaction, which often go hand-in-hand with woodland creation.
- Restoring soil nutrients and soil biodiversity to **'leached out' soils in upland** areas (which probably had tree cover in the past), or to **depleted/compacted arable soils**.
- Establishing trees/woodland/scrub on riverbanks to **reduce bankside erosion** in peak flows.
- Upland bog-fringe woodland to help stabilise the **'eroding edge' of blanket bog**.
- Woodland to buffer sensitive habitats downstream – to **reduce agricultural pollutant runoff** into them.
- Woodland creation on **brownfield sites** (such as ex colliery and capped waste tips) provided they do not have existing nature conservation interest of higher value. This may involve restoration of **toxic soils**.

Unsuitable soils

Some soils are unsuited to woodland creation, and there is an increasing body of evidence on this topic. One example is **deeper peats** which can store significant volumes of **carbon** which will be released by tree planting and, in good condition, are generally too wet for significant tree growth. (Check current UKFS guidance and country-specific guidance for information on peat depths and tree planting.) Deep and shallow peats are capable of supporting **other high value habitats** such as blanket bog and fen. This is also true of other soil types and high value habitats that occur on shallow peats, peaty organo-mineral soils, and other mineral soils. These interests may mean that other soils are unsuitable because they support non-woodland nature recovery objectives. Many upland peats in the UK have been drained with the explicit objective of improving vegetation growth for livestock grazing or tree planting for forestry. Such drainage, along with the growth of tree roots, can lead to drying out of the peat which results in soil carbon losses.

Some **skeletal soils** which are very shallow, rocky or stony and drought-prone, may also be unsuitable both in terms of the conditions which few trees and shrubs may successfully establish in, and because they may support high-value habitats (e.g. chalk grassland). The suitability of soils needs considering alongside many other factors, such as how trees are established and which species might be appropriate. Accurate soil survey and mapping will be particularly important in such circumstances, and woodland creation activity may need to include other measures, such as blocking peat drains to restore a more natural hydrology.

Examples of soils objectives

Lowland example: Combine trees with the cereal crop on 50ha of lowland farm in a silvoarable scheme, and establish shelterbelts to protect the fine grade soils from wind erosion, restore compacted soils, replenish soil nutrients and soil biodiversity and enhance water penetration.

Upland example: Having removed intensive sheep grazing from the site, plant native trees in the eroding gullies to prevent further erosion, stabilise soils and increase infiltration and trap sediment to protect the drinking water reservoir downstream.

Useful resources

- **Decision support framework for peatland protection and the establishment of new woodland** (UK Government, 2021). Intended as a guide to interpreting and applying UKFS in England only.
- **Carbon storage and sequestration by habitat** (Natural England, 2021). Useful evidence on carbon storage in vegetation and soils and comparisons across habitats – see woodland, woodland creation, scrub, hedgerow and peatland chapters.
- **The role of trees in arable farming** (The Woodland Trust). Arable land and soil protection advice.
- **The opportunities for woodland on contaminated land** (Forest Research, 2002). Older guidance, but still useful regarding species choice and diagrams on planting locations.

JESSICA MAXWELL

Engaging the local community in planning at Loch Arkaig.

2.4 Stakeholder engagement and consultation

UKFS (water): The appropriate regulator must be consulted for new woods next to main rivers and flood defences. Early consultation should determine site sensitivity and inform plans and operations. This should include water regulatory authorities (nitrate vulnerable zones, river basin management plans), local fishery bodies (fisheries, spawning streams and times), water companies (drinking water protected areas) and local authorities (private water supplies).

UKFS (landscape): Where visual sensitivity and local distinctiveness are important, the predicted visual effects of proposals should be communicated to interested parties and local opinions considered in developing the best overall solution.

UKFS (people): Consider involving people with an interest in the site in the development of proposals. Engage local communities and build cooperative partnerships. Take into account all groups in society that may have an interest or something to contribute. Communicate plans clearly – consider presenting several options for consultation and try to accommodate local needs.

People are generally interested in place. Fundamentally, woodland creation is about instigating change to places – albeit sometimes at a slow pace. Using the concept of landscape to underpin stakeholder engagement is valuable in that it helps people understand how different elements of the landscape interact and can create change. There is often a particular fascination in looking at the impact of historic and cultural elements of the landscape story, which is helpful in demonstrating that change is constant. This can shift perceptions and perspectives to becoming more open to continued or new changes where benefits to people and wildlife can also be demonstrated.

In contrast, framing a participatory conversation around a focus on a single theme or objective that might tend to involve a more limited number of people with a similar, but perhaps restricted view, can be less successful. It may even lead to increased tensions if others feel excluded from the project. Such single-theme conversations may miss important evidence and the ability to predict the outcomes of environmental interactions, and so could well lead to less sustainable and less widely accepted projects.

Inspiring and methodical stakeholder engagement can be applied whatever the scale and type of creation, from planting a small length of urban hedgerow, to a 10,000ha new woodland landscape, with detail and depth adjusted to fit the scale and context of the project. The number and range of stakeholders engaged should be proportionate to the size and complexity of your project – and as a minimum include relevant statutory consultees. Other stakeholders – including neighbouring landowners, local communities and interest groups – may have a significant contribution to make towards the design of the project, and their inclusion could be the making of a popular and successful project.

When to engage stakeholders

Successful woodland creation projects involve stakeholders from the outset and at each phase, from **visioning** and **objective setting**, through **design** and **initiation**, and on to monitoring and management through the **establishment** phase. This creates a sense of **wider ownership** in the project among stakeholders, so that they continue to be involved and supportive throughout the life of the project.

Who you engage with, and how, may need to change as the project progresses. It is an iterative process and, at all stages, it is important to maintain ongoing dialogue with your stakeholders and provide feedback on how their views have been listened to, even if you have not managed to incorporate everything in your project.

The development and sharing of **concept designs** in the design phase is a key stage for engagement. For some projects, success may be achieved by **co-designing** your woodland. Co-design means collaborating with everyone who has an interest, to develop a shared vision and to solve real issues with them. Actively seek their input and feedback, based on their lived experiences, to improve your woodland design. Co-design puts the emphasis on what is learnt from the combined opinions of participants alongside reviewing available evidence.

Your project may require a formal consultation process; for example, if it needs a planning application or as part of the EIA regulations process. In some cases, this may involve making your proposal available on a public register. If any concerns are raised – for example, about UKFS compliance – this may lead to your proposal having to be amended, or the design changed, so that the consultation concerns are addressed. **Early engagement and consultation** with your stakeholders to take account of their views, including those with statutory responsibility, can avoid having to amend plans at the formal consultation stage.

A **live consultation plan** can be useful to keep track of inputs and decisions. Key discussions and agreements with stakeholders should be noted in writing so they can be submitted as evidence to support regulatory or grant applications, and as evidence of UKFS compliance. A consultation plan will help to guide the development of your project and will enable you to track stakeholder engagement and provide structured feedback to your stakeholders as your proposal develops.

Identifying your stakeholders

A stakeholder is anyone with a legitimate interest in your site and the project. This may be because they have a legal obligation to ensure compliance with legislation and standards, or it impacts the place where they live, or they are invested in a cause linked to your site, or they have some information, evidence, ideas or funding to support your project. Taking time to find out who your stakeholders are, what their interests are and how you can help each other, and addressing areas of difference, will be time well spent in ensuring the success of your project.

Stakeholder mapping involves identifying who your stakeholders are and classifying them according to their level of interest and the influence they may have on your project. It can help to identify connections and shared motivations between stakeholders and is a useful exercise for ensuring an appropriate level of engagement with different groups. Begin by considering:

- Who are the stakeholders that are likely to have the most influence on your project? These may include advisers, funders, statutory bodies.
- Which stakeholders will be most affected by your project? These may include neighbouring landowners, rights holders, local communities, users and beneficiaries, campaigners.
- Which stakeholders have influence, but may have little interest, or even be hostile to your project? These may include special interest groups, local councils, campaigners, residents' associations.

- What are the top motivations and interests of your stakeholders? Knowing stakeholders' motivations will help you understand how best to engage them; for example, financial, emotional, practical, supportive, unsupportive, etc.

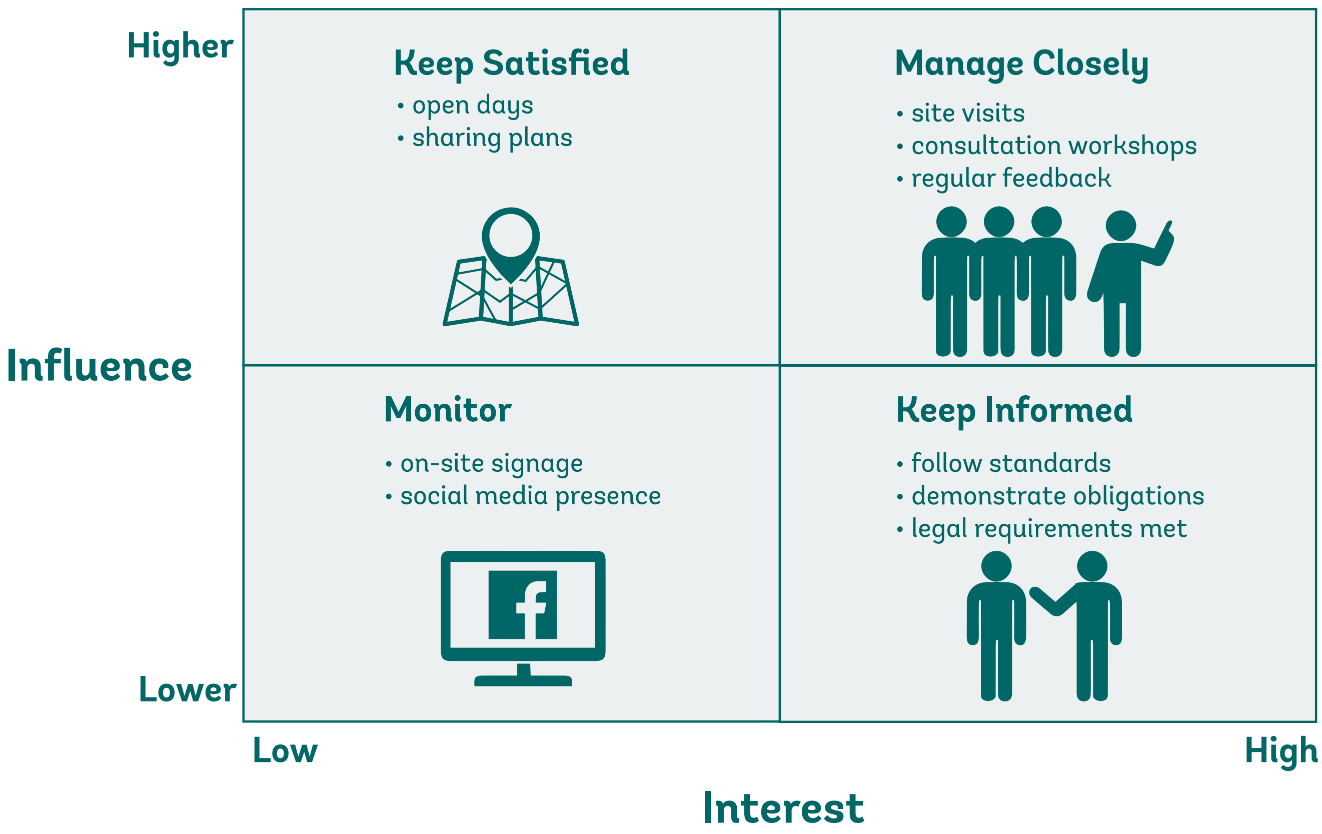


Figure 2.2: Stakeholder classification

Stakeholder consultation methods will vary between the different categories:

High interest; higher influence: This group might include key statutory consultees, local community groups, conservation charities, heritage charities, your neighbouring landowners, funding bodies and so on, if they have a high interest in features or functions on or associated with your land, and have decision-making powers or influence. They need to be **managed closely** to ensure your project learns from their expertise, and to avoid the risk of them derailing your project at any stage. Involve them early in your plans (e.g. via **group site visits** or **consultation workshops**), listen to their points of view and evidence provided, and **provide regular feedback** on how you have addressed their points.

High interest, lower influence: The group may include some local communities, education establishments, wellbeing groups, recreation/sports clubs and so on, including those active on social media. They may be very interested in your plans, but have little direct say in your proposals from a legal perspective. It is important **to keep these stakeholders well informed** through, for example, **open days** to **share plans**, bulletins in community magazines to social media sites.

Lack of information to this group may lead to speculation about plans which could end up being damaging to your project.

Low interest, higher influence: This group might include parish or community counsellors, or representatives of farming or land-owning organisations. These may also include utility companies who have specific rights over your land. They are likely to be less interested in your specific objectives and outcomes, but they need to be **kept satisfied** that you are going through **processes** such as assurance schemes and standards, and any **legal requirements**, and that you are not negatively impacting their areas of interest or that of their members.

Low interest, lower influence: This group, sometimes called 'the silent majority', might include members of the public who are not actively engaged in relevant community groups nor members of charities or clubs relevant to your project. However, it is possible they will be watching from the sidelines and choose to get involved if they spot something they are not happy or familiar with. As such, this group should be **monitored** via social media or your local relationships, to ensure any 'grumblings or rumblings' (which may be genuine concerns they are usefully alerting you to) are addressed before they gain traction. This might involve **onsite signage** to explain activity or **information** on social media.

Who are the statutory consultees?

Statutory consultees are the agencies responsible for the administration of forestry regulations and grants in each country of the UK – The **Forestry Commission** in England, **Natural Resources Wales**, **Scottish Forestry** and the **Northern Ireland Forest Service** – and charged with regulating the creation of new woodlands. The UK Forestry Standard provides a common standard for regulation and is used as a baseline throughout this guide. The application of the standard (including EIA determination) and grant application processes vary between the countries and regions, and early discussions with the responsible agency's officer or adviser are critical.

Local authorities are statutory consultees for any activity requiring an **Environmental Impact Assessment** or **planning permission**. In general, woodland creation will fall outside the planning system, but any ancillary development such as car parks or buildings will require planning consent. The planning consent process includes consideration of the impact of any change in land use on the local road network. Local councils are also responsible for assessing woodland creation proposals for impacts on local biodiversity, heritage or community assets; for example, local wildlife sites, sites listed on the Historic Environment Register, ancient woodland and ancient trees. Council tree or woodland officers may usefully be consulted at the beginning of any woodland creation project.

Some statutory consultees may only engage through formal consultation processes. It is recommended you check organisational websites for advice, guidance and criteria on whether consultation is necessary, and to identify the relevant process.

Who should be consulted beyond the statutory consultees?

As your project progresses through the different phases, you may need to **update your stakeholder mapping exercise** as some interests will have changed, or additional 'hard to reach' stakeholders may have been identified. It is also important to consult any **funders** to ensure your project meets their requirements. Your **neighbouring landowners and landscape partnerships** may become more interested in the project as it moves into the design phase.

These stakeholders may include:

National and local **conservation organisations**, such as the RSPB and the relevant Wildlife Trust, Plantlife, Bat Conservation Trust or Butterfly Conservation, who can bring a wealth of expertise and provide data and information on landscapes and species. Societies such as the Botanical Society of Britain and Ireland, British Lichen and Bryological Societies may also be able to contribute data and expertise. Local groups, including entomological societies, county bird clubs, bat groups and local flora groups can be a source of valuable knowledge and information.

Local Environmental Records Centres, which hold valuable data on the presence of species (and sometimes habitats) on land at a county level or sometimes groups of counties. Access to **Historic Environment Records** online is variable across the countries and counties of the UK. In many cases it will be necessary to contact the **local authority** or responsible archaeological service to access up-to-date HER data.

Other community groups or partnerships. These could include, for example, resident committees, community archaeologists and countryside management partnerships who may be worth contacting or informing of your plans.

Parish councils (England) and community councils (Scotland and Wales) who are valuable for gathering views from a local community, but are not necessarily representative of all views in a local area. Northern Ireland has no equivalent body.

Local amenity groups, such as such as ramblers, hiking, biking, horse-riding, fishing and water-sports groups, who can provide valuable information about formal and informal use. Some areas have a Local Access Forum which brings these groups together. Engaging with access and recreation groups at an early stage can ensure their needs are considered during the development of a project. It is also important to identify user groups representing the disabled community to ensure that those with limited mobility also engage with the project.

Representative groups of farmers, landowners, tenants and commoners associations who will hold valuable information and influence with neighbouring landowners. **Landscape-scale projects and partnerships** operating in your locality will also be an important source of information and advice to help your project have maximum impact in the area.

Harder to reach groups within the local community. Identifying them is important, especially when developing urban or semi-urban creation projects, and more effort is needed to engage with them. There is a wide range of local voluntary community groups and networks which can help put you in touch with the right organisations. The Conservation Volunteers and Groundwork UK are often well connected into local community networks. The Community Action Network and local councils can also help identify groups that could be important to engage with. Religious groups, such as local churches, synagogues, mosques or temples, are valuable as ways of reaching into local communities.

Education bodies, such as local schools, as they are a very useful contact point for reaching into local communities, as well as for creating opportunities to involve children in woodland creation projects. Nearby universities or land-based colleges may also be useful to involve in the early stages, as baseline data collected before work begins could be important if your site offers the potential for science activity.

Engagement methods

There are different ways to **find and contact stakeholders**, from the traditional approach of letter drops, phone campaigns (subject to GDPR[1]) and posters, through to social media and websites. Different groups are more likely to be found using different media. If there are statutory consultation and approval requirements – for example, for an EIA – then consult with the planning officers to ensure that your contact with selected stakeholders is not viewed as an attempt to influence these processes.

Inclusion means making sure that stakeholders can engage with your project without having to overcome barriers; for example, people with physical or mental health conditions or disabilities, communities where English is not their first language, those with limited internet access, and for other hard to reach groups. Some ethnic minority communities, or residents of deprived areas, may be less likely to engage with environmental projects, so more effort may be needed to meaningfully include them.

Methods of engagement also need to be tailored to the needs of different groups,

[1] General Data Protection Regulation (GDPR), see Guide to the General Data Protection Regulation - GOV.UK (gov.uk)

but could include face-to-face contact in **meetings**, inspiring **site visits** and **workshops**. Focus groups are valuable, especially for qualitative information, such as gathering people's views and feelings about a project. Online virtual events (webinars and video calls) can be highly effective if well planned (particularly if stakeholders are geographically distant). Physical letters and printed questionnaires, as well as phone calls, are still essential means of engaging with your stakeholders, depending on their preferences.

Prepare materials to meet the needs of your stakeholders, bearing in mind the media they are most likely to be familiar with and respond positively to. **Maps and plans** should be designed so they can be easily used in physical presentations at meetings, as well as online and in print. Colour palettes should be selected to ensure that there are no opportunities for confusion, such as sight issues caused by red-green colour blindness (1 in 12 men), for example. Accessible options are required for those with limited sight or hearing (e.g. including audio descriptions for imagery – or podcasts). **A short film** can convey as much information about a site as a large report.

An online or physical **questionnaire** is a highly effective way of gathering stakeholders' responses, if the right questions are asked. Open questions also allow for greater depth of stakeholder responses, but are more difficult to analyse. Both qualitative and quantitative information should be gathered. Once responses have been collected, they should be collated and analysed.

Stakeholders value feedback and confirmation that their views have been considered, otherwise they may feel they are being ignored. Explain how their views will be used and then how their views have led to changes in your plans, and show them the changes. Show them you care.

Table 2.4: Responsibilities of statutory consultees

Consultee	Country	Responsibilities	Consult for (examples only)
Local planning authorities	All	Planning, highways, TPOs	Does your scheme affect the local wildlife sites, historic environment, ancient woods, public highways (e.g. new access) or require planning consent?
National Park authorities	All	Protected landscapes	Is your scheme in a National Park?
Network Rail	UK	Lineside vegetation	Is your scheme close to a railway line?
National Grid	UK	Trees near electricity network	Is your scheme near electricity transmission/gas lines?
Water companies	Across UK	Trees near water infrastructure	Is your scheme near or likely to affect water infrastructure?
The Gardens Trust	UK	Designed landscapes and gardens	Grade II registered parks and gardens
World Heritage Site Partnership Board	By site	World Heritage Sites	Land within World Heritage Sites
Forestry Commission	England	Forestry	Does your woodland creation require an EIA (Environmental Impact Assessment)? Are you applying for a woodland creation grant?
Natural England	England	Nature	Does your scheme affect designated nature sites, habitats or protected species?
Environment Agency	England	Water, air, waste	Does your scheme affect flooding, drainage, air quality or waste sites?
Historic England	England	Designated heritage assets	Does your scheme affect Scheduled Monuments, Grade I and II star listed buildings, Grade I and II star registered parks and gardens, registered battlefields or World Heritage Sites?
National Parks England	England	Protected landscapes	Is your scheme in a National Park?
AONBs England	England	Protected landscapes	Is you scheme in an AONB?
DAERA	Northern Ireland	Forestry	Does your woodland creation require an EIA? Are you applying for a woodland creation grant?
DoENI	Northern Ireland	Nature	Does your scheme affect designated nature sites, habitats or protected species?

Consultee	Country	Responsibilities	Consult for (examples only)
Northern Ireland Environment Agency	Northern Ireland	Water, air, waste	Does your scheme affect flooding, drainage, air quality or waste sites?
DfC historic environment division	Northern Ireland	Archaeology, history	Does your scheme affect ancient monuments or historic buildings, or the historic environment?
DAERA	Northern Ireland	Protected landscapes	Is your scheme in an AONB?
Scottish Forestry	Scotland	Forestry	Does your woodland creation require an EIA?
NatureScot	Scotland	Nature	Does your scheme affect designated nature sites, habitats or protected species?
Scottish Environmental Protection Agency	Scotland	Water, air, waste	Does your scheme affect flooding, drainage, air quality or waste sites?
Historic Environment Scotland	Scotland	Archaeology, history	Does your scheme affect ancient monuments, historic buildings or the historic environment?
NatureScot	Scotland	Protected landscapes	Is your scheme in a National Scenic Area?
Natural Resources Wales	Wales	Forestry	Does your woodland creation require an EIA?
Natural Resources Wales	Wales	Nature	Does your scheme affect designated nature sites, habitats or protected species?
Natural Resources Wales	Wales	Water, air, waste	Does your scheme affect flooding, drainage, air quality or waste sites?
CADW	Wales	Archaeology, history	Does your scheme affect ancient monuments or historic buildings, or the historic environment?
Welsh local planning authorities	Wales	Planning, highways, TPOs and protected landscapes	Does your scheme affect the public highway (e.g. new access) or require planning consent? Is your scheme in a National Park or AONB?

Useful resources

- **Public engagement in forestry – toolbox** (Forest Research, 2011). A range of engagement techniques explained, suitable for a variety of scales.
- **Stakeholder engagement for regional forest frameworks** (Scottish Borders Forest Trust, 2020). Engagement methodology and useful templates.
- **Recipe for successful landscape-scale projects** (RSPB, 2016). Engagement for landscape-scale projects.
- **Stakeholder and community engagement guide** (Sylva Foundation, 2013). How to structure stakeholder engagement (England focus).

2.5 Monitoring and reviewing progress

The establishment of new woods and trees takes time. It is all too easy to set out with a clear idea of what is intended, but for this to be lost over the 15 or 20 years of the establishment phase. Progress against the objectives will need to be monitored and the objectives periodically reviewed and refreshed, leading to an **adaptive management** approach.

Guidance on **monitoring the impact of your project**, **progress against the agreed objectives**, and **assessing the ecological condition of the site,** is included in the final section of this guide. However, it is important to give this consideration as early as possible – the information collected during the site assessment will provide a valuable baseline from which to measure progress. Where this is not the case, you may need to consider a further survey to establish a baseline. It's important to carry out this work before ground preparation or other works get underway in the initiation phase of your project.

As new woods and trees become established, some objectives or milestones towards them may be achieved; for instance, a given percentage of tree cover established or the installation of infrastructure completed. The objectives for that theme may need refreshing to ensure that they are relevant to the next stage of establishment.

It is also possible over the timescale for establishment that the **context** may change, requiring a revision of the original objectives. For instance, changes in the financial support available, management capacity, adjacent land use or visitor numbers may alter the basis for objectives, and new evidence may come to light suggesting a different approach. Equally, new pests or diseases, the spread of invasive plants or extreme weather events may impact the development of the site and have significant resource implications.

A clear vision and well-defined objectives should help to ensure that the project remains true to its original intentions, although the detail contained in the objectives may need modifying to reflect the changing context.

CASE STUDY

CHRIS MATTS

White park cattle, introduced to graze the wood pasture areas at Brynau Farm.

Brynau Farm – from opportunity to reality

Brynau Farm and its surrounding farmland in Neath in southern Wales extends to around 95ha, comprising semi-improved and improved grassland, fragments of ancient woodland and relict wood pasture. Situated adjacent to the **Gnoll Country Park**, it links other ancient woodland sites to the north and east. Purchased by the Woodland Trust in 2019/2020, plans are now underway to plant around 150,000 trees to create new woodland, hedges and wood pasture and an important amenity for the public.

Creating new native woodland in this area will provide multiple benefits to the community of Neath, including natural flood management, biodiversity enhancement and carbon capture. It will buffer the remaining fragments of ancient woodland and also provide a significant new area of accessible greenspace for surrounding communities. Brynau Farm is in easy reach of 530,000 people, so provides the opportunity to connect up to 18% of the Welsh population with nature – contributing to improved physical and mental health through a peaceful oasis above Neath's urban sprawl.

CASE STUDY

Searches and surveys

The first step for woodland creation in Wales is to check the Glastir Woodland Creation Opportunities Map, which uses a geographic information system (GIS) to identify areas of Wales most suited to new woodland creation. It is found online at DataMapWales, the geo-portal for Wales, and screens against the presence of priority habitats and other macro-level constraints, such as deep peat. This confirmed that most of the land at Brynau Farm provided a good opportunity for woodland creation and would, therefore, be likely to obtain financial support through the Welsh Government's Glastir Woodland Creation scheme. The land was also identified as a priority for catchment woodland planting to alleviate flooding in the ***Working with Natural Processes*** report.

The National Biodiversity Network and Ancient Woodland Inventory databases were consulted and showed that no rare species were present that would be adversely affected by woodland creation, and that the site retained a portion of ancient woodland and was bordered by further ancient woodland in the neighbouring Gnoll Country Park. The Trust's site manager had prior knowledge of the local woodland habitat type and past management (including the use of some fields as arable), and the presence of ancient trees (including a previous 'Tree of the Year').

Searches undertaken as part of the sale process revealed no statutory designations on the land other than a Tree Protection Order protecting part of the existing ancient woodland. Service plans were obtained from the relevant utility companies which revealed the location of an underground gas pipe and overhead electricity cables, where planting must be avoided, which helped determine where open space would be located.

Initial desk-based surveys were subsequently ground-truthed with site visits. A botanical (National Vegetation Classification) survey was undertaken which confirmed the initial visual impression that the land was largely improved grassland and of low biodiversity value. Some areas bounding existing ancient woodlands and around wet flushes were deemed of higher floristic interest and were, therefore, left unplanted within the eventual planting design.

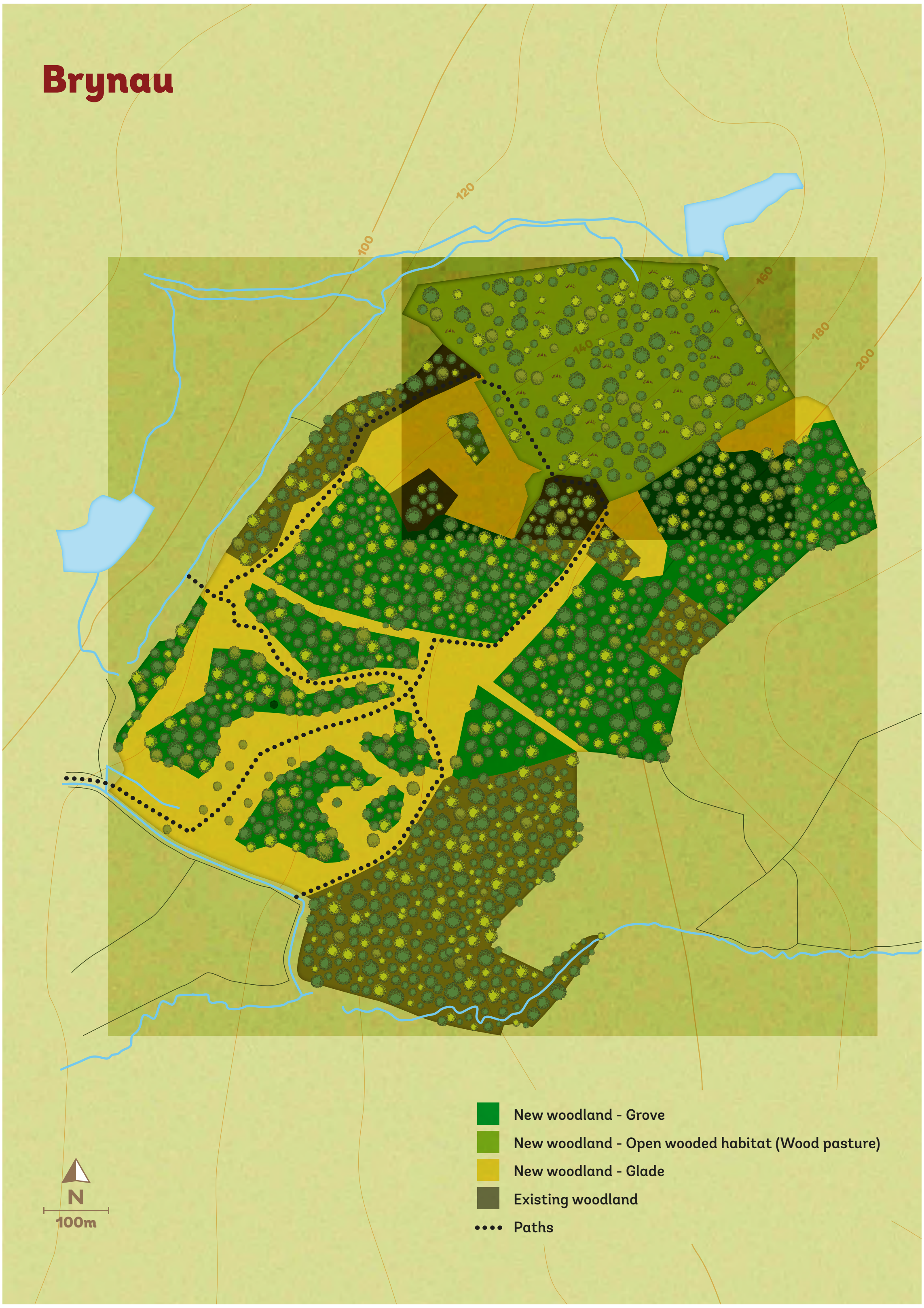
CASE STUDY

Following these surveys, an Environmental Impact Assessment (EIA) opinion with an outline planting scheme was submitted to Natural Resources Wales. This was approved, confirming that Brynau Farm meets criteria for new native woodland creation without the need for a full EIA. The site hosted a landscape design training workshop which fed into plans for the site design and included the retention of viewpoints and restoration/re-instatement of historic features, such as the farm orchard and wood pasture, which feature on historic maps of the site.

Stakeholder consultation

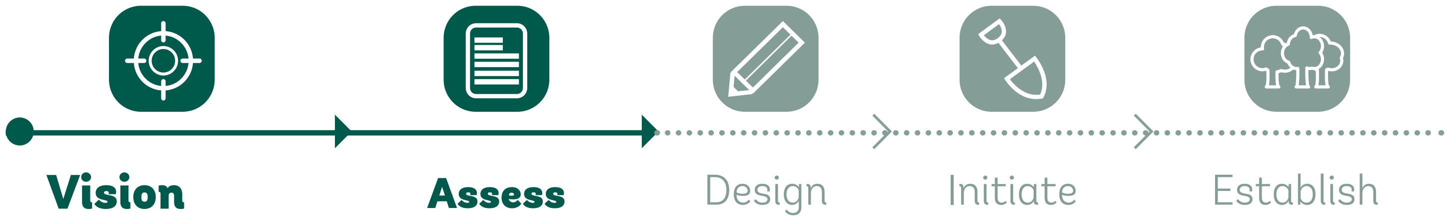
As part of the Glastir Woodland Creation scheme application process, relevant stakeholders were consulted. This included a presentation of draft plans to the Local Nature Partnership group for comment, and consultation with Cadw who expressed an interest in the site due to its location and connection with the historic landscape of the adjacent Gnoll Park. Site staff and volunteers accessed historic mapping and estate archives which provided evidence of past land use, including lost ancient woods and wood pasture on the site. Site staff also surveyed and mapped ancient and relict field trees and hedges and as a result, these field trees were buffered and an area of wood pasture – earmarked for grazing with the Trust's Welsh white cattle – was incorporated in the eventual site design to provide continuity with the historic landscape.

CASE STUDY

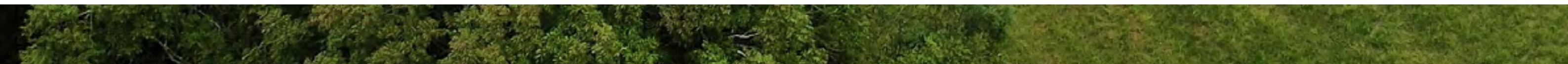

Brynau
120
100
160
180
200
140
New woodland - Grove
New woodland - Open wooded habitat (Wood pasture)
New woodland - Glade
Existing woodland
Paths
N
100m

Assess

BEN HARROWER



- **Scoping**
- **Desk survey**
- **Site survey**
- **Specialist survey**



3: Assess

A sound **understanding of your site** is essential to inform the creation of new woods and trees. In this phase of the creation process you will need to gather information on the **landscape context, characteristics, features** and **constraints** of your site.

It is essential to always look beyond the boundaries of your site and consider the **landscape context** of your project. This should include gathering information on the surrounding landscape as well as an analysis of the landscape character and visual sensitivities. An understanding of the landscape context should also include an assessment of how people access and use the land around your site.

The **site characteristics** are a combination of the physical foundations of the site, including location, aspect, elevation and exposure, and the ground conditions created by the geology, soils and water (hydrology) on the site.

New woods and trees should complement and enhance existing **features** of a site and the landscape. This requires sufficient information to be gathered on the existing trees, habitats and species interest at the site and in the landscape context. Many sites will have historic environment features that require identifying and interpreting. This appraisal of features is essential to ensure that negative impacts are avoided, and provides key information to inform and inspire the design so that new woods and trees reflect and showcase their biological and historical context and significance.

During the site assessment phase, you will also need to identify any practical site **constraints** to the creation of new woods and trees on all or part of your site. These could include built infrastructure and above or below ground services. Other constraints may be important in shaping decisions about your approach to initiating and establishing new woods and trees. These include the impact of browsing animals and the presence of invasive non-native plants.

3.1 Assessment stages

The site assessment progresses though four stages: **scoping, desk assessment, site survey and specialist survey**. The conditions, landscape context and all potential features and constraints should be considered through the scoping and desk-assessment stages. As more information is obtained, then it is possible that the site survey may have a narrower range of features and constraints to consider. Specialist surveys are likely to be focused on a single feature or constraint.

The purpose of the site assessment is to provide a rich description of the site to inform and inspire the design phase. Site assessment may also be a legislative requirement. In principle, a decision can be made to proceed to the design phase at any stage of the site assessment. In practice, most sites will require a site survey as a minimum, but for some small and straightforward projects, the scoping or desk assessments may provide sufficient information. Smaller sites should not be seen as lower risk or requiring less consideration. But if they are small and not complex, then the assessment should be relatively swift as a consequence.

The site assessment and objectives may be iterative, and as the site assessment progresses, new or different objectives may develop. But a decision may also be made at any stage not to pursue the woodland creation opportunity on the site, where specific objectives cannot be accommodated without impacting on existing high value features, or on the practicalities and costs of mitigating constraints. Scoping of potential sites will benefit greatly from an awareness of the site assessment approach from the outset.

The initial **scoping assessment** can be carried out based on collating information from a suite of easily accessed national mapping and other data sources. The scoping assessment will provide enough information to identify whether the site is in an 'Area Sensitive to Afforestation' and whether an Environmental Impact Assessment may be required. There may be other regulatory requirements to consider at this stage. It also provides a basis for an initial decision on whether to proceed with a more detailed assessment.

The **desk assessment** involves a more detailed investigation of information on the site that is available more locally. This should draw on a wide range of mapping and other data and is likely to generate multiple sources of information, often less structured and consistent than the national datasets used in the scoping assessment. The desk assessment requires knowledge of the area and the skill to interpret multiple sources of information. The desk assessment links directly to the next stage of site assessment as it provides key information to direct and focus the site survey.

The **site survey** is the best way to build an understanding of the features, constraints and context of your site, both within and outside its boundaries. A site survey is essential for all but the smallest and most straightforward of projects and should record the locations of features with sufficient detail to inform decisions on designing, initiating and establishing new woods and trees.

The presence or potential for high value or complex features may be flagged at any of the preceding stages. If this is the case, then it will be necessary to commission more in-depth **specialist surveys**. This will involve engaging with individuals, consultants and other organisations who have expert skills in identifying, evaluating and advising on specific features. It may include soil surveys, detailed vegetation assessments and species-specific surveys (e.g. birds, invertebrates and fungi). Specialist surveys need forward planning to ensure that certain seasonal survey windows are not missed (e.g. for particular species or habitat features).

Detailed guidance on the four stages of the site assessment is provided in the accompanying *Site Assessment Handbook*. This includes sources of information to inform the scoping and desk survey stages as well as guidance on identifying and assessing features and constraints through site survey.

3.2 Recording and presenting assessment information

It is important that information from each stage of the site assessment is recorded appropriately. It needs to be comprehensive enough to provide a rich description of the site. Detailing site characteristics, features, constraints and its surrounding landscape is essential to informing the best design, supporting decisions over the most appropriate initiation, and inspiring the establishment and longer-term vision for the site. Information gathered at each stage of the assessment will also inform and guide each subsequent stage.

The best way to present any spatial information from the scoping, desk assessment, site survey and specialist survey is on one or more annotated **assessment maps**. These can develop and be refined as each stage progresses to the next. All characteristics, features and constraints that can be described spatially within the site and immediate landscape context should be accurately **mapped** as either points (e.g. an individual veteran tree feature or historic environment feature), lines (e.g. a powerline, public right of way or watercourses), or shapes/polygons (e.g. an area of species-rich grassland vegetation, different soil types, area of ancient woodland adjacent to the site). Mapping can be high or low-tech as long as it captures all the necessary detail.

Desk survey mapping or aerial imagery can begin to pin-point likely features to investigate on a site survey. Site surveys may benefit from Toughbook technology to use GIS in the field, but hand annotations on printouts can work just as well. Checklists can be used as a prompt and a way of gathering information in a structured format. For some larger and complex sites, it may be useful to divide the site into **compartments or zones** based on **variation in soils, hydrology, slope** or **vegetation cover**. Site survey and specialist surveys will benefit from well-labelled and georeferenced **photographs.** These can provide useful evidence of the site and surrounding landscape to support the design phase.

Some features and constraints may not lend themselves to being recorded spatially (e.g. bird and bat records). This is also true of many site characteristics, landscape context and other practical notes (e.g. site access). Therefore, assessment maps should always include a **summary site description**. This can also include additional information on previous land uses or recent management history.

The information gathered in the site assessment should ideally be presented separately to design maps, although for small and less complex projects it may be possible to represent the site assessment and design phases on a single annotated map.

DESIGN EXAMPLE

Smithills Estate – site assessment

This indicative example of the UK Forestry Standard 'woodland design process', based on an area of the Smithills Estate, has been produced by Richard Hellier – landscape and woodland design adviser at Forestry Commission England. The site sits on the edge of an extensive open moor, with views down to the urban fringe of Bolton. Woodland creation is proposed to extend and connect fragments of ancient woodland in the valley and to complement restoration of the open moorland habitats damaged by wildfire. Woods and trees can help to achieve a number of objectives: slowing water runoff from the moor, increasing carbon storage, and providing shelter for livestock.

This example has been produced to illustrate the woodland design process, and design principles in general, but specifically in an upland context. It does not represent actual plans for this part of the Smithills Estate, which are still in development.

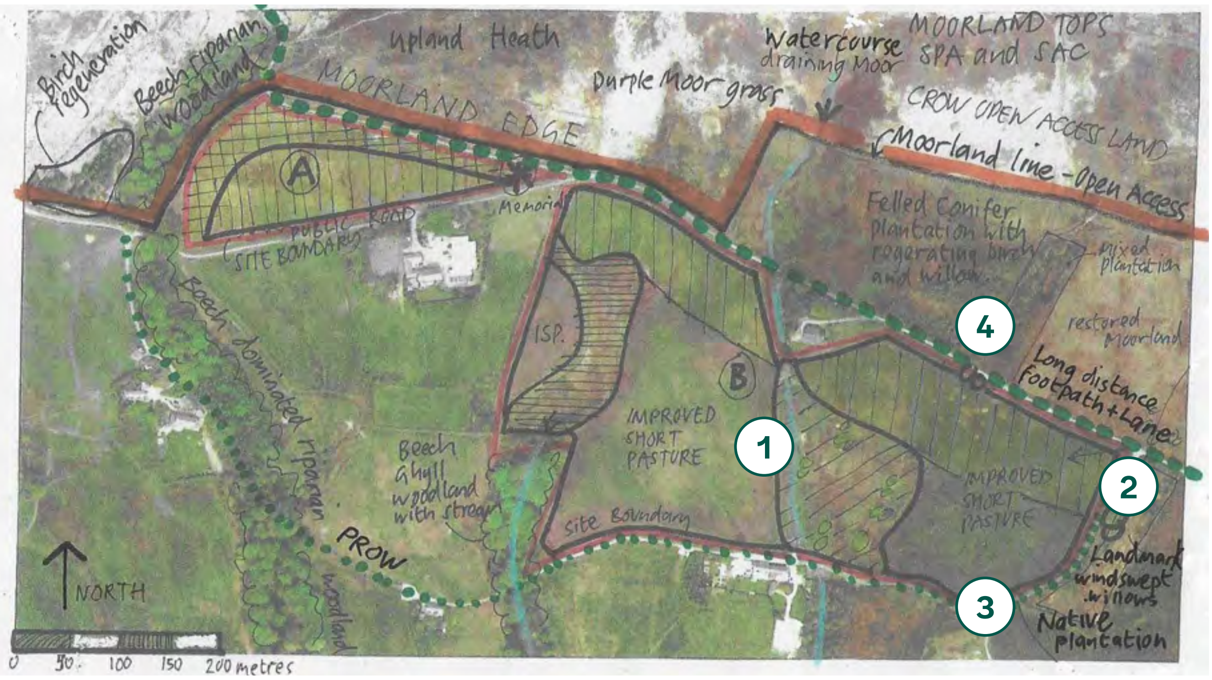


Fig. 3.1. Smithills Estate, site assessment

DESIGN EXAMPLE

Key

- Site boundary
- Moorland edge
- Semi-improved/improved grassland adjoining or close to the moor
- Wet, rush-dominated pasture
- Wet rush pasture with grey and goat willow

(A) Smaller, prominent, semi-improved pasture adjoining moor and beech-dominated riparian zone

- Historic memorial at east end of site
- Open zone along beech ghyll and adjoining moorland provides shelter, site on gentle south-facing slope

(B) Steeply sloping pasture

- Facing south within farmed enclosure enriched with horse grazing
- Bounded on three sides by public right of way and public road with dry stone wall
- Large-scale rush pasture adds diversity, open with high public visibility

1. Water course draining the moor bisects site B
2. Distinctive windswept mature willows
3. Native plantation of birch, willow, oak and hawthorn
4. Long-distance footpath and public road

DESIGN EXAMPLE

Pepper Wood – site assessment

The series of maps and illustrations provide an example of the woodland creation design process, from site assessment to final design. The site is an area of mixed farming, with permanent pasture and arable fields adjacent to the ancient woodland of Pepper Wood. The design was produced by Gareth Price of GIDE Associates for the Woodland Trust and illustrates woodland creation design in a lowland setting with an established pattern of fields and hedgerows.

The design aims to deliver nature-recovery objectives, extending and buffering the ancient woodland with a diverse mosaic of wooded habitats. Carbon storage will also be significant, with woodland creation on arable fields with mineral soils. In addition, the site will add to the options for visitors to the popular Pepper Wood, offering extended access on a site with excellent long-distance views.

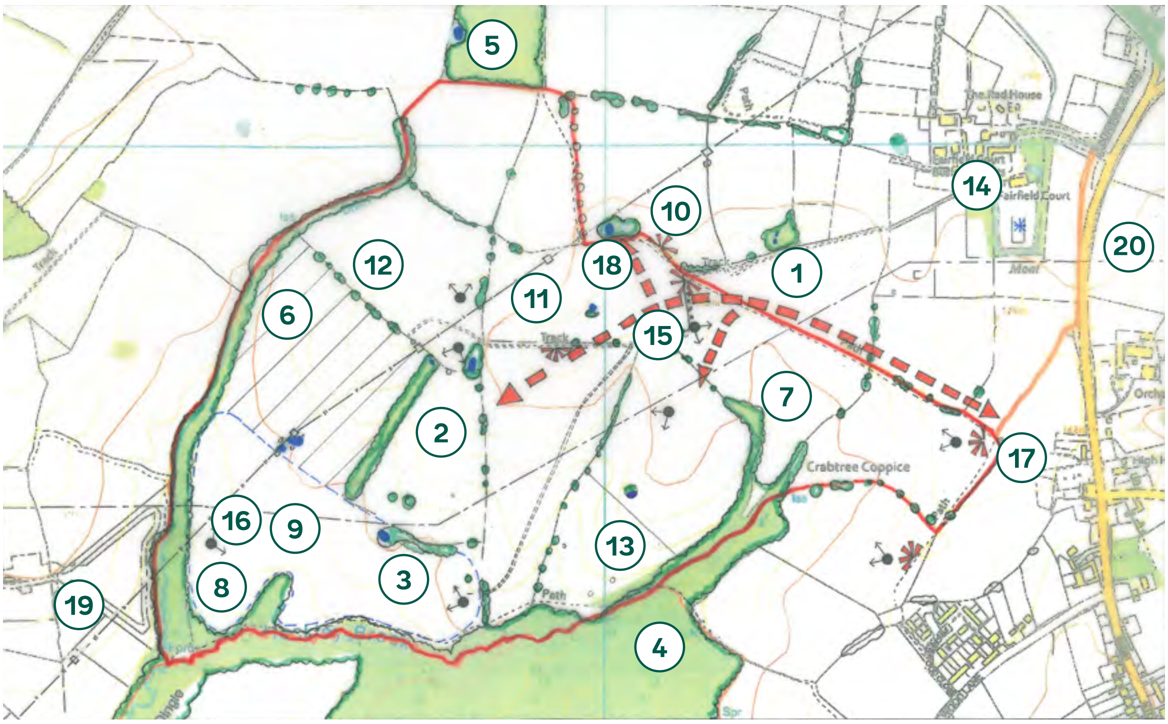


Fig. 3.2. Pepper Wood extension, site assessment map

DESIGN EXAMPLE

1. Site Characteristics – Location and Topography: *Strong, prominent ridgeline. Allows great long views to the north, west and southwest*

   Site Characteristics – Soils and Geology (S1/S2): *Crumbly brown earths, especially in the first 10–20cm, with high clay content and heavy clay soils at depth across most of the site*

2. Site Characteristics – Soils and Geology (S1/S2): *Presence of plough pan identified in arable fields*

3. Site Characteristics – Water (W1/W2): *The site has numerous ponds which provide interest and diversity – need to sensitively integrate these into the design*

   Features – Trees and Woodland – Woodland (TW1): *Adjacent ancient semi-natural woodland of Pepper Wood. The site offers an opportunity to significantly extend the core ancient woodland habitats.*

5. Features – Trees and Woodland – Woodland (TW1): *Small adjacent block of existing plantation woodland to the north*

6. Features – Trees and Woodland – Woodland (TW1): *An area identified as having previously been woodland – Cross Coppice*

7. Features – Trees and Woodland – Woodland (TW1): *Existing trees and woodland tend to follow the valleys*

8. Features – Trees and Woodland – Woodland (TW1): *An area with good prospects for natural colonisation from adjacent ancient woodland (approx. 50 metres wide)*

9. Features – Trees and Woodland – Woodland (TW1): *A former woodland link that has been lost through field enlargement*

10. Features – Trees and Woodland – Mature and Veteran Trees (TW2): *Mature and veteran trees in hedgerows*

11. Features – Trees and Woodland – Hedgerows (TW5): *Ancient field pattern – rather more intact on the higher ground. Hedgerows are beginning to thin and gap in places.*

12. Features – Trees and Woodland – Hedgerows (TW5): *Western field hedgerow beginning to become gappy and fragmented, although some trees are still prominent*

DESIGN EXAMPLE

13 Features – Vegetation and Other Habitats – Grassland (OH1): *An area of semi-improved grassland. Already quite floristically rich. Retain and enhance.*

Features – Species – Protected Species (SP1): *Signs of badger recorded on the site survey, with a likelihood of several setts in the adjacent woodland. Two brown hares recorded on the site survey.*

Features – Species – Rare and scarce plants, lichens and fungi of open habitats (SP3): *No rare or scarce plants have been recorded on the site. No rare arable plants were recorded on the site survey.*

14 Features – Historic Environment – Archaeology (HE1): *Scheduled Ancient Monument at Fairfield Court. Not visible from the site and does not appear to have a visual influence, but should be checked with Historic England.*

15 Features – Historic Environment – Cultural features: *Remains of trackway and buildings associated with WWII decoy site. Should be retained as a feature of cultural interest.*

16 Features – Historic Environment – Cultural features: *Former site of Second World War star fish decoy. No remains left but an opportunity for interpretation.*

17 Features – Public Access (PA1): *Access point and public footpath*

18 Features – Public Access (PA1): *Viewpoints*

19 Constraints – Infrastructure and Services (IA1): *High-voltage overhead powerlines and pylons are prominent features and need to be kept free of trees. Need to ensure that the design does not emphasise this strong linear corridor.*

20 Constraints – Infrastructure and Services (IA1): *Underground gas pipeline. Not directly visible, but the route needs to kept free of trees. Need to avoid creating an unnatural corridor effect with tree planting.*

Constraints – Herbivore Impacts – Deer population and impacts (HI1): *Roe, muntjac and fallow deer are known to be present in the local area and adjacent woodland. Population densities are likely to be too high for unprotected trees to establish. Carry out thermal imaging survey to establish the local deer population and inform management and tree protection.*

3.3 Landscape context

It is always important to consider the **landscape context** of your site, regardless of the scale of your project. An understanding of the **geographical and historical context** in which you are working is required to inform your creation design. Considering the landscape context from the outset will help with gathering information and evaluating the significance of site characteristics, features and constraints, all of which need taking into account – both within the site, and in the landscape beyond its boundaries.

Native woods and trees are key components of the character of many of our landscapes. An appreciation of **landscape character**, and its evolution over time, helps determine the capacity of a landscape to accommodate new woods and trees and inform their design with respect to the key landscape characteristics of a particular area. Landscape character should be seen as a valuable source of information to inform your design and not as a constraint on the establishment of new woods and trees. Well-designed woodland creation can **complement and enhance landscape character** and **restore landscapes** which have become both **ecologically and aesthetically degraded**. Understanding the role of woods and trees in **how people** (visitors, communities and neighbours) **experience and value the landscape** can ensure that designs are sensitive to the landscape context. As a framework for stakeholder engagement, it can also support the identification of more qualitative aspects and can provide an informed and engaged understanding of the needs for and benefits of change.

UKFS (landscape character): Refer to relevant Landscape Character Assessments and associated design guidance. Interpret the landscape character at a local level, identifying the key characteristics of the landscape, and use the analysis to inform the forest design. Identify what makes a place special or unique (Spirit of Place), and consider how you can conserve and emphasise these qualities in your design.

UKFS (landscape and visual sensitivities): Assess the visual sensitivity and local distinctiveness of the landscape; consider visibility, how people view the area, the nature of the viewing experience and the importance of views. Also consider completing a Visual Impact Assessment, for larger and more complex sites and those in sensitive landscapes. Reflect the landform and patterns of enclosure in your design.

Landscape character assessment is a systematic process of identifying distinct, recognisable and consistent patterns of elements that give landscapes their character and coherence. Landscape character assessment considers the interaction of people and nature and is based on identifying distinct combinations of geology, landform, watercourses, land use, settlement patterns and cultural features. The assessment itself is a process to collate baseline evidence.

The approach to landscape character assessment varies between the countries of the UK. In Scotland, the 390 **Landscape Character Types** (LCTs) are the key reference, and similarly in England, with 159 **National Character Areas** (NCAs). In Wales, Landscape Character Assessment is incorporated in the 48 **Area Plans** and many local authorities have also published their own Local Landscape Character Area descriptions. Northern Ireland also has two levels of assessment, with 26 **Regional Landscape Character Assessments** (NIRLCA) and 130 **Landscape Character Area** (LCA) descriptions. The description of a landscape's current character is not intended to prevent further change, but to allow informed decision making which might include objectives to conserve, restore and enhance existing character, or to create new landscape character.

Landscape character descriptions and protected landscape designations should be included in the scoping and desk assessments. This landscape context provides the wider context for site assessment, and landscape character evidence will begin to reveal information on characteristics, features and constraints.

Much of the information about the context of your project that you will need in order to produce your design can only be gained from an appraisal of the landscape as part of your site survey. An annotated map of the site and surrounding area, along with photographs of landscape features and views (both from and into the site), are important to inform the design phase. This summary of the landscape context, drawing on each stage of the assessment, should be presented as a landscape appraisal.

For large and complex sites, especially in sensitive or protected landscapes, it may be necessary to commission a chartered landscape professional to carry out a specialist **landscape character appraisal** and/or a **landscape and visual impact assessment**.

Smithills Estate – landscape context

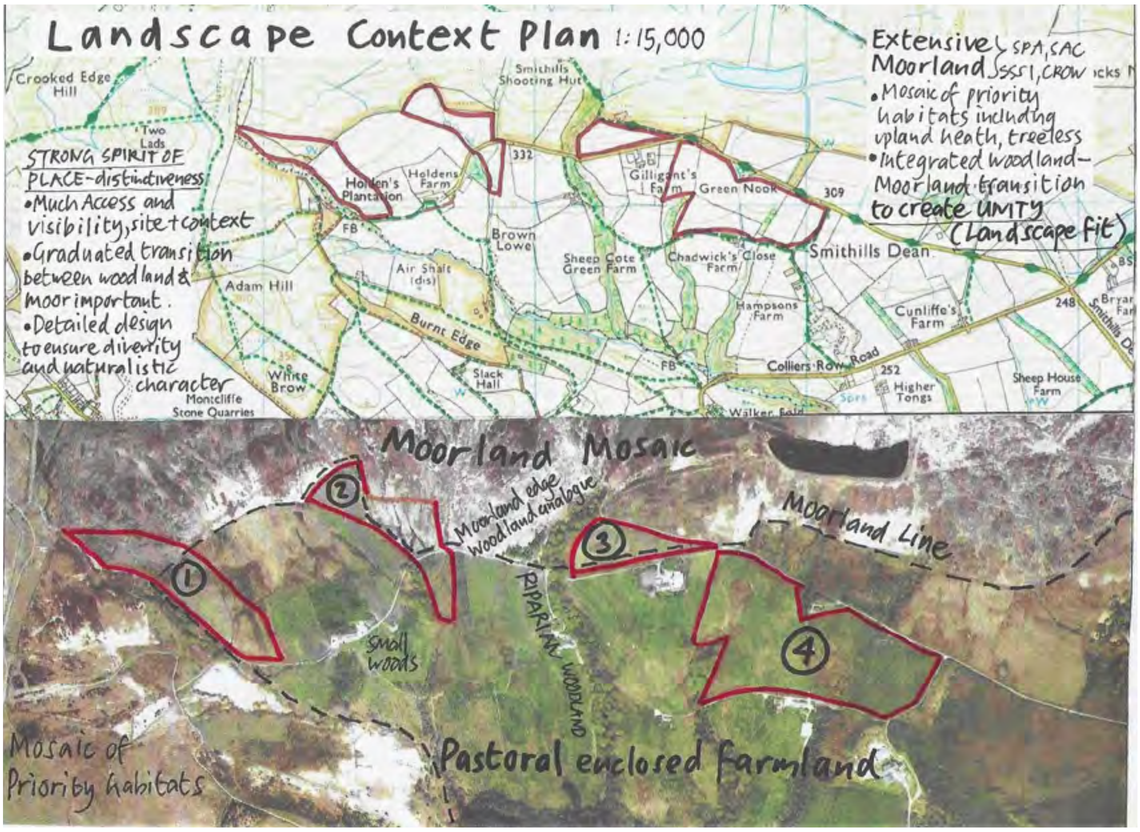


Fig. 3.3. Smithills Eestate, landscape context and appraisal

1. **Extensive moorland.** A mosaic of open habitats, including upland heath and grassland, largely treeless. A range of desigiations, including SAC, SSSI, SPA and CROW open access land.

2. **Creating unity.** Harsh boundary between moorland and enclosed farmland. There is a big opportunity to create wildlife-rich moorland and open woodland transition that will create a sense of unity and ensure a good landscape fit for new woods and trees.

3. **Spirit of place.** The distinctive landscape, with high levels of public access and high visibility, has a spirit of place. A detailed design needs to create a gradual transition between the moorland and woodland, to ensure diversity and maintain the natural character of the landscape.

4. **South-facing bowl** with views across Bolton. An extensive and well-used rights of way network through enclosed pastoral farmland, with beech-dominated ghyll woodland and small conifer plantations.

DESIGN EXAMPLE

JOHN MACPHERSON/WTML

Restoring woods and trees to the moorland fringe at Smithills Estate.

DESIGN EXAMPLE

Pepper Wood – landscape context

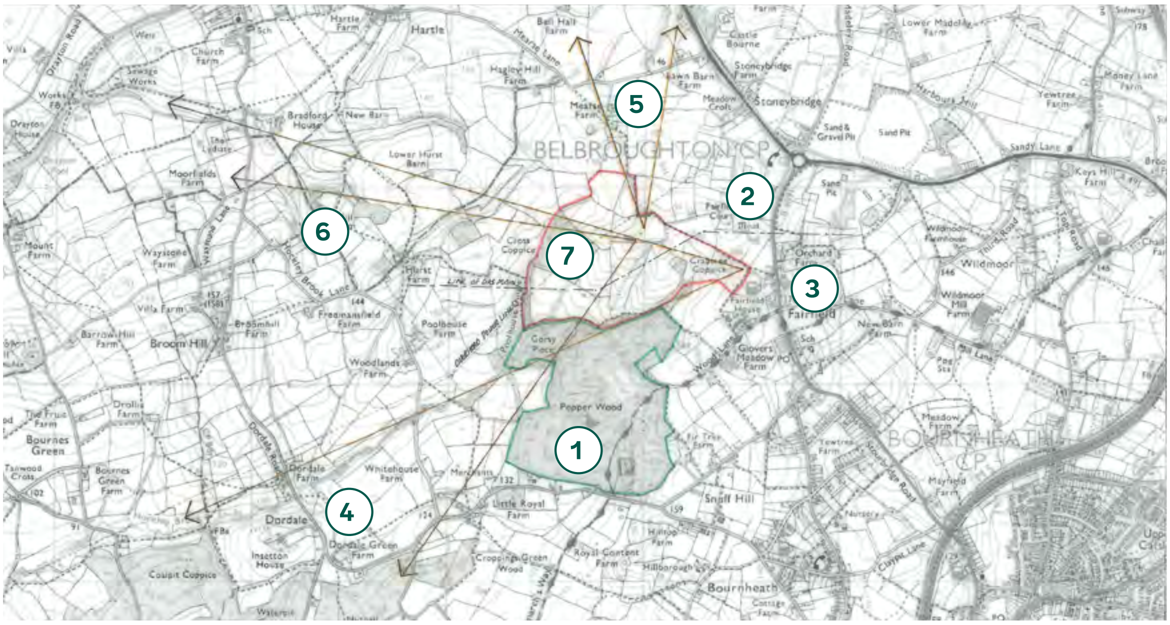
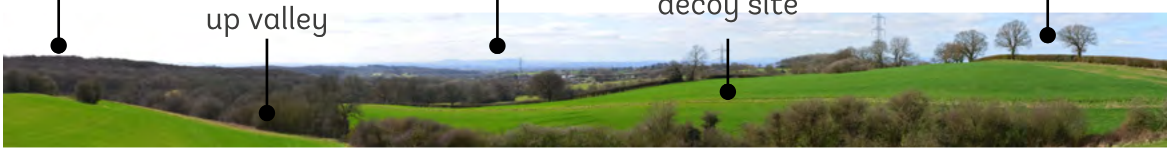


Fig. 3.4. Pepper Wood extension, landscape context map

1. Pepper Wood, ancient semi-natural woodland
2. Fairfield Court
3. Limited views into the site from adjacent houses due to existing trees and hedgerows and falling landform
4. Very limited views towards the site from the southwest
5. Good views up towards the Lickey Hills
6. Good long views towards the west
7. This woodland no longer exists



3.4 Site characteristics

The **physical characteristics** of your site will strongly influence the design and initiation of woodland development. These include the **location, aspect, slope, elevation** and **exposure** of the site, as well as the ground conditions created by the **geology, soils** and **water** (hydrology) on the site. For some larger or more complex sites, variation between some of these characteristics may influence the approach to site survey. Differences in characteristics within a site might result in dividing up the site into different compartments or zones to structure a survey visit and assess separately.

3.4.1 Location and topography

The physical characteristics of the site will have a significant influence on the development of woods and trees and may be strongly reflected in the surrounding habitats, land use and landscape. A simple description of **location** and relevant information on **aspect, slope, elevation** and **exposure** should be provided at the start of the site assessment.

These physical characteristics of the site will play an important role in shaping the spatial design of woods and trees. They will also inform decisions about tree and shrub species choice, based on appropriateness to the growing season and conditions. Finally, they may inform the options for initiation and establishment, based on the likelihood of natural colonisation and successful establishment of different tree species.

LAURIE CAMPBELL/WTML

Geology, soils and water, along with climate elevation and aspect, combine to create the site charctersitics of Geordie's Wood in East Fife.

3.4.2 Geology and soils

The **geology and soils** on the site will strongly influence the development of woods and trees, shaping species distribution and the development of vegetation communities and structure. Matching your trees and shrubs and other habitat components with the soils that can sustain them is critical in determining the success of your new woodland. Identifying any problems with your soils (such as **drainage** or **compaction** caused by recent or historic management, **pollution**, or **fire**) during the assessment phase is helpful to inform the design and initiation phases.

Soil types, **texture, structure** and **fertility** can influence woodland creation in many ways. For example, **clay soils** may be nutrient rich (promoting lush vegetation growth), but are very sensitive to compaction when wet, and to cracking when dry, so soil disturbance and machine movements should be minimised. **Loamy soils** can have good nutrient status, are also sensitive to compaction and are often easily eroded by water, risking siltation of watercourses following any disturbance. **Sandy soils** are most easily eroded by water and wind and are liable to desiccation. Disturbance should be minimised, and direct seeding or natural colonisation may be good options for tree establishment. **Shallow, skeletal** and **rocky soils** will be prone to drought and may be less fertile, limiting which tree species might successfully establish, and may be more likely to support vegetation features. On many **arable** and **agriculturally improved pasture** soils, high fertility in the topsoil may hinder opportunities to develop species-rich field-layer vegetation as part of glades and open wooded habitats.


A soil profile of chalk downland

NIGEL SAWYER/ALAMY STOCK PHOTO

Sensitive soils, such as **deep peats** and associated blanket bog, should be identified and protected. In this case, accurate mapping will be required to inform the design. Appropriate mosaics of native woods and trees can play a role in enhancing and complementing peaty wetland habitats – highlighting the need for a sound understanding of soils and hydrology to inform the design phase of your woodland creation project. Mapping the depth of peat soil is also important to inform decisions on tree establishment and woodland creation design.

The priority for all **peat soils** should be to **restore the natural hydrology** and **increase saturation**, for carbon and biodiversity outcomes. Woodland creation should never involve artificially modifying soil conditions to enable trees, or those of a specific species, to grow.

As well as being **characteristics** of the site, some soils (e.g. deep peats) or geological exposures (e.g. Geological Conservation Review [GCR] sites) may need to be considered as **site features**, and mapped accordingly.

Where appropriate, **soils** should be recorded under the following features:

S1 – Deep peat

S2 – Other geological or soils feature

UKFS (biodiversity): New woods and trees should not be established on peat exceeding 50cm in depth, or on sites that would compromise the hydrology of adjacent bog or wetland habitats.

**The current UKFS definition of peat is under review and the depth may be lowered. Our recommendation is to check relevant standards and latest evidence when undertaking your site assessment.*

A **scoping** and **desk survey** can reveal basic information about soils, geology, landforms (e.g. via the British Geological Society and Soilscapes datasets), water and vegetation cover. A **site-based soil survey** (including digging soil pits) may be necessary to identify and map detailed **soil types, soil properties, condition** and any **challenges**. A site survey will reveal soil texture and particle size (which determine soil behaviour in relation to moisture and nutrient levels or fertility), and soil horizons to understand likely tree-growth potential and rooting depth.

If the presence of complex, peaty or damaged soils is indicated, then it may be necessary to commission a detailed **specialist soil survey** to inform your creation proposals.

3.4.3 Water

The hydrology of the site will also have a strong influence on the development of woods and trees. Understanding and mapping the **hydrological characteristics** of the site is critical information to inform the design phase. Any broad patterns of surface flow, **watercourses** (which may be occasional, seasonal or permanent) and evidence of **waterlogged ground**, **seasonal inundation** or **periodic flooding**, should be recorded. These characteristics are important and present in some form on many sites. They may be strongly associated with particular features, such as wetland habitats, and may often provide important opportunities to meet multiple objectives for nature recovery and water and climate change mitigation.

Seasonal flooding at Fordham Hall estate. Woodland creation can reduce peak flows and restore important wet woodland habitats

The presence or scale of some of the **hydrological characteristics** may **vary seasonally** or with **extreme weather events,** and local knowledge and/or repeat site survey may be required to build a sound understanding of the role of water in characterising and shaping the site. In addition to a description and mapping of hydrological characteristics across the site, specific **water** features should be recorded under two features:

W1 – Waterbodies and watercourses

W2 – Springs and flushes

UKFS *(biodiversity): There is a legal requirement to protect and conserve legally protected and designated aquatic habitats and species, including a requirement for appropriate assessment.*

Scoping and **desk surveys** will help to identify **main rivers**, and it is important to consider any downstream impacts to designated rivers and standing water bodies.

During the **site survey**, it is particularly important to consider how historic land management has affected the hydrology of the site and how the restoration of natural hydrological processes could influence and complement the creation of new woods and trees.


HELIVIEW/WTML

Surveys of existing woods, open grown trees and hedgerows can play a key role in shaping woodland creation design

3.5 Features

3.5.1 Trees and woodland

Existing **woods and trees** play a key role in shaping your design, providing a starting point for developing **habitat structure**. They may also be an important **seed source** for natural colonisation (and/or propagation) and inform decisions about initiation methods on the site. In addition, **ancient woodland**, **ancient hedgerows** and **mature open grown trees** (including ancient and veteran trees) are important features and should be **protected, restored** and **enhanced** in the design, initiation and establishment of new woods and trees.

Trees and woodland should be recorded under six features:

TW1 – Woodland

TW2 – Mature and veteran trees

TW3 – Trees and shrubs (Including younger regeneration)

TW4 – Scrub

TW5 – Hedgerows

TW6 – Decaying wood

Your **desk survey** should include searches of the **Ancient Woodland Inventory** and the **Ancient Tree Inventory,** and any further ancient or veteran trees identified during the site survey should be recorded and added to this inventory, with the landowner's consent. Historic maps may also provide you with information on the location and presence of old or historic trees, hedgerows or woodlands, which may help focus your survey on these features as well as interpret what you find on site.

The **site survey** should record and map all existing trees and woodland on the site. In addition, you will need to look beyond the boundaries of the site and record **nearby woods and trees,** which may inform tree species choice in your design as well as provide **seed sources** for natural colonisation. In particular, the adjacency of ancient woodland will influence initiation methods, as in most instances their expansion through natural colonisation will be both possible and most appropriate [26]. Decaying wood should also be recorded, including significant decaying wood in the canopies of trees and any standing or fallen dead trees or large branches.

In surveying and describing woodland on or near the site, it will be useful to categorise the woodland structure. Areas with high canopy cover (>80%) should be categorised as **groves**, with areas of between 20–80% canopy cover described as **open wooded habitats**. The latter category could include patches of **trees and scrub, wood pasture, wet woodland, ffridd,** etc. A summary description of woodland structure will be helpful to inform the site design.

If the existing trees and woodland are a significant feature of the site, you may need to decide whether the project is better considered as a restoration, rather than a creation project. For example, a remnant wood pasture with scattered mature or veteran trees may not be recorded on any habitat inventory, but may be better viewed as a restoration project informed by a condition assessment of the habitat.

3.5.2 Vegetation and other habitats

Aside from trees and woodland, the existing field-layer vegetation may be a key asset for developing richer ecosystems – inspiring and informing the design. Other habitats may also have developed in open situations. Any existing **semi-natural vegetation** and other **open habitats** should be recorded and mapped as accurately as possible. This includes habitats which may be in poorer condition but could be enhanced through restoration as part of your project. With the exception of very species-poor agriculturally improved grassland and arable, most other vegetation will require a thorough evaluation necessitating a site survey. But even in those situations, an evaluation of species, including birds and plants of arable and agriculturally improved pasture, is still required.

The establishment of new woods and trees should not significantly impact and alter the characteristics of existing priority habitats. Of particular concern are **species-rich grassland** and **wetland habitats**. These habitats have declined dramatically in most landscapes in the UK, but **remnant patches** may be found on marginal ground in farmed landscapes which may be identified as potential woodland creation sites. Important remnant patches of species-rich grassland and wetland may be very small, making it important to identify these habitats on even the smallest of woodland creation sites.

Vegetation and other habitats should be recorded under four features:

OH1 – Grassland

OH2 – Wetland

OH3 – Heathland

OH4 – Other vegetation and habitats

UKFS *(biodiversity): Proposals for new woods and trees should include an assessment of the potential impacts on priority habitats.*

Basic information can be collated during the **scoping stage**, with designated sites and priority habitats inventories available on several websites. The Woodland Trust has developed a **botanical assessment tool**, in collaboration with the Botanical Society of Britain and Ireland (BSBI). This tool provides a list of indicator plant species records for the site and its immediate surrounds. The results are classified by habitat and a quality score is provided for each habitat present on the site. This will not give a definitive assessment of the presence or absence of semi-natural vegetation and other more open habitats, but should be used to focus the site survey and, potentially, specialist surveys.

Species-rich grassland declined by over 95% and remnant patches are often found on marginal agricultural land that are sometimes seen as opportunities for woodland creation

An array of information sources may be used during the **desk survey**, including Local Environmental Records Centres (LERCs), National Biodiversity Network (NBN) Atlas, local floras, and locally commissioned surveys.

The **site survey** should aim to map any areas of existing semi-natural vegetation and more open habitat. On large sites, survey the whole area if at all possible, while ensuring that any areas of potential habitat are identified in the scoping and desk assessment. Recording vegetation and semi-natural habitats in the site survey can be challenging. You should aim to record habitats even if they are significantly degraded as there may be opportunities to restore other habitat elements as part of your woodland creation project. The accompanying **Site Assessment Handbook** provides more detail and guidance on how to identify and record these features.

Be aware that you may be carrying out your site survey at times of the year when the presence of important habitats is not obvious; for example, when indicator plants are not in flower or have recently been cut or heavily grazed. If at any stage of the site assessment you find evidence of semi-natural habitats, you should consider either delaying the design phase to allow for a further site survey in the spring or summer when plants are in flower, or commissioning a **specialist vegetation survey** of the site.

Ground-nesting birds such as curlew can be impacted by tree planting, both from direct loss of nesting habitat and from an increase in populations of predators.

3.5.3 Species

Recording the extent of semi-natural vegetation and habitat features will give a good picture of the overall biodiversity significance. However, in order to fully understand the potential impact of new woods and trees and the opportunities for nature recovery it is important to gather information on key species separately.

The information collected on existing trees, woodland, vegetation and other habitats won't always give an indication of the likely presence of important species. Conservation-priority birds, such as lapwing, curlew, chough and skylark, will use more agriculturally improved grassland, and sometimes important **grassland fungi** may occur in relatively species-poor grassland. Corn bunting and grey partridge may occur in more intensive arable fields, as well as the group of plants known as **arable** weeds. These once common plant species are associated with open, disturbed ground and have suffered dramatic declines and are now rare or scarce, requiring special consideration on arable land. For plants and fungi, some areas may occur within Plantlife's 'Important Plant Areas' and 'Important Fungi Areas', and maps can be checked in the scoping stage of the assessment. Many **urban** locations, including brownfield sites, can support priority invertebrate and plant species, yet may not have any semi-natural vegetation features.

It is particularly important to ensure that the presence of **legally protected species** is accurately recorded to avoid disturbance or the loss of supporting habitats or features. **Priority species** associated with **open habitats** may be impacted by the establishment of new woods and trees, particularly denser groves. These include plants, breeding birds, invertebrate assemblages, lichens and mosses and grassland fungi. For some groups, it is very important to consider the landscape context. Species need to be considered well outside the boundary of any site being assessed. For example, **ground-nesting birds**, including golden plover, curlew, dunlin and lapwing, may suffer from edge-effects extending beyond 400 metres and up to 700 metres from plantation edges (Stroud et al. 1990, Wilson et al. 2014). The issue is not so much with the trees themselves, but is more related to how they support predators and emphasise the lack of ecological integrity and resilience in many UK landscapes, with numerous processes being out of balance. It is important to check maps of BirdLife's Important Bird Areas and other data sources for records of priority birds.

In addition to those species which may be negatively impacted, it is very useful to understand the presence of **woodland specialist species**, such as woodland indicator plants, woodland birds, invertebrates and bats. The **Woodland Wildlife Toolkit** will give you a list of species recorded in the area, which provides a useful starting point for searches and surveys. These may be present on the site; for example, in hedgerows or boundary features. An assessment of woodland specialists is greatly enhanced by looking beyond the site boundaries to understand the potential for use and colonisation of the site by these species.

Species should be recorded under six features:

SP1 – Protected species

SP2 – Priority bird species of open habitats

SP3 – Rare and scarce plants, lichens and fungi of open habitats

SP4 – Open habitat invertebrate assemblages

SP5 – Woodland specialist species

SP6 – Other species feature

UKFS *(biodiversity): Proposals for new woods and trees should include an assessment of the potential impacts on priority species.*

The National Biodiversity Network Atlas and Local Environmental Record Centres (LERCs) can provide detailed species records during the scoping and desk assessments. Further information is likely to be available from local organisations and groups such as the Wildlife Trusts, bat groups and local BSBI groups.

The **BSBI botanical assessment tool** will provide information on rare and scarce plants recorded, including those associated with boundary features, arable land and exposed rock. The site survey can add current observations and new records to the collated species lists. Species records can be submitted to national recording schemes and LERCs to ensure that data is stored and can be used again to inform other work.

The identification, survey and evaluation of many of these species is a specialist skill. Searching existing data and a good site survey can provide a satisfactory understanding of the species interest of a site. However, if the presence of protected or priority species (or other locally important populations) is indicated, then consideration should be given to commissioning further specialist advice in order to assess the significance of any changes in land use or vegetation cover.

STEVE SPELLER/ALAMY STOCK PHOTO

An ancient field system in Wiltshire. Integrating woods and trees into landscapes with such time depth requires careful design, informed by detailed assessment of the historic environment features.

3.5.4 Historic environment

It is important to assess any historic environment features which may be present. **Archaeological features**, **historic land use** form and features, and other **significant cultural features,** should be identified and mapped as accurately as possible.

Historic environment should be recorded under three features:

HE1 – Archaeology

HE2 – Historic or designed landscapes

HE3 – Cultural features

UKFS *(historic features): Steps should be taken to ensure that historic features are known and evaluated, taking advice from the local historic environment services.*

UKFS *(historic context): Check for historic assessment or categorisation and use this to inform your design.*

UKFS *(evidence of the historic environment): Check for historic environment records and take advice from historic environment services. Look for indications of the historic environment on the ground and conduct further investigation where evidence is found. Commission specialist surveys where evidence is significant and ensure survey results are added to the historic environment record.*

UKFS *(designed landscape): Check for any historic or designed landscape register or inventory listings. Seek specialist advice to inform the design phase for listed sites. For listed sites and those where there is evidence of designed park or landscape, investigate the original design intentions to inform your design.*

Archaeology: Scheduled Monuments and non-scheduled archaeology can be extant, above and/or below ground, or buried. It can include, for example, Roman remains, surface scatters and finds (of artefacts), burial mounds, castles, bridges, earthworks, the remains of deserted villages, industrial sites and 20th-century military complexes.

Designed landscapes – registered or not – are an important part of the cultural heritage of many of our landscapes. The term can be applied to parks, gardens and estates which have been modified primarily for aesthetic effect. Often associated with the 18th-century English landscape gardens of Capability Brown and Humphry Repton, designed landscapes can be found dating from the 15th century onwards. Many designed landscapes are listed on registers such as Historic Environment Scotland's Inventory of Gardens and Designed Landscapes, or Historic England's Register of Historic Parks and Gardens. However, these inventories are incomplete, and it may be possible to identify a fading design history in many landscapes. Where this is the case, the identifiable features of the designed landscape should be an important consideration in the design of new woods and trees.

Cultural features, including land use, settlement patterns and living history have left a legacy of varied landscapes, rich in historical and cultural values. Understanding the historical interactions between people and nature that have shaped the landscape is important in shaping the design of new woods and trees. These may be reflected in local history, stories and place names as well as physical features. The use and management of woods and trees will have shaped the composition and structure of ancient woodland in the landscape. Evidence of coppicing, pollarding and felling may be present in the form of charcoal platforms, boundary banks or saw pits. Ancient hunting forests and wood-pasture systems which combined livestock grazing with the harvesting of firewood, fodder and timber may each have a legacy of distinct wooded habitats or be discernible as remnant features or 'ghost woods'. Other semi-natural habitats, such as hay meadows or heather moorland, are a result of a long history of land management which needs to be taken into consideration when creating new woodland.

Scoping assessments should include searches for historic environment assessments, scheduled monuments and registered designed landscapes. The desk-top assessment should include a search of the Historic Environment Record (HER), which may be freely available or may have to be requested from the local archaeological service. Requests for data may be combined with requests for advice, which may reduce any costs. Cultural uses or interest on the site may require conversations with neighbouring landowners and local residents.

Many of the **inventories and registers** mentioned above are incomplete, and it is essential that the **site survey** includes observations on any features or indications of historic land use.

Where searches or the site survey indicate the likely presence of poorly recorded or understood historic environment features, it may be necessary to request **further advice** from the local archaeology service and/or to commission a specialist survey by a heritage specialist. This will help to ensure that the features are properly evaluated against the significance of any changes in land use or vegetation cover

JOHN ATHERTON/WTML

'*Witness*', an oak sculpture by John Merrill, stands in Langley Vale Wood, one of the Trust's four flagship First World War centenary woods.

3.5.5 Public access

It is important to understand how the site is presently used by the public. Start by looking at the wider area to determine the current sources of visitors (local communities and businesses, etc.), what other areas of accessible green space are nearby and how your site could complement these. If the site is currently open to the public, ascertain how they access the site (e.g. on foot or by car), where the **access points** are and if parking is available. Consider how visitor levels may change with new woodland creation – woodlands are attractive destinations and people may travel further to visit the site. Local development plans may be a means to ascertain future changes/increases in footfall. Local groups may also want to use the site; for example, scout groups, forest schools, or amateur naturalist societies.

Establish if there are any legal rights of way or informal access routes within the site. If there are any existing public rights of way, these will need to be integrated into the design of the new woodland, along with other site features. Engaging and liaising with immediate neighbours is particularly important as access arrangements often cross ownership boundaries and changes in use are likely to have a direct impact on neighbours.

The locations of **open access land** and public rights of way can be obtained from published maps, but informal access routes and levels of use, as well as the types of recreational activities being undertaken (e.g. walking, horse riding, cycling) can only be established through site visits. During a site visit you could map footpaths, desire lines, unofficially constructed cycle trails, etc. as well as any obvious areas of frequent use – for example, for picnics and den making – which could be incorporated into your design. Visitor counts, whereby the number of people and dogs are recorded during a set period at an access point or path section, along with the activity they are performing, will give an indication of the current level of use. Visitor questionnaires could be used to obtain information on how frequently people visit, how they get there, how long they spend there, how far they travel, etc. to help to predict overall visitor pressure.

If current levels and distribution of recreational pressure are adversely affecting other features at the site, this needs to be addressed in the design. This could involve re-routing paths, closing paths at certain times of the year, restricting which activities can take place, and careful placement of access points, amenities and car parks. Equally, you should consider whether the current access network works well with other site features; for example, do paths lead to points of interest, such as archaeological features or viewpoints? Could improvements be made in terms of linking routes within the site with other public rights of way, or new routes be created like nature trails, mountain bike tracks or all-ability surfaced paths?

Public access should be recorded under one feature:

PA1 – Public access

Scoping and desk surveys should include establishing the definitive routes of any **public rights of way** and any **rights of access** under the Countryside and Rights of Way Act 2000 (England and Wales) or the Land Reform (Scotland) Act 2003. The site survey should additionally record any **permissive access routes**, **de facto access to open land** (especially In Northern Ireland) and any evidence of **informal use** of the site (e.g. desire lines and ground compaction at viewpoints).

Ideally, a map of current **visitor infrastructure** should include: the path network, categorised by type (footpath, bridleway, restricted byway or byway open to all traffic) and/or use (walking, cycling, horse riding, shared use); **access points,** categorised by mode of access and, if applicable, number of parking spaces and any **amenities,** such as toilets, cafés, benches and play areas.

If visitor numbers and behaviour are known, it is possible to produce a 'heat map' of visitor pressure to assess how it is distributed over the site and overlay this with other mapped features to identify any opportunities or conflicts. It may be helpful to conduct visitor counts or surveys to gain a better understanding of current use and, if necessary, conduct these at different times of day, days of the week and times of year to reflect variability in recreational use.


SHAUN DAVEY/ALAMY STOCK PHOTO

Utilities infrastructure, such as overhead powerlines, are likely to have to be kept permanently free of trees.

3.6 Constraints

Constraints are practical issues or other limiting factors that need to be considered in the design phase. They may require certain parts of the site to be kept free of trees, require additional management in the initiation or establishment phases, and may also incur additional costs.

3.6.1 Infrastructure and rights

The presence of trees, or even smaller shrubs, may not be appropriate in some locations due to the siting of infrastructure or services. There may also be legal requirements to maintain access to the site for others. Any such areas need to be identified and clearly mapped.

These spatial constraints should be recorded under two constraints:

IA1 – Infrastructure and services

IA2 – Third-party rights

Some buildings, infrastructure and services may preclude the presence of trees, either as a precautionary tree safety measure or due to requirements for defined clearance.

Overhead cables, underground services, buildings, roads and boundaries with other land uses may be covered by legal wayleaves requiring defined areas to be kept free of trees and shrubs. In other areas, risks of trees to public safety may be important to consider. High-risk zones along property boundaries, roads, etc. should be mapped to ensure that they are considered in the design.

Third-party rights may grant people other than the landowner rights of access across the land, the right to a private water supply, or fishing or shooting rights. It is important to be aware of the details of any such rights as they can significantly affect your design.

Legal wayleaves and easements relating to the site and existing third-party access rights should be investigated as part of the scoping and desk assessment. These constraints should also be assessed during site survey which can provide a more detailed understanding of the practical issues. A specialist survey or advice may be required for constraints such as underground services, especially if these are close to access tracks, proposed fence lines or any part of the site where excavation may be required.

3.6.2 Herbivore impacts

There are six species of wild deer within the UK. Of these, the two truly native deer (red and roe) have an important role to play in the function of woodland ecosystems. However, with no natural predators, populations of all six resident deer species are increasing. The population densities of deer species vary between landscapes, depending on land use, habitat suitability and historic management, and can have a particularly detrimental impact on young trees and shrubs and at high densities, can present a major constraint to the successful establishment of trees. Good information on deer populations and the impacts they are having on the existing vegetation, is essential to inform decisions on culling and/or protecting trees from browsing to secure their establishment.

The browsing impacts from other herbivores, such as feral goats, feral pigs/wild boar and livestock, can also be considerable constraints on tree establishment. Voles, rabbits and hares will also require consideration and an assessment of existing impacts, as will the presence and population of grey squirrel.

Herbivore impacts should be recorded under three constraints:

HI1 – Deer population and impacts

HI2 – Other herbivore impacts

HI3 – Grey squirrel population

National maps of deer species distribution may provide an initial indication at the scoping stage. During the desk assessment, information on deer surveys should be sought. This may be at local or landscape scale and could include count or census results, deer impact assessments and/or cull figures.

The site survey may reveal deer activity, such as dung, tracks (slots), racks and scrapes or fraying, browse lines and selective grazing. These should be recorded and may indicate that more detailed specialist survey may be required. This could include herbivore impact assessments and/or an assessment of the actual population size through a count or thermal imaging survey.

The deer population in the surrounding landscape should be considered, alongside evidence of activity on the site, as the suitability of the site for deer is likely to increase significantly as trees start to establish, and deer numbers and activity on the site may increase dramatically if large populations are present in the area.

Evidence of other herbivore impacts, including vole surface runways, browsing, bark damage, racks and slots of rabbits and hares, should also be recorded as part of the site survey. Existing vegetation cover may also be indicative – dense grass swards provide ideal cover for voles especially. Grey squirrel presence or damage on trees should be noted. Although their impacts may not be significant until well into the establishment phase, it is important to consider the significance of grey squirrels and their potential damage to certain species and structures more than others (e.g. denser groves of even-aged trees around 10–40 years).

3.6.3 Competing vegetation

The existing vegetation on the site may compete with tree saplings for moisture and nutrients. In addition, tall vegetation can become wet and heavy in the autumn, collapsing onto and smothering establishing trees. Competitive vegetation can be a barrier to the successful establishment of trees and may require management. But this needs to be considered holistically alongside habitat features (3.2.4) to inform the design and initiation of different wooded habitat structures (groves, open wooded habitats, glades). If invasive non-native plants are present on the site and are not controlled, they can seriously impact the successful establishment of trees and the delivery of nature recovery objectives and many of the other benefits of woodland creation.

The potential impact of vegetation on tree establishment should be recorded under two constraints:

V1 – Competing vegetation

V2 – Invasive non-native plants

ROB PENN

Bracken cutting at Bryn Arw. Tall bracken can collapse, smothering shorter tree saplings.

Dense grass swards significantly reduce moisture and nutrient availability for establishing trees and suppress colonisation by other plants as the site develops. Vigorous and taller plants, including bracken, can have a similar effect. In addition to competition for moisture and nutrients, they can reduce the light reaching small saplings and crush young trees as they die back. If the ground is disturbed during the initial establishment phase, or management is changing, for example on ex-arable land, then there is a risk of a vigorous response from ruderal plants which can also compete with tree saplings [27].

It may be possible to gather some evidence during the scoping and desk assessment stages by looking at land use maps or aerial photography. In most cases, an assessment of the challenges presented by competing vegetation can only be made through a site survey. The development of vegetation alongside establishing trees can be difficult to predict and soil conditions and fertility may need to be considered as part of this assessment.

Invasive plants can also compete directly with tree saplings and present a barrier to tree establishment. They can also seriously compromise the delivery of our woodland creation objectives and present a lasting risk to the successful establishment of a high-quality woodland habitat. Site survey is the key step to identifying plants such as rhododendron, laurel, Japanese knotweed and Himalayan balsam. Even if these plants occur infrequently, or over a small part of the site, eradication will need to be included in the plans for woodland creation. A specialist survey to record locations and extent in detail may be required.

3.7 Environmental Impact Assessment

The **Environmental Impact Assessment** (EIA) is a UK-wide system designed to ensure that due consideration has been given to the environmental impacts of woodland creation.

There are three different types of EIA application, depending on the scale of your project and the sensitivity of the site and landscape. You may be required to give a **notification** of your project, in a **basic or full application**. Alternatively, you may be required to **apply for a formal opinion** on your project proposal.

The relevant government **woodland officer or adviser** will be able to advise you on the requirements for your project, and it is suggested that you make early contact to assist you in planning your assessment and design requirements. You are strongly advised to engage these responsible officers early in the development of your project to understand their requirements and gain their support. There are a range of **statutory and standard consultees** for EIA applications, and it is equally important that you **identify and engage** with these people, communities and organisations to avoid objections to your application in the later stages of the process.

In each country, thresholds are set below which a woodland creation project is deemed unlikely to have significant effect on the environment. However, the relevant government agency can require projects below these thresholds to apply for consent in exceptional circumstances.

Lower thresholds are applied for projects that lie within **sensitive areas**. Sensitive area definitions include National Parks, Areas of Outstanding Natural Beauty, Natural Heritage Areas and National Scenic Areas, National Nature Reserves and Sites/Areas of Special Scientific Interest, RAMSAR sites, Special Areas of Conservation and Special Protection Areas, Scheduled Ancient Monuments and World Heritage Sites, along with all areas of peat soils exceeding 50cm in depth. Within these, projects as small as 2ha or less may be required to submit an EIA application.

Work which has been carried out in an area adjacent to the project within the previous five years must also be counted towards the area threshold.

The agencies responsible for the administration of the EIA regulations are: The **Forestry Commission** in England (EIA Regs 1999 as amended), **Natural Resources Wales** (EIA Regs 1999), **Scottish Forestry** (EIA Regs 2017) and the **Northern Ireland Forest Service** (EIA Regs 2006). These agencies each publish periodically updated thresholds and guidance for EIAs in each country.

CASE STUDY

Taw Valley: small site, big ambitions

A site in the Taw Valley in Devon shows why assessment is vital no matter how big the area is. Despite its small size (<2ha), part of this complex site was found to support a high value habitat feature. This was mapped during the site assessment, informing the design plan and future management.

A young couple approached the Woodland Trust as they wanted to plant trees on their pasture for nature, and sustainable food and timber for their own use. After some initial scoping and desk-based assessment, the site was visited to undertake a site survey. This aimed to record all existing **features**, along with any **constraints** which might affect woodland planting.

The site was adjacent to an existing semi-natural woodland feature, but the main feature within the site was the presence of species-rich Culm grassland, with indicator plants such as ragged robin, bird's-foot trefoil and knapweed. This increasingly rare, damp grassland vegetation is found only in north Devon and north Cornwall in areas with heavy clay soils overlying carboniferous rocks. This is an important site **characteristic** and a consideration of the **landscape context**. Similar grassland types are found only in South Wales (where it is known as Rhos Pasture), southwest Scotland, northwest France and a few other places. Not only is Culm grassland important for biodiversity, but it holds water, filters pollution and stores carbon. This was an important feature of the site.

The extent of the species-rich grassland feature was identified during the site assessment and mapped, along with other areas of the site dominated by rank grass with low plant-species diversity. Based on the assessment, the recommendation was to develop a design which accommodated the species-rich grassland as an open glade and establish native wooded habitats on the most species-poor grassland areas. The assessment also revealed a number of constraints, including overhead powerlines.

CASE STUDY

The final design incorporated all factors from the site assessment (see Fig. 3.1):

- The wayleave for the overhead powerline was left clear.
- The glade of species-rich grassland was retained, and although it may benefit from an element of grazing in the future, it would continue to be managed via a cut and remove regime.
- 0.7ha was identified for tree planting, mainly of oak, but with field maple to enrich the existing hedge, alder for wetter areas, and a selection of native shrubs to enhance the existing woodland edge and make use of the sunny margins.
- New native woodland provides connectivity with existing woodland, and small areas of the periphery were designated for a few other species to achieve the additional objectives of food and timber production.

Despite being a small-scale site, multiple outcomes will be achieved with this project due to clear objective setting at the outset and the use of on-the-ground site assessment to identify features and constraints.

CASE STUDY

Figure.3.1 Map of Taw Valley

Design

PHILIP FORMBY/WTML

Vision → **Assess** → **Design** → Initiate → Establish

- **Design principles**
- **Synthesis**
- **Concept design and consultation**
- **Final design**

4: Design

The **site assessment** will have given you a good understanding of the site and the surrounding landscape. You should by now have described the important **characteristics** of the site and identified and mapped key features. You should also have identified any **constraints** to woodland creation and carried out an appraisal of the **landscape context**. You will have a good understanding of the priority objectives for your project and confidence that these are shared with landowners, partners and other important stakeholders. These should have been articulated in a series of **objectives** and ideally a long-term vision for the site.

In the **design phase**, you will bring together this knowledge of the site and your project objectives to produce a woodland creation design which will require the **synthesis** of all the information gathered in the previous phases to produce a **concept design**. A set of **design principles** are provided for each of the objective themes. Blending and balancing the principles for each of your project's objectives is an integral part of this synthesis stage.

It is important to continue to **engage** and **consult stakeholders** in the design phase. The result should be a **finalised design** based on a sound understanding of the site and its landscape, with broad stakeholder support, which delivers the project's objectives for people and wildlife.

4.1 The design phase

The design phase provides an important opportunity for reflection and the development of ideas before the activity of initiating and establishing woods and trees begins on site. As with other phases of the approach, the **time and resources** required for the design phase will depend on the **scale and complexity** of the project.

The first stage of the design phase is a **synthesis** of **information and ideas** gathered and developed during the **site assessment** and **objective**-setting phases. To support this phase, a set of **design principles** is provided in this chapter for each of the themes used to define and prioritise objectives.

There are numerous **synergies** between the various sets of design principles, but you are likely to have to make **compromises** to accommodate different objectives. Having fewer objectives or a smaller number of **priority objectives** will make the synthesis stage easier. At this stage, decisions need to be made on blending and balancing the different design principles to inform the design.

The synthesis stage should result in the production of a **concept design,** which need not be more sophisticated than a sketched map with notes on key aspects. The landscape appraisal, site description, maps and notes provided in the **site assessment** will include a base map that shows where trees and shrubs may be appropriate.

The **landscape design principles** are relevant to all projects, not only those with specific landscape objectives. They emphasise the role of landscape as a unifying element, underpinning the development of **integrated designs** which contribute to landscape character, including visual amenity and beauty, biodiversity and habitats, the historic environment, people and access, the climate, soils, hydrology, topography, land use and management.

It can be a very useful discipline to challenge yourself to produce an **alternative concept design**, illustrating and testing a different configuration of woods and trees on the site. For large projects, you may want to produce a range of concept designs. Producing more than one concept design is a good way to stimulate creativity and visualise different solutions.

As there is no simple matrix for combining design principles, producing several different concept maps can help to **illustrate options** and the consequences of prioritising one objective over another. It can also illustrate the options for balancing control over establishment and allowing time and space for natural processes.

Your design will provide a spatial plan for the establishment of new woods and trees as well as a basis for the **initiation** and **establishment** phases of the project. It should provide enough information to support the specification of works in the initiation phase (site preparation, infrastructure installation, planting and seeding, fencing, etc.) and will continue to inform management throughout the establishment phase. Over time, natural processes will shape the development of the site, and management will need to become more responsive and adaptive. The design should, therefore, consider this natural development and dynamism and allow time and space for it to develop.

In addition to the site assessment and objectives, the concept design will have to take account of the requirements of any funding mechanisms that are supporting the project. However, as far as is possible, the initial concept design should be developed without any limitations imposed by the **funding for the project**. Matching the appropriate funding mechanisms to the design, rather than producing a design to meet the requirements of a specific **grant scheme** or other **funding mechanism**, will help to ensure that your project delivers on the agreed objectives.

The design phase should be a collaborative process, with the concept designs providing the basis for continuing **stakeholder engagement**. This may include discussions with a single landowner, consultations with statutory and regulatory bodies, or wider consultation with community and interest groups.

You will probably want to include information on the target **composition of trees and shrubs** and **methods of initial establishment** in the design. Detailed guidance on compiling a target species list, based on an understanding of the woodland vegetation community appropriate to the site characteristics, is given in the following chapter on **initiation**.

The output of the design phase should be a **final design**. This will usually need to be presented in a format to meet the requirements of grants or other key funding. Generally, it should include a **map** showing the proposed spatial arrangement of woods and trees, along with sufficient **annotation** and **supporting information**. The supporting information will need to include: how **site features** have been incorporated and enhanced in the design, how **constraints** have been addressed, and information on proposed access arrangements and any infrastructure required, along with an overview of the **management** that is planned or required during the establishment phase.

4.2 Design principles

Your design should also reflect your priority objectives to ensure that your project delivers for people and wildlife. The **design principles** set out in this section will provide a starting point from which to begin shaping your concept design, and the links to useful resources will provide more detail on specific topics.

4.2.1 Nature recovery

The creation of new woods and trees has a critical role in supporting the recovery of nature [3]. This can be achieved by creating **quality native woodland habitats**; increasing **native tree cover** in the landscapes between woods; supporting the **recovery of species populations** and **restoring natural processes**; and building **nature recovery networks** to restore the natural functioning of healthy woodland ecosystems and landscapes.

Native trees and shrubs provide the essential architecture to a variety of habitats that support an immensely diverse range of associated wildlife. The richness (number of different species) and abundance (size of the population of each species) of wildlife on any given area of land is largely governed by the **extent** and **quality** of the habitat. It is important, therefore, that woodland creation provides quality habitat as well as an increase in extent to drive nature recovery.

*UKFS: Woodland creation should seek to extend and improve **semi-natural and priority habitats** and restore populations of **priority species. Ancient woodland** should be enhanced through native woodland creation to reduce edge effects. Designs should include the creation and enhancement of **open habitats** and improved **landscape connectivity** by linking conservation features. They should also include graded-edges – providing diverse transitional zones between structural components. The habitats of special and **designated sites** should be extended, and **veteran trees** should be retained and managed. Wetland features, such as **springs, flushes and bogs,** should be protected and restored, and **riparian zones** enhanced by creating varied shade and a source of woody debris and leaf litter.*

Design principles for nature recovery:

Predominantly native trees

Our wildlife has co-evolved with our **native trees** over thousands of years, making native trees the best for wildlife and nature recovery [28]. Strong associations have been built between individual tree species and a **rich diversity of wildlife**, supported by the specific structures and chemistry of leaves and bark; phenology of flowering and fruiting; particular patterns of wood decay; food sources; and roosting and nesting sites. This is why native woodlands are the most species rich, supporting a quarter of our priority species for conservation [29]. Native oak alone has at least 2,300 species known to be associated with it, of which 300 depend on it entirely [30].

For these reasons, we state that all our woodland creation should consist of predominantly native trees and shrubs, as the contribution of non-native trees to nature recovery is likely to be much more limited. The use of 'predominantly' is intended to provide scope for trees which are included in the design to meet other clearly defined objectives. This might include the use of fruit and nut trees in agroforestry projects, or certain non-native trees in hard infrastructure (e.g. street trees) to deliver air quality or urban landscape objectives.

The definition of 'predominantly native' does not include commercial plantations of mixed native and non-native species. However, the creation of well-designed commercial plantations can contribute to nature recovery at landscape scale, especially those that include a substantial proportion of native trees and a diversity of structure. We will work with partners and landscape projects where non-native timber production objectives are a priority, and where conservation goals can be achieved, and we will include productivity objectives from native trees in our projects.

The selection of tree species to incorporate in your design is discussed in the following section of this guide. The aim should be to design species compositions that are distinctive and create a strong sense of place. Species should combine to form recognisable **woodland vegetation communities** that are well matched to the location and conditions of the site, as described in the site assessment.

Develop habitat mosaics and promote structural complexity

To drive nature recovery, the design of new woods and trees should aim to develop **habitat mosaics** and promote a varied and **complex structure** at a variety of scales.

Structural complexity is a useful and simple proxy for habitat quality [31,32]. Methods of tree planting which use consistent spacings between trees are intended to promote tree growth and form for timber production. Extensive use of these methods across a site will limit structural complexity, suppress ground layer vegetation and reduce opportunities for natural processes and dynamism.

Structural complexity enhances the conservation value of woods and trees by creating a diversity of **microclimates** and a range of **resources for wildlife**. With varying structure and density of vegetation, a complex pattern of environmental conditions – including light, shelter and humidity – is created. Equally, structural complexity (and associated plant species diversity) provides a greater range of resources for wildlife, including food sources such as nectar, food plants, berries and nuts, breeding habitat and nesting sites, and important wood decay habitats. If a broad range of microclimates and resources are frequently available on the site, then an extraordinary range of habitat niches is provided to drive nature recovery.

Mosaic woodlands

Habitat mosaics can be developed through the design, initiate and establishment phases. In new **woodland**, a **mosaic of structural components** can be created by including **groves, open wooded habitats** and **glades** in your design.

Groves are areas of **dense canopy**, typically in excess of 70% once established. In groves, most trees compete for crown space – creating unique conditions of **shade and humidity** which support an assemblage of associated species. The conditions favour **woodland specialist** plants. High humidity is vital for associated species like bryophytes [33] and a diverse invertebrate assemblage associated with woodland soils and leaf litter [34–37]. The competition within establishing groves drives self-thinning processes, while competitive exclusion creates standing decaying trees of small diameter and the development of small cavities in young trees.

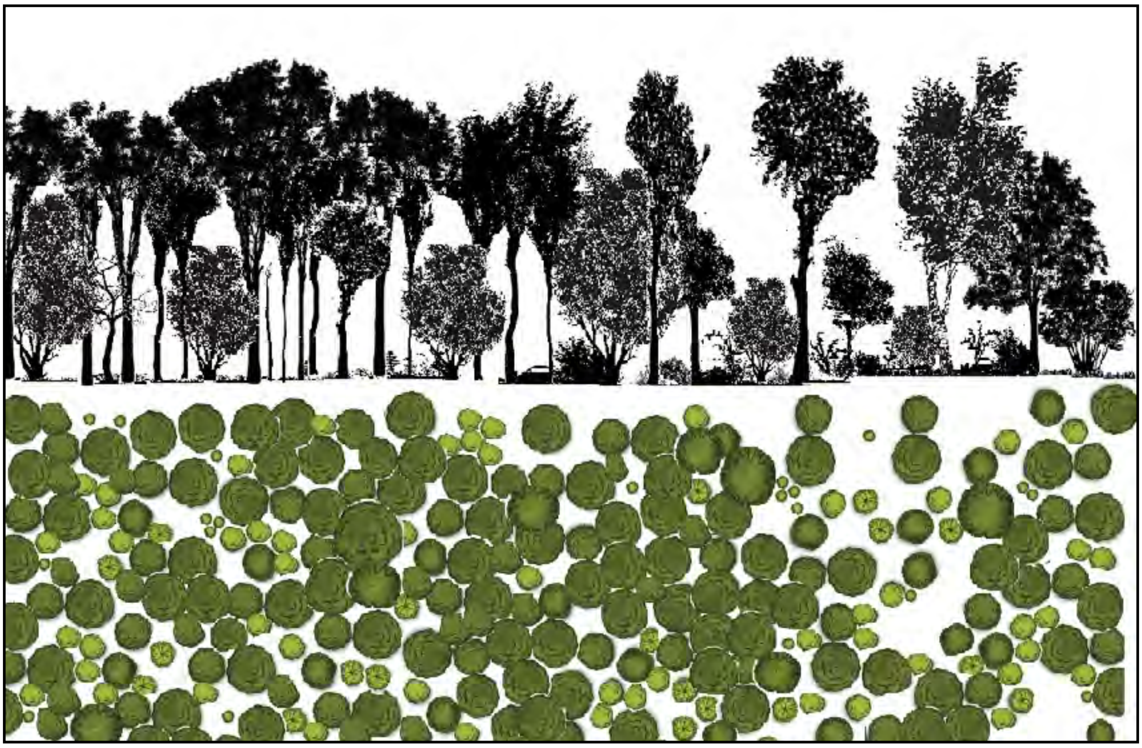


Figure 4.1. A grove structure

Open wooded habitats refers collectively to a wide range of woodland structures with canopy cover varying from 20%–70%, within which many individual trees will establish with limited crown competition from neighbouring trees. These wildlife-rich habitats may be created and maintained by **environmental conditions** such as shallow stony soils, rock outcrops, open water or deeper peat. Such habitats can also be shaped by **management**; for example, coppicing, pollarding or felling trees and mowing or cutting the ground vegetation and scrub. They are perhaps most often the result of **natural disturbance** by grazing and browsing animals, whether wild or equivalent domesticated livestock [38], and to a lesser extent by events like storms and fires.

These habitats can provide an intimate mix of varied tree cover, early successional and mature scrub, ground vegetation and bare ground, which together deliver a great range of **habitat niches and resources** supporting a unique and rich **assemblage of wildlife** [39]. This is particularly important for species that have different requirements through annual, **seasonal** or **daily cycles** [29,39]. Examples include insects whose larvae live in decaying wood, soil and leaf litter and are dependent on sunlit, open-structured flowers such as hogweed, hawthorn and bramble as adults [40,41]; and birds like great spotted woodpecker that shift between open wooded habitats and denser groves at different times of year. Some species often associated with open habitats, such as moths of calcareous grassland, can be more abundant in open wooded habitats that provide a combination of flower-rich swards and shelter [42].

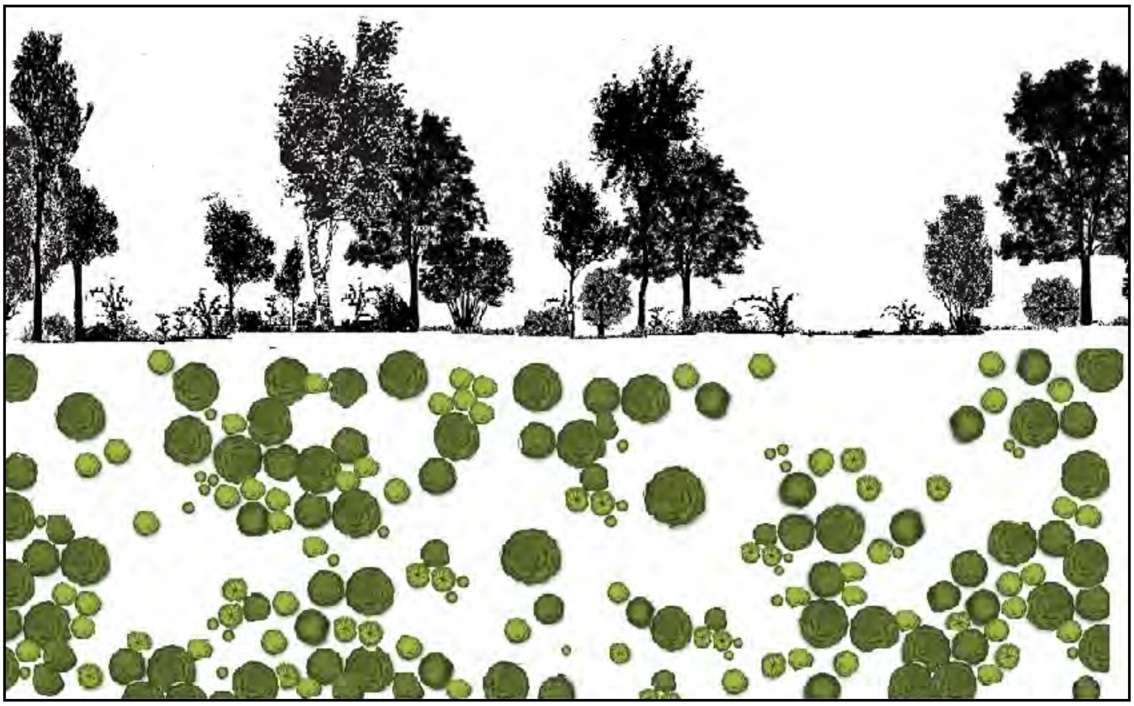


Figure 4.2. An open wooded habitat structure

There is strong evidence that open wooded habitats were **historically far more extensive**. These habitats may have covered large parts of many of our landscapes as a significant part of the wildwood that dominated the UK following the last ice age [43]. They would have been the dominant vegetation structure across the extensive Anglo-Saxon hunting forests and later Norman forests and chases. They were also much more extensive on lowland commons and open hillsides across the UK prior to the extensive enclosure of the countryside.

The loss of open wooded habitats is symptomatic of the fragmentation of the countryside and increasingly sharp divisions between dense woodland and open land, along artificial boundaries of ownership and land management [44]. Nature recovery depends on a re-blurring of these divisions: resisting dividing land into narrowly defined habitats and land uses [45] through the restoration of our fragmented and rare open wooded habitats [43].

Glades are the most open component of the woodland habitat mosaic, with canopy cover typically below 20%. Glades provide **sunnier microclimates** and a range of resources for wildlife, including **nectar sources, food plants** and **shelter**.

The vegetation structure of glades can be complex, comprising short grassland sward or dwarf shrub heathland, tall herbs and patchy scrub as well as scattered open grown trees. The glade structure can be incorporated as linear rides, wide enough to provide a gradient of vegetation height from the tree canopy to the ground layer, and incorporating scrub and tall herb elements. A wider range of glade sizes and shapes will provide greater complexity across the site. Individual glades, whether linear or irregular in shape, need to be large enough to prevent the ground layer from becoming too heavily shaded as the woodland develops. An overrepresentation of glade structures in your design will provide additional opportunities for natural colonisation and dynamism as the woodland develops.

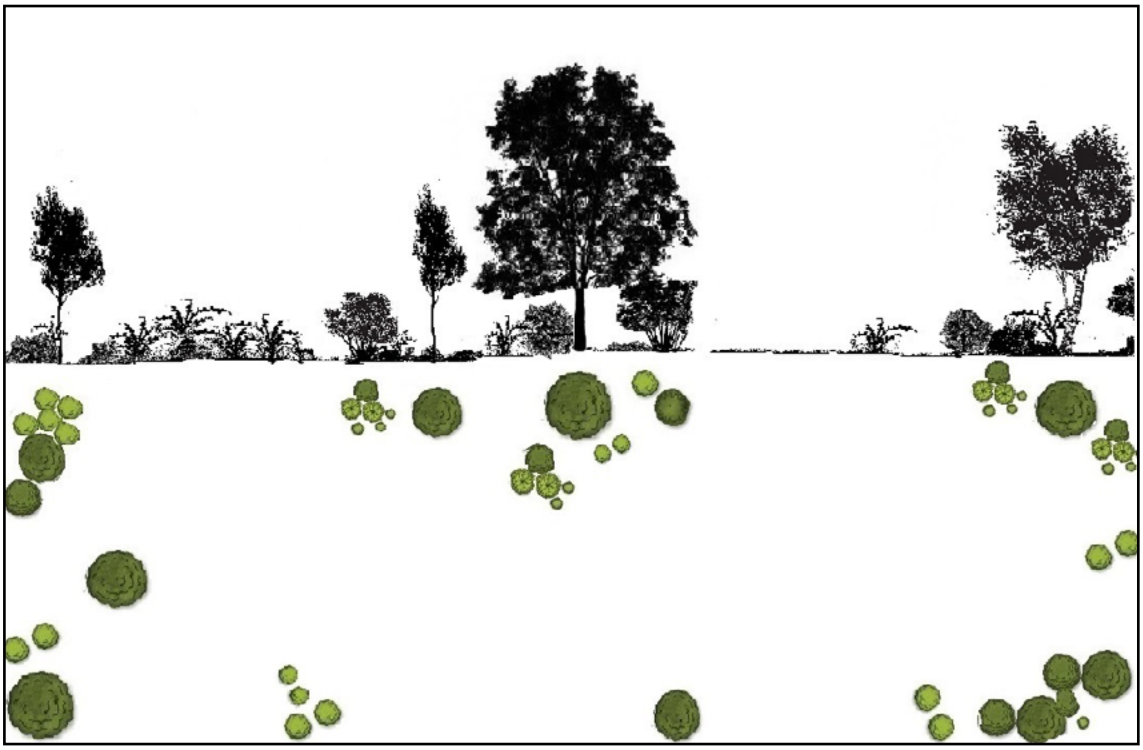


Figure 4.3. A glade structure

Mosaic landscapes

At **landscape scale,** structurally complex **mosaic woodland** can be combined with **trees, hedgerows, scrub** and **open habitats**, such as species-rich grassland, heathland and mire, to create a larger-scale mosaic.

Hedgerows and shelterbelts create linear patterns that shape the character and beauty of many landscapes. They can deliver numerous benefits, including providing shelter and fodder for livestock, intercepting surface water flows and slowing the drying of surface soils by reducing wind speeds [46]. These features can make a huge difference to the **permeability** of these landscapes for wildlife – providing patches of quality habitat that can be essential to enable movement of woodland specialist species between patches of core woodland habitat. The value of hedgerows and shelterbelts for nature can be greatly enhanced by creating wide hedgerows of mixed native trees and shrubs; cutting less frequently to provide shelter, nectar and food sources for wildlife; and including frequent standard trees in hedgerow design to increase structural complexity.

Scrub is an important and often undervalued component of many landscapes[47]. As well as a key component of structural complexity in groves, open wooded habitats and glades, patchy scrub can itself greatly enhance the structural complexity of the landscape habitat mosaic. The complexity, habitat niches and resources provided by scrub vary through successional stages, and creating a habitat composed of elements of pioneer and mature scrub may increase its wildlife value. Patchy scrub can contribute significantly to the permeability of landscapes. In some exposed upland areas (above the treeline) as a transition to montane habitats, while in wetland areas, scrub and dwarf shrub communities can form the climax vegetation community, rather than a staging post to woodland.

Trees – especially those that have established with open grown canopies – add a unique structural element to sites and landscapes [48]. Important components of open wooded habitats and glades, open grown trees can also be incorporated in woodland creation design as hedgerow, trackside or boundary trees.

The canopies of open grown trees, developing free from competition for light from other trees, have a more complex architecture than trees which establish surrounded by other trees. In this way, open grown trees provide complexity at a range of scales. Complex branching structures create **a wider variety of habitat niches,** and open grown trees are far more likely to develop into veteran trees with decaying wood features capable of supporting an extensive and specialist invertebrate assemblage[49]. High-density planting suppresses the formation of wider crowns, with larger lateral branches providing valuable habitat niches [50]. It is important that open grown trees are established without close competition from the outset to achieve the branching structure which contributes to structural complexity.

Ensuring a succession of **veteran tree wood-decay habitats** into the future is essential to support the associated biodiversity [51]. This means that if veteran trees are present on the site or in the surrounding landscape, you should seek to include open grown trees in your design. Many wood decay invertebrates and fungi are associated with particular tree species, so matching the existing veteran tree species is important. There may be value in diversifying the range of open grown trees as well.

More extensive areas of priority open habitats are an important component of the landscape mosaic and provide niches and resources for a diversity of wildlife. While these habitats are unlikely to be the target of a woodland creation plan, there may be opportunities to promote their **restoration** or **enhancement** alongside woodland creation, especially where this is being carried out as part of a landscape-scale project or partnership.

Structural complexity

Each of the structural components of woodland and landscape-habitat mosaics can be used as appropriate in your design, reflecting the site characteristics, landscape context and the project objectives. Building habitat mosaics into your design provides the basis for the development of structural complexity as woods and trees establish and develop.

The site assessment will have provided information on **existing woods, trees** and **scrub** on the site, and these can provide important structural components which may take decades to replicate with newly established trees and shrubs. Open grown mature trees in particular offer an invaluable structural component and should be given special consideration.

Further complexity can be added to the habitat mosaic through a few simple design elements.

Building your habitat mosaic as a patchwork of **interlocking** components will increase horizontal structure. This is achieved by avoiding geometric shapes and designing using natural forms, and following landform or boundaries between soil types or different hydrology to create longer, sinuous boundaries between components.

Once the long, sinuous and interlocking boundaries have been designed, they can be established to provide broad **transitional zones**, or **ecotones**, between the different vertical heights of adjacent patches in the habitat mosaic. These transitional zones will help to avoid any sharp and artificial divisions between

Figure 4.4 A structurally complex woodland mosaic, comprising groves (far left), glades (centre) and open wooded habitats (far right), with broad transitional zones in between.

habitat components. It can be very informative and engaging for stakeholders to include a section drawing showing the structure that will develop across the site as woods and trees become established. This illustration of horizontal structure helps to demonstrate the importance of broad transitional zones in maximising structural complexity across a site.

Finally, complexity can be enhanced within each component by establishing trees with a **range of stem densities**. This will increase structural complexity within each component of the habitat mosaic and is itself a further indictor of wildlife value [52,53]. Diversity in stem diameter is an additional indictor of conservation value and can be promoted by establishing trees at a range of stem densities, or distances between young trees.

Growth rates in densely growing trees are likely to be suppressed, resulting in smaller stem diameters compared to more widely spaced or open grown trees. Building variation in stem density into your design can, therefore, help promote a greater variation in stem diameter as the establishment phase progresses [50,54,55].

Stem densities will be highest in **groves**, with spacings generally between one and five metres. Areas of **open wooded habitats** and **glades** in your design offer greater opportunity to vary stem density. Within woodlands and across landscapes, a great range of stem densities can be developed by utilising elements ranging from areas of **dense scrub** to completely **open grown trees** (trees that will grow with full canopies free from any competition for light from adjacent trees). The space required for this may appear out of proportion in your design, but the canopy of an open grown oak or beech tree may extend to a radius of 15 metres or more from the stem.

Restore and enhance existing habitat features

Your site assessment map may indicate areas of **existing priority habitat** (e.g. OH1 – Grassland, OH2 – Wetland, OH3 – Heathland) and an assessment of the current condition of these habitat patches. The evidence of semi-natural vegetation features may be as sparse as **small remnant patches** or scattered indicator plants.

The **restoration** or **enhancement** of **existing habitat features** will make an important contribution to the creation of quality woodland. Grassland, wetland and heathland habitats will support an assemblage of specialist species of their own and provide resources that are important to many woodland specialist species. Your design should not negatively impact areas of **existing priority habitat**.

The extent of open habitats, including **species-rich grassland** (e.g. **hay meadows**) and **wet grassland**, has declined dramatically in recent decades. Remnant patches of high-quality habitat may be very small (less than half a hectare) and are likely to be found on the marginal land in both rural and urban landscapes which are often the areas targeted for woodland creation. It is important that these are protected and enhanced wherever possible.

Where evidence of priority habitats is recorded in **degraded condition**, as small **remnant patches** or through the presence of **remnant indictor plants**, design decisions will need to balance the opportunity for restoration of the open habitats with the benefits of establishing trees. The current condition of the habitat should be considered as all habitats will occur on a spectrum of quality and degree of agricultural improvement. The capacity and motivation to restore and manage these habitats appropriately will also inform design decisions.

It may be appropriate to incorporate smaller or remnant patches of semi-natural grassland, wetland and heath within the more open components of the **woodland habitat mosaic** (open wooded habitats or glades). The decision to do this should be informed by an understanding of the long-term management required to restore and enhance the semi-natural habitat features in this context. Even the occasional presence of key indicator species may highlight an opportunity to restore or enhance a wider range of habitats within the design of your woodland habitat mosaic.

Larger areas of semi-natural habitat may be encountered, particularly in the uplands. In this scenario, the detail of the site assessment, an evaluation of the habitat condition and species presence, along with a sound understanding of the landscape context and history, are important to inform decision making. Delineating areas as grassland or heathland may drive management which produces uniform, short vegetation structures and maintains habitat in a degraded condition. Introducing a tree and scrub component to create a **richer habitat mosaic** may provide a route to restoration of the open habitat component while enhancing structural complexity. This may make an important contribution to creating a more permeable landscape for a range of species[25]. Similarly, the establishment of an appropriate proportion of **wet woodland** may complement the restoration of many **wetland habitats**, providing an important structural element in the wetland habitat mosaic.

Regional and **local significance** is also a valid consideration. For example, in an area where acid grassland is abundant across extensive areas of hillside, woodland creation on areas of poorer quality acid grassland (more agriculturally modified U4b grassland in the National Vegetation Classification [NVC] system) may be appropriate, while in other landscapes where acid grassland is scarce, the same habitat may be a restoration priority.

Conversely, a semi-improved neutral grassland (e.g. MG6 in the NVC system) may have greater significance and value in upland settings dominated by acid heath and mire than would be the case in many lowland landscapes. The same consideration should be given to heathland habitats, which may provide an opportunity for upland woodland and wood pasture creation in many parts of the UK; whereas the high conservation importance of lowland heathland in England would generally preclude any form of woodland creation on these habitats.

It is important to consider the **management implications of habitat restoration** and address any infrastructure and ongoing resource requirements to effectively restore and manage each component. For example, the botanical richness of semi-improved grassland and semi-natural grassland which has become rank due to a lack of management, can often restore surprisingly rapidly under appropriate grazing regimes. This may be achievable through the creation of open wooded habitats managed as wood pasture.

Restore natural processes

The previous sections address the issues of composition and structure of quality woodland creation. Less easily expressed in plans and on maps, but nonetheless essential, is consideration of the **restoration of natural processes**. How the woodland ecosystem functions will influence its contribution to nature recovery as trees establish and mature. Although these processes may take time to develop, your design can create the conditions and initiate the processes that will lead to the establishment of healthy, naturally functioning woodland ecosystems.

Processes such as **decomposition** and **wood decay**; **competition for space, light, water and nutrients; and disturbance, herbivory and predation;** are all essential processes in a functioning woodland ecosystem with a diversity of habitat niches.

Trees intercept rainfall, their roots bind soil, while roots and leaf fall improve soil structure. This can contribute to increasing the infiltration of surface water and slowing runoff [56]. This effect can be greatly enhanced by blocking surface drains to reduce surface flow. **Restoring the natural hydrology** of your site could also include re-naturalising water courses which have been 'canalised', and introducing large woody debris into water courses [57].

Restoring natural surface water flows can contribute to flood risk management, improve water quality and increase carbon storage as well as enhance the conservation value of the site. Holding more water for longer on your site could also involve the creation of permanent wetland habitats (potentially including pools of open water) or temporary or seasonal areas of inundation which support a unique wildlife assemblage.

Restoring natural hydrology is particularly important when considering sites with organic (peaty) soils. The drainage of these soils is very damaging to soil structure and releases carbon into the atmosphere [58]. In contrast, re-wetting previously drained organic soils as part of your woodland creation design will help to ensure that trees are only established on the appropriate areas of the site, especially if establishment is based predominantly on natural colonisation. Re-wetting peat is also usually associated with development of important open habitats, such as blanket bog or fen. It would always be contradictory to the nature recovery objective to drain land to facilitate the establishment or enhanced growth of trees.

Decay is a critical process in the natural function of woodland systems and a significant proportion of the wildlife associated with woods and trees is linked to the breakdown and decay of leaves and wood[59].

Decaying heartwood in larger-diameter living trees is especially valuable. It is important to incorporate and perpetuate any existing **veteran trees** and other established open grown trees (TW1 – mature and veteran trees) that have been identified in the site assessment in your design. These trees should be given sufficient space to continue to grow, free from competition from younger trees that are established on the site as part of your design. To avoid younger trees competing with the canopies of existing open grown trees, no new trees should be established within a distance that is 15 times the diameter of the trunk or five metres from the edge of the crown if that is greater [60].

Any **standing or fallen decaying wood** that is present on the site – for example, from trees outside woods or adjacent woodland edge features (TW6 – decaying wood) – should also be incorporated into the design. Variations in temperature and moisture make a significant difference to the bacteria, fungi and invertebrates associated with wood decay. Decaying wood, especially of larger diameter, should be retained without sudden change to its environmental conditions. If the resource is sufficient, aim for a mix of standing and fallen, shaded and exposed decaying wood to provide variation in this essential and under-represented habitat [61].

Genetic diversity and **genetic adaptation to site conditions** are important in creating diverse and resilient habitats [62]. This process is particularly important in the earlier stages of establishment of new woods and trees. While native trees across the UK are genetically diverse and, therefore, equipped to adapt to a changing environment, planted trees – which start life in a tree nursery – miss the important early selection pressures that drive adaptation. Therefore, it is important that **natural colonisation and/or direct seeding** feature in your design wherever possible, both as methods for initiating new woodland and throughout the establishment phase. Ensuring that the process of **natural**

competition plays an ongoing role in shaping the development of the site through the establishment phase requires a degree of **dynamism** in the ecosystem.

Large herbivores are keystone species in naturally functioning woodland systems. Cattle, ponies, native deer and pigs (or wild boar) can individually and collectively provide a unique role in driving dynamism in woodland ecosystems, providing benefits that are impossible to replicate through any other form of management [63,64].

Grazing with livestock at **stocking densities** that mimic **natural populations** produces a patchier and more **complex vegetation structure** in woodland ecosystems [64,65]. This can be beneficial in all the structural components of the design, but may be especially important in maintaining the conservation value of the ground layer and scrub in glades and open wooded habitats.

Decisions on the most appropriate **grazing animals, stocking densities** and **wild herbivore control** will be dependent on the site characteristics, including the growing conditions (elevation, exposure and length of the growing season), existing vegetation cover and soil fertility. The extent of the grazed area will also be an important factor. Extensive grazing, in which animals at low stocking densities can range freely across large areas, can be particularly beneficial in promoting greater diversity of vegetation structure and species composition [66].

Extensive animal grazing drives other natural processes. They enhance functional connectivity by **dispersing seeds**[67,68] **and create conditions for germination** by disturbing soils and breaking up brambles, bracken and competing grasses [69–71]. They also further promote structural complexity through **nutrient transfer** from dunging and the decay of carcasses [72,73].

The timing of any introduction of large herbivores is important in woodland creation. Wild **deer populations** will present a threat to successful establishment of trees in most landscapes and will **require control or exclusion** during the initial stages of establishment. Equally, **over-grazing with domestic livestock**, especially sheep, will supress tree establishment and can reduce vegetation structure to uniform short sward. A fallow period of up to five years may be required to initiate woodland creation on many sites. Earlier introduction is likely to extend the successional stage of open and pioneer scrub. This may be beneficial for nature recovery in many landscapes, but its acceptability will depend on the other objectives for the site.

Address the needs of indicator and target species

Applying the above principles to create habitats with complex structures, and restoring semi-natural features and natural processes, will go a long way to ensuring that your project supports rich and abundant wildlife. Depending on your site and the nature recovery objectives that you have defined, you may also wish to consider the habitat and resource requirements of specific **wildlife species, communities** or **assemblages**.

In the site assessment, you may have identified species requiring **protection from disturbance** (SP1 – Protected Species). You may also have recorded the presence of **target species** associated with open habitats on the site which could be negatively affected by new woods and trees (SP2 – Priority Bird Species; SP3 – Rare and Scarce Plants, Lichens and Fungi; SP4 – Invertebrate Assemblages). You may also have identified **woodland specialist species** (SP5 – Woodland Specialist Species) on the site.

Often, you will be looking for evidence of the wildlife potential of your site, rather than existing species. This can be found from a variety of sources. You can gather information on the species recorded in the surrounding landscape, including nearby woodland, from local and online sources, to build on the habitats and species recorded during the site assessment. The **Woodland Wildlife Toolkit** provides a list of selected rare or declining woodland species that have been recorded in the locality. The toolkit also provides a summary of the habitat requirements and suggested management for each of the 90 species, assemblages (invertebrates) and communities (fungi, lichens and bryophytes) included, which will inform decisions about the relative extents and patch sizes of groves, open wooded habitats and glades.

Your design will need to reflect the habitat requirements of any **indicator** or **target species** for which you have defined specific objectives. Monitoring of these species will provide an important measure of success for the project. Relatively common or generalist species may provide useful short-term indicator species, as colonisation by specialist species may be subject to a significant time lag [74].

If you have identified objectives for **flagship** or **keystone** species, then these may also require consideration in the design.

Contribute to nature recovery networks

Species populations experience natural cycles of **colonisation, expansion, decline** and **localised extinction** as suitable habitats emerge and decline within landscapes. Often, an individual site, such as a single woodland, cannot continuously provide all the required resources or conditions to support a viable population of a species [75]. To survive, wildlife needs to be able to disperse and move across sites and landscapes to occupy suitable habitats.

To support nature recovery, your design needs to **look beyond the site boundaries** and consider how your project can contribute to habitat networks at landscape scale [76]. A resilient landscape is not one in which species-richness is maximised at every location, but one in which fine-scale dynamism continually creates new opportunities for species to colonise suitable habitat patches and across which species are able to move freely.

To contribute to nature recovery networks, consider how your project can **extend** or **buffer** existing high-value habitat patches in the landscape [75]. **Larger patches** support more robust populations than small, isolated patches, reducing the risk of localised extinction. This also provides the greater abundance needed to enable the colonisation of patches beyond the site – a spill-over of wildlife into the surrounding landscape.

The preceding design principles for nature recovery will ensure that you are creating **quality habitats** – building on any existing habitat features of the site. An important consideration is to identify the **missing and underrepresented components** of the habitat mosaic in the landscape. This is particularly relevant in highly simplified landscapes dominated by a single intensive land use, such as agriculture, forestry, moor burning or urban development. Incorporating missing components like early successional scrub, pioneer woodland or open wooded habitats into your design can make an important contribution to the range of available habitat niches.

Core patches of quality habitat are increasingly **fragmented and isolated** in many landscapes. Intensification of the management of the land between these isolated patches results in landscapes that are more hostile to the daily or seasonal movements of animals and the dispersal of spores, pollen and seed between habitat patches.

New woods, trees and hedgerows can increase the **permeability of landscapes**, reducing the resistance to species dispersal. Even small patches of quality habitat can provide **functional stepping stones** to aid dispersal, while **linear features** such as hedgerows and riparian woodland can also be effective, especially where they provide the specific habitat requirements of those species likely to utilise linear corridors. Increasing the canopy cover on farmland through agroforestry approaches, such as silvopasture and silvoarable systems and shelterbelts, can also increase connectivity. The **Woodland Wildlife Toolkit** will help to identify potential target species in your landscape, and local species-recovery projects may also be able to provide detailed guidance on species requirements.

Woods and trees can also play an important role in enhancing landscape permeability for **wildlife associated with more open habitats** (grassland, wetland and heathland). If your project is adjacent or close to open habitats, the shade of dense groves may create a barrier to species dispersal and potentially harbour predators (e.g. of ground-nesting birds). In contrast, the creation of woodland composed largely of open wooded habitat and glade components may help to provide a more permeable landscape for a wider range of species [25].

Useful resources

- **Woodland wildlife toolkit.** Interactive map data (regularly updated) showing which rare or declining woodland species are present within the search area, and their habitat and management requirements. Also includes woodland condition assessment method and forms.
- **National biodiversity atlas** (website with mapped data). The NBN Atlas aggregates biodiversity data from multiple sources and makes it available and usable online. It is the UK's largest collection of freely available biodiversity data.
- **Woodland creation and ecological networks – outputs** (website with resources). The WrEN project provides evidence of how new woodland develops over time for a wide range of species.
- **The Species Recovery Trust** (website). Information about conservation of very rare species.
- For **landscape-scale nature network projects,** there is no UK directory of initiatives, but worth contacting National Parks and other protected landscape organisations, local rivers trusts, government statutory nature conservation bodies, local authorities, etc., to identify any projects in your locality that can advise on the contribution your plan could make.

4.2.1.1 Nature recovery – the urban forest

Green space within urban areas (including parks, commons, gardens, woods, rough ground, golf courses and riverbanks, etc.) can support a surprising richness of wildlife. By following the design principles for nature recovery, urban woods and trees (collectively known as the **urban forest**) can achieve quality wildlife habitat, while providing a range of benefits to people on their doorstep (including air quality, flood management, urban cooling, health and wellbeing, and landscape enhancement). The extent of canopy cover in urban areas is highly variable, and many towns and cities have targets and strategies to increase canopy cover. We recommend aiming for 30% when designing new developments, with trees forming an integral part of the design.

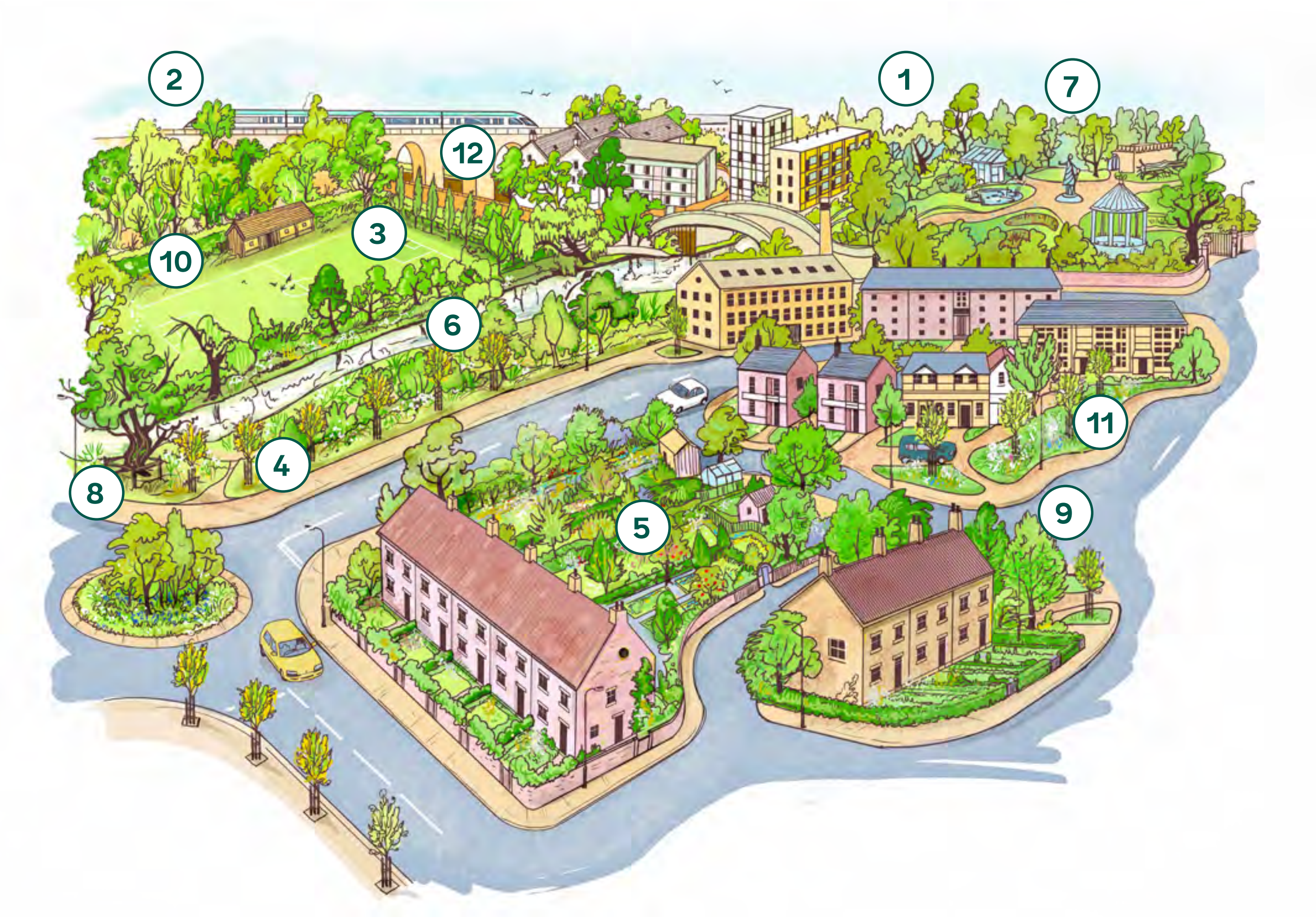


Figure 4.5: Design principles for urban nature recovery

1. Increasing canopy cover of trees and shrubs to 30% can create an urban forest which provides valuable wildlife habitat as well as enhancing the environment for local communities.

2. Tree species selection may need to reflect the particular characteristics and requirements of the urban environment, but including a diversity of native species will provide richer habitats.

3. Well-chosen non-native trees can play important roles in urban environments, providing shelter and visual amenity. Some non-natives may also be well suited to challenging growing conditions, such as planting in hard infrastructure.

4. Well-designed tree and shrub planting can greatly enhance the structural complexity of the urban forest, providing a mix of tree age classes, dense scrub and open grown trees.

5. Replacing garden fences with hedgerows of native shrubs, and planting more garden trees, can be an important element of developing the urban forest. These elements can also be important for people: intercepting airborne pollution, providing shade and privacy, and bringing more wildlife into urban gardens.

6. Roadside trees and planting along river corridors can help to make urban environments more permeable for wildlife – allowing animals, seed and spores to move through areas which may otherwise be a barrier.

7. Urban parks can provide core areas of woodland habitat in the urban forest. Many of the principles of woodland conservation can be applied to parks, where a diversity of native trees and shrubs with a range of sizes and ages, and an accumulation of decaying wood, will increase the value of the park for wildlife.

8. Existing mature and veteran trees provide irreplaceable decaying wood habitats and are a critical component of the structural complexity of the urban forest. Protecting them from the negative impacts of development and the intensive use of urban environments is of the highest priority.

9. Well-designed street trees and other urban planting can provide successor trees of the same species for veteran urban trees, ensuring a continuity of veteran tree wood-decay habitats.

10 Small adjustments to the management of amenity grasslands such as reducing chemical use can increase their value for wildlife. Providing space in playing fields and parks for margins of taller grasses, flowers and scrub can introduce a valuable new element to the urban forest.

11 Flower-rich verges and embankments can provide an urban proxy for woodland ground flora. There may be opportunities to include positive indicator woodland plants in these locations.

12 Brownfield sites may provide important additonal habitat components which can be overlooked, such as bare ground and old walls. They should be incorporated into a woodland creation design in a similar way to other semi-natural habitats.

Design principles:

Predominantly native trees

It is often assumed that native tree species will struggle in urban areas, given the higher levels of air pollution, compacted or disturbed soils, lack of space for rooting, people's preferences for trees' appearance, allergies to birch pollen, and so on. However, native trees can and do thrive, provided the species selected are well-matched to location and prevalent conditions. In doing so, they provide excellent resources for pollinators, birds, bats and other wildlife, as well as a wonderful range of seasonal shapes, colours and textures to enhance urban landscapes. Non-native trees can also thrive in urban areas and sometimes are selected for their colour, landscape effect or ability to thrive in difficult conditions (e.g. London plane is particularly tolerant of air pollution). If non-natives are chosen, they should also be assessed and selected for their value to native wildlife.

Develop habitat mosaics and promote structural complexity

The component parts of a woodland ecosystem (e.g. ground layer, shrubs, trees, ponds, glades, etc.) can all be present in the urban forest, but may have a different spatial arrangement to rural woods and trees. Hedgerows alongside roads; groups of trees on golf courses; standard trees in avenues; ponds in urban parks; shrubs and small trees in gardens and allotments – all can contribute to structural complexity. Artificial habitats like bird boxes and seed feeders also play a part. This will impact how wildlife uses the resources of the urban forest, and which species can thrive. If designed with wildlife in mind, the urban forest can provide a significant area of well-connected wildlife habitat to complement that of rural areas and avoid urban centres becoming a barrier for biodiversity.

Restore and enhance existing habitat features

Scrub, flower-rich grassland, heath, orchards, reed beds, open water, canals, rivers and streams, and brownfield land, can all be found within urban settings and should be incorporated into your site design where they occur. In urban areas, these habitats often have multiple uses, such as part of sustainable drainage systems, or areas for recreation, foraging (e.g. brambles), or moderating summer temperatures – which should also be considered in your design. In the urban environment, some seemingly degraded brownfield sites can provide important habitat components such as bare ground, crumbling walls and scrub. The wildlife value of this open mosaic brownfield land should not be disregarded.

Restore natural processes

Achieving naturally functioning ecosystems within an urban setting can be challenging, and usually a higher level of management intervention is required.

Your design will need to:

- **consider how trees can grow free from browsing impacts**
  (For example, grey squirrel populations can often be high due to thriving on garden bird feeders.)
- **manage invasive plants**
  (Invasive garden escapes are common, and they may also host damaging tree pests and diseases. Trees and shrubs may provide a valuable buffer between gardens and patches of high value habitat.)
- **consider design that discourages vandalism, litter and dog waste**
- **evaluate how wildlife will respond to traffic, lighting and air pollution** as well as addressing soils which may be polluted, compacted, drained or enriched with nutrients
- **balance the need for standing and fallen decaying wood –** especially that found in ancient and veteran trees – as a key habitat, against safety considerations in areas of high access.
  (Any trees felled for safety reasons should be left in-situ (or nearby) where possible, to continue the decay process and provide essential habitat.)

Address the needs of indicator and target species

Consider how artificial habitats, such as bird, bat and dormouse boxes, or connectivity tools like hedgehog highways, or signage for toad crossings, could help to meet the needs of species likely to be attracted to your new urban woods and trees. Ensure any legally protected species (e.g. amphibians, bats, etc.) are protected, and their habitats enhanced by your woodland creation project.

Contribute to nature recovery networks

Urban areas without connected habitats can be extremely hostile places for most wildlife. Waterways and their associated habitats are often the places where nature will have retreated to in urban areas. Extending quality habitats near rivers and canals (woodland, scrub, hedgerows, individual trees), or providing stepping stones to link urban rivers to other habitats, such as parks, small woods and avenues of trees, can provide significant additional resources for wildlife and support movement through the urban landscape.

4.2.1.2 Nature recovery on farmland

Seventy-two percent of the UK land surface is farmed. If there is going to be a large expansion of new woods and trees, it follows that much of this will have to be on farmland. **Agroforestry** is one way in which more trees can be incorporated into farmed systems, alongside agricultural production. If carefully designed, agroforestry systems can deliver great benefits for wildlife, as well as products and ecosystem services for people [77].

Woods and trees on farms can provide connectivity or stepping stones between core woodland habitats for associated woodland specialist species; for example, woodland birds, bats and butterflies. They are also important habitats and resources for farmland species, such as farmland birds, pollinators and insect predators of crop pests. The colonisation of newly created woodlands by woodland-specialist species depends to a large extent on the **permeability** of the farmed landscape. Trees on farms and agroforestry systems provide the opportunity for species to move into new woods as the habitat develops.

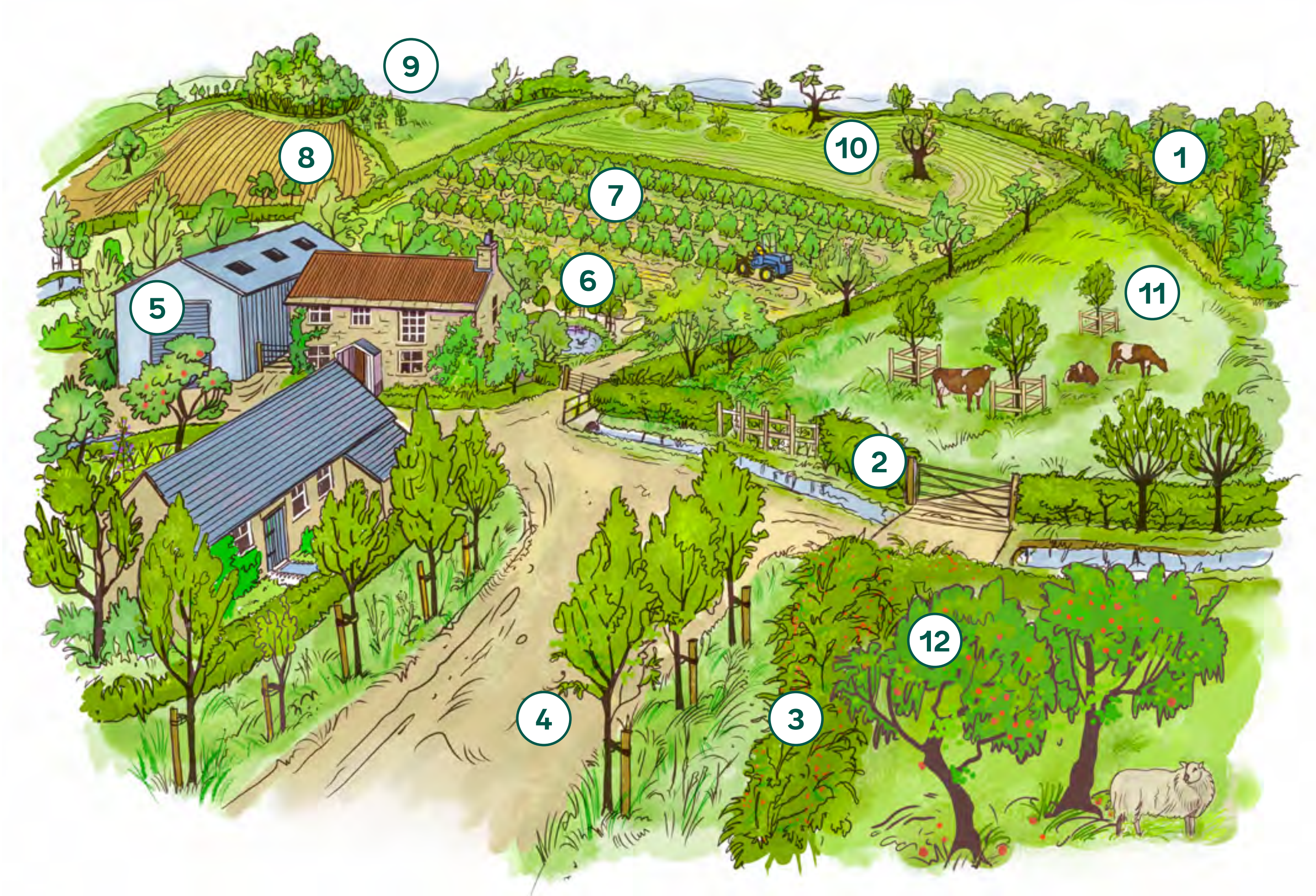


Figure 4.6: Design principles for farmland nature recovery

1. Shelterbelts of native trees increase structural complexity and provide a range of habitat niches and resources for wildlife.

2. Hedgerows of mixed native trees and shrubs provide shelter, food and nectar sources for wildlife as well as sheltering soils and animals.

3. Cutting hedgerows less frequently (e.g. on a three-year rotation) increases their structural complexity and their value to wildlife.

4. New open grown trees in hedgerows and on roadsides add another structural element.

5. Trees around farm buildings, especially those homing livestock or poultry, can intercept pollution and reduce the dispersal of ammonia emissions.

6. Trees along watercourses can intercept surface runoff, improving water quality and regulating water temperature.

7. Silvoarable systems, such as alley cropping, can increase tree cover by integrating trees in productive and sustainable farming systems.

8. Cross-slope trees and hedgerows can intercept surface runoff, reducing soil loss.

9. Tree planting can help to buffer and connect small farm woodlands, significantly increasing their wildlife value.

10. Existing mature and veteran trees provide irreplaceable decaying wood habitats and are a critical component of structural complexity. Protecting them from the negative impacts of farm machinery, livestock or chemicals is of the highest priority.

11. Silvopastoral systems integrate open grown trees with grazing livestock and can be of great value to wildlife as well as beneficial for livestock welfare.

12. Traditional orchards can provide decaying wood habitats and support pollinators, as well as diversifying food production on the farm.

The **design principles** for **nature recovery** can be applied to the establishment of new woods and trees on farmland in combination with the design principles for food production and other objectives – such as those for soils, water and air quality:

Predominantly native trees

Native trees will substantially enhance the biodiversity value of the site, particularly where your agroforestry scheme connects or bolsters existing semi-natural woodland and other habitats, and the trees are retained to maturity.

Develop habitat mosaics and promote structural complexity

Structural complexity can be achieved in agroforestry systems, but the spatial arrangement of the components will differ from a woodland setting. Hedgerows, shelterbelts, alley cropping, wood pasture and short-rotation coppice, will be more common than groves. The structural component and plant community of glades might be provided by uncropped strips at the edges of fields, or the gaps between trees in the open wooded habitats of silvopasture systems. Ancient and veteran trees can be more common on farmland, both in fields and hedgerows, than in woodland, so care should be taken to accommodate them in your design. Include provision for new **open grown trees** in places such as hedges or alongside rights of way, which have the potential to become ancient trees in the future.

The structure of **hedgerows, shelterbelts and orchards can** have a huge impact on how useful they are for wildlife. From the herbaceous vegetation at the base, to the woody shrubs that create the structure and the trees that grow above the hedge canopy – all the parts that make up a hedge play a role for wildlife. On top of physically providing more habitat volume, larger hedges that are cut less frequently can provide a more complex habitat: one that offers more niches and, therefore, more homes for a wider range of wildlife. Larger, more mature hedgerows are similar to some types of woodland and can , therefore, also offer a safer corridor in which animals travel. Dormice, for example, have been found to live in tall hedgerows in densities comparable to those in woodland, but they are not found in short, intensively managed hedges.

Structural complexity can be introduced through the choice, number and spacing of standard trees. A mixture of sizes and species of hedgerow tree is recommended for nature recovery as they will support a greater abundance and diversity of species. As different hedge structures are beneficial to different plants and animals, and each species may have its own preferred hedge type, the more variation in the hedge architecture within the network, the more species will be supported ('People's Trust for Endangered Species' [PTES]). A good margin of undisturbed ground and unsprayed vegetation from the base of the hedge will help protect the future structure of the hedge as well as immediately benefitting plants, insects, birds and small mammals (PTES).

Shelterbelts in an agroforestry ecosystem can deliver multiple objectives, and structural complexity can be achieved through good design. If crop shading is an issue, smaller species can be selected, such as crab apple, rowan or hazel, for east to west boundaries, while larger species like oak or cherry can be planted along north to south boundaries, introducing structural diversity at the field scale.

Some **orchard** fruit and nut trees are native tree species, such as crab apple, hazelnut and wild cherry. However, many are cultivars of native or non-native species which have been selected for their greater productivity. Most orchard trees (native, non-native and cultivars) provide significant habitat for native wildlife, where their management is not too intensive; i.e. limited use of herbicides, pesticides and other crop protection methods such as netting. When left to reach a great age, orchard trees can become very important for communities of deadwood invertebrates – some of the UK's rarest insects – and specialist woodland birds.

Restore and enhance existing habitat features

There are many potential semi-natural habitat features which can be found on farms and should be incorporated sensitively into your design. Examples include:

- Areas where significant/**rare arable plants** might emerge, such as lighter sandy or stony soils. A substantial buffer should be left around field edges and light annual cultivation continued.
- **Organic farming systems,** without the use of pesticides and herbicides, are generally richer habitats for invertebrates – potentially attracting large populations of **ground-nesting birds** which may be unable to thrive if woods and trees are created on or near their nesting sites. In organic registered systems, organic tree-planting stock can be difficult to source, but a derogation from the certification authority is usually possible as it will often be at least two years before the first fruit or nuts are available.
- Trees and woodland cover can often improve the water quality in farmland **ponds and water courses** due to reduced sedimentation and buffering from fertiliser pollution, but excessive shading of ponds may impact on aquatic plants and amphibians such as newts.

- **Flower-rich grassland** or **heathland** areas could be suitable for low-intensity wood pasture with widely spaced open- grown trees and grazing animals.

Restore natural processes

Providing time and space for natural processes on farmland can be challenging. However, agroforestry approaches may offer an opportunity to restore some missing natural process, including grazing and disturbance by large animals such as cattle.

To support the restoration of natural process, your design will need to consider how:

- trees can grow free from significant **browsing damage**
  (This may be caused by livestock, but can also occur where large deer populations are supported by cropping systems; for example, over-wintering cereals which provide year-round food. A combination of individual tree protection, fencing and deer control may be required.)
- tree crops, such as apples, will be **protected and how you can avoid using pesticides, herbicides, or physical barriers like netting that could trap wildlife.**
- **soil issues** – including polluted, compacted, drained or nutrient-enriched soils – will be addressed.
- you can ensure your developing woodland habitats and new trees are **not damaged** by spray drift or nutrient runoff, or by farm machinery (e.g. by ensuring correct row spacing).

Address the needs of indicator and target species

Some farmland wildlife, such as ground-nesting birds, may be adversely affected by new woods and trees. However, others that are often characterised as farmland birds, like yellowhammer, turtle dove and tree sparrow, may thrive in open wooded habitats and glades.

Contribute to nature recovery networks

Design your scheme to optimise landscape-scale movements of target species. This may be frequent movement, such as between roosting and feeding sites of bats or birds, or seasonal movement between over-wintering and summer breeding areas, or migration in response to climate change (e.g. by amphibians and reptiles).

4.2.1.3 Nature recovery in the uplands

The uplands (land over 300 metres or lower land with similar soil, climate and exposure) cover around one third of the UK and were once substantially more wooded landscapes than many of them are today. Nevertheless, they still contain significant amounts of ancient woodland, recent woodland (both through planting and through colonisation where grazing pressure has eased) and scattered trees – some of it remnant woodland and wood pasture.

Most upland landscapes are grazed by livestock (sometimes via common land rights) or browsed by wild deer, or in some cases burnt as part of grouse-moor management. These land uses mean tree establishment – naturally or by planting – is challenging. Existing tracts of valuable non-woodland habitats (sometimes designated as SSSI), deeper peat soils, protected landscapes and the historic environment, may help to determine where it is acceptable to establish new woodland.

Added to that, climatic extremes, thin or infertile soils, steep or rocky terrain and a lack of labour, create further issues to be resolved in any design and implementation of woodland creation. Loss in the diversity and abundance of wildlife from the uplands, along with fluctuations in the economics of livestock farming, climate change, ecosystem-services outcomes and other factors, mean that there is both significant need and opportunity to expand woods and trees of all types in ways that deliver benefits for wildlife and people.

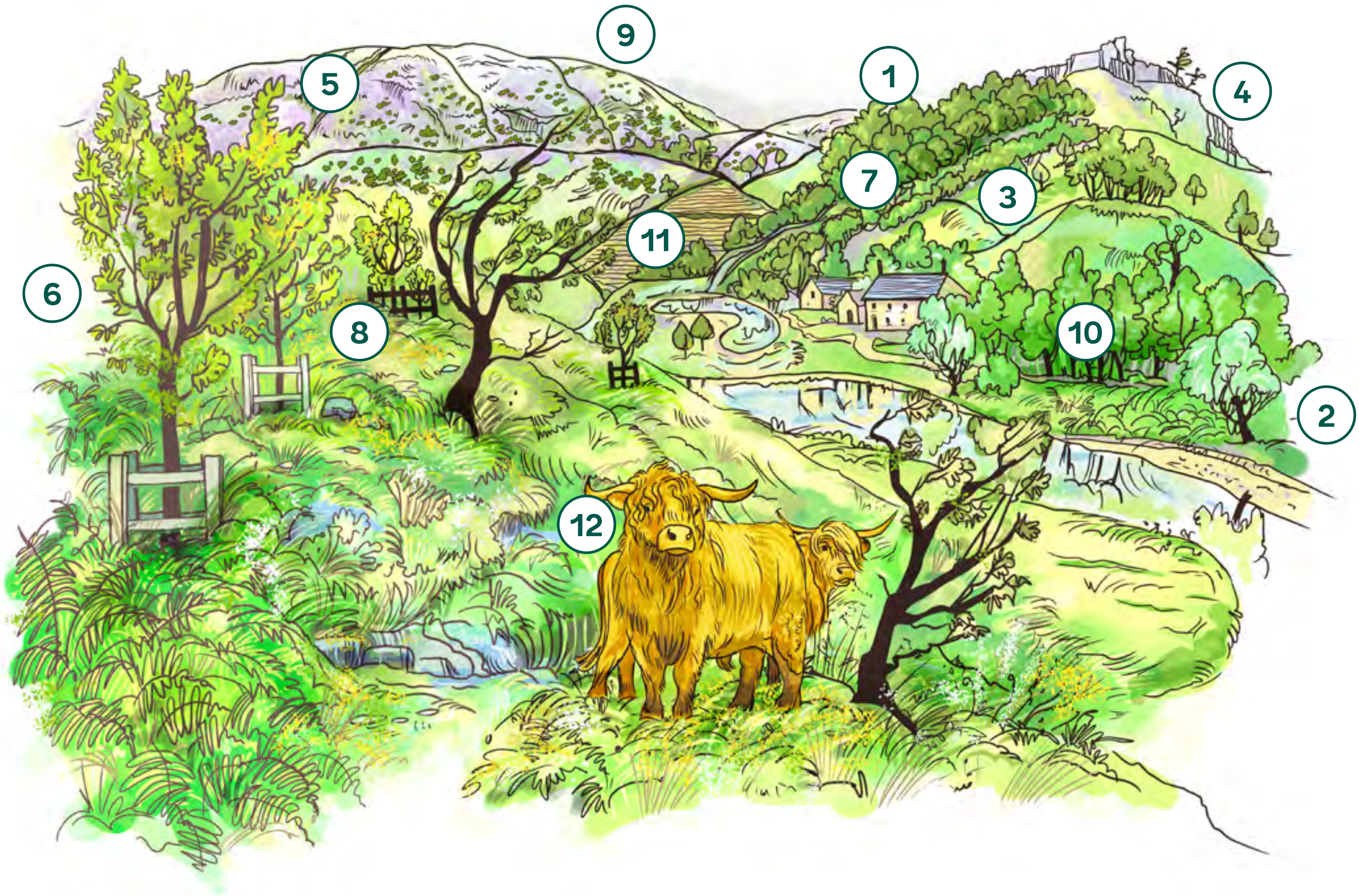


Figure 4.7: Design principles for upland nature recovery

1. Hardy and montane native trees and shrubs produce distinctive upland woodland communities.

2. Willow species are important pioneers in upland settings, providing numerous benefits.

3. Even in degraded landscapes, native seed trees can survive where protected from livestock and deer, such as on steeper crags.

4. Framework trees, or facilitation planting, can help to create the conditions and establish a seed source for more extensive establishment through natural colonisation. This can be an effective way of developing structural complexity in new woods and trees.

5 Natural colonisation of hillsides by trees and scrub can greatly enhance the habitat value and start to restore structure in degraded landscapes.

6 Tree planting in upland pasture can restore tree cover and provide an important structural component by establishing open grown trees.

7 Planting along rivers and in stream valleys can provide an element of more dense and sheltered grove woodland.

8 Well-designed woodland creation can restore an element of tree cover that is integrated with other open habitats, to create diverse open wooded habitats that combine the features of open grassland or heathland with scattered tree cover.

9 Woodland creation projects should avoid tree planting on deeper peats, but can offer an opportunity to restore upland peat bog habitats to form rich habitat mosaics.

10 Woods and trees can reduce surface water flows and help to restore water quality in streams and rivers. They can also help to regulate water temperature in upland streams.

11 Woodland creation projects can offer an opportunity to restore natural processes in rivers and streams, enhancing water quality and the diversity of aquatic habitats.

12 Hardy cattle breeds can help to establish and maintain rich habitat mosaics, restoring the natural disturbance that creates dynamic landscapes.

When designing new woods in the uplands, where nature recovery is a key aim, the focus should be on:

Predominantly native trees

Tree species that are native to the local environment will contribute most to nature recovery and have proven adaptations to harsher conditions. **Willow** is a stand-out tree for establishment as it creates maximum low scrubby habitat, and is an early nectar/pollen source, yet it is often missing due to prior grazing pressure. A range of small native trees and shrubs, such as willows (eared, tea-leaved and grey), **juniper**, downy and dwarf **birch,** and **rowan**, can be useful on more exposed slopes and towards the treeline. Over time, other species such as **aspen** can be introduced, but care is required as these very palatable species can be targeted by browsers.

Neighbouring native woodland may give an indication of trees that will thrive, but often the diversity of tree species will have been reduced by management or grazing. Palatable species like aspen and willow are likely to be underrepresented, and **alder** woods may be mere remnants of much more diverse woodland. Searching steeper, craggy areas may provide an indication of suppressed woodland communities and show what will thrive if grazing pressure is reduced.

Develop habitat mosaics and promote structural complexity

New woods and trees will greatly increase the structural complexity of many barren upland landscapes. Hillsides offer an ideal canvas on which to create a **woodland mosaic**. Groves are most appropriate in stream gullies and on lower slopes, opening into open-wooded habitats and gradually into scattered scrub on more exposed slopes, ridges and plateaus.

Landform and existing vegetation can further inform establishment, indicating suitable soils and providing sheltered areas for planting. Wetter ground at the foot of slopes, around water courses or in natural bowls, is ideal to get willow and alder growing out of the wind; while drier hummocks and gorse or bracken beds are ideal for hawthorn and rowan, or oak. To some extent, gorse or bracken can act as a nurse, providing shelter to saplings.

The scale of upland landscapes can offer opportunities for a more **phased approach** to establishing woodland. In some situations, it may be effective to focus on establishing smaller patches of trees on the most suitable ground. A combination of scattered patches, very low density planting and appropriate management of open ground can provide a seed source and conditions for natural colonisation and succession. A phased approach can promote structural complexity and may be an appropriate way to **initiate landscape change** in sensitive landscapes.

Restore natural processes

Natural colonisation can play an important role in the uplands. Whether promoting natural colonisation or planting, the impacts of wild deer and domestic sheep, cattle and goats will need to be managed to minimise browsing of saplings.

Grazing animal numbers need to be low to very low for any kind of natural colonisation. It is best to exclude sheep altogether and only accept a low number of deer (or none to start with). The infrastructure to manage deer (vehicle access, highseat locations, extraction routes, etc.) needs to be incorporated in the design to enable effective management. To some degree, cattle can promote establishment by removing grass thatch and creating seed beds, but this needs to be balanced with the impact on establishing trees.

Upland areas are often lacking a tree/shrub seed source to enable **natural colonisation**. A few 'framework trees' or perches, can encourage birds to bring in other seed, such as rowan or hawthorn, to start colonisation. Birch seed is wind dispersed and while most is deposited within 200 metres, a smaller amount may travel a reasonable distance by wind well beyond that. Birch saplings also produce seed within just a few years of emergence, supporting its wider colonisation of upland sites where ground conditions and management of grazing pressure allows.

Trees will establish best within the protection of shrubs which protect them from browsing, harsh wind and temperature extremes. Most upland sites have poor soil and a short growing season. Establishing simple mixes of rowan, hawthorn and willow will provide wildlife with a significant start and create natural shelter from which later trees can develop. Shelter is vital to small birds, but also physically supports other trees.

Where **hydrology** has been altered through drainage of upland pastures and moors, blocking drains will be important to restore natural hydrological processes and encourage a mosaic of wetter and drier habitats across a site, with more natural transitions between them.

Restore and enhance existing habitat features

Your site assessment may have identified existing **priority habitats**, albeit often in a poor condition. Their restorability to high-quality grassland, heathland or wetland, should be determined and built into your design. Often, this will require low-density grazing by non-selective grazers like cattle.

Ancient and veteran trees and boundary features (including hedges and drystone walls) are hugely significant for wildlife in upland landscapes – given the shelter and resources they can offer in exposed situations – so they should be protected and enhanced in your design.

Give time to **evaluating the existing ground conditions**, as in many upland areas soils will vary across a site. It is possible to have drought-prone soils immediately adjacent to wet peats. Picking planting zones very carefully with a good planting contractor will ensure the trees selected are appropriate for the soil (and save many wasted trees!). Existing areas of bracken can indicate deeper soils where woodland has been lost through past clearance combined with grazing pressure, and may be a useful target for woodland creation. But bracken beds may need management as they often dry quickly, creating drought stress for young trees, and can cast deep shade over saplings.

Address the needs of indicator and target species

Black grouse need low-density, scrubby habitats at the edge of their territories and benefit from low-growing hawthorn/willow scrub. In turn, rowan seedlings can often be found where grouse are regular visitors to new woods as seed dispersal is a beneficiary of good bird habitat.

Other upland species associated with woods and trees, including migratory birds such as redwing and field fare, will benefit from increased insect activity for food, and the safety and security of thickets and low-growing scrubby vegetation. Hawthorn can be especially valuable. Combining habitats which are flower rich with new tree patches can create significant biodiversity.

Unwanted 'seeding in' from rhododendron stands or nearby forestry plantations of less palatable non-native conifers (e.g. sitka spruce) can be problematic and can reduce the value of your new habitat.

Contribute to nature recovery networks

In upland situations, there may be other priority habitats in the vicinity of your site – whether open habitats or woodland. Aim to ensure that similar features on your site create appropriate connectivity with adjacent habitats. Curlew (a threatened bird with a declining population), for example, require areas of tussocky, open wet-grassland areas for nesting and feeding their young, that are away from scrub and woodland which could harbour nest predators such as crows or foxes. You will need to work with local landowners and nature organisations to ensure your design protects the requirements of such species.

CASE STUDY

Diverse woodland created at Victory Wood links and extends the ancient woodland habitats of The Blean. The project has also created extensive species-rich grassland habitats, enhancing the landscape habitat mosaic.

CLAIRE INGLIS

Achieving a wildlife-rich wooded landscape

Victory Wood is a 140.4ha site acquired by the Woodland Trust in 2004 to create a wooded landscape that provides important habitat for a range of wildlife. Following several site surveys and much public consultation, plans for large-scale woodland creation were designed to turn an arable farmed landscape into a wooded landscape. Sixteen years later, the transformation is well underway and wildlife is thriving.

The vision was to put back a wooded link between Ellenden and Blean Wood, part of the Blean complex Special Area of Conservation, which were disconnected between the late 1940s and early 1970s due to agricultural conversion. When creating the connecting link, the new woods and trees had to look correct within the landscape.

During 2005–2008, 86ha of new woodland was established along the main ridge towards the southern area of the site, which provides spectacular views over the north Kent coastline. The woodland creation design consisted of randomly spaced groups of trees and shrubs. Species mixes were based on observations of the communities in adjacent ancient woodland. Trees and shrubs were planted with variable spacing within groups and allowed for approximately 13ha of natural colonisation adjacent to the existing ancient semi-natural woodlands. Woody shrubs were concentrated on the ride edges.

CASE STUDY

Between 2011–2014, a further 18ha of new woodland was established northwest of the main ridge, again with areas planted in irregular spaced and sized clumps to form blocks of woodland of variable sizes, interspersed by open ground. A number of trees and shrubs were planted in more traditional sinuous rows in two small sub-compartments. Due to ash dieback fungus (*Hymenoscyphus fraxineus)* arriving on site in 2013, the species choice was changed to exclude the small percentage of ash in the mixture and use other native species, such as common alder. A small area (0.14ha) was fenced to prevent sheep grazing, to allow natural colonisation of scrub. The remaining 30ha of land is being managed as semi-natural open habitat and features a number of open grown trees established in fenced exclosures during 2014.

Approximately 13ha of the secondary woodland is maintained as wide rides which were sown in the autumn of 2006 with a neutral grass mixture suitable for wet clay soils, comprising two types of rye variants plus Timothy, cocksfoot, crested dog's tail, red fescue, trefoil and wild red clover. By 2021, the rides were being managed through short-rotation coppice, whereby 2.6km of the woodland edge is cut in a piecemeal fashion: zone one areas to be cut annually, zone two to be cut and collected on a 3–5 year rotation with around a third cut each year, and zone three to be cut on a rotation of 8–10 years. This approach will help to accentuate the woodland edge and provide valuable temporary open space coppice habitat, while also ensuring that any encroaching trees and vegetation are cut back for safety and ease of visitor access along the path network. Over the following five years, it is expected that the woodland edge and scrubby areas will start to exhibit a more diverse structure and mosaic. These rides help to maintain the views out towards the North Sea, but are also important for management access.

Victory Wood is fast developing as an important haven for wildlife, including a diversity of bird and invertebrate species. Several red and amber list Birds of Conservation Concern readily utilise the scrub, hedgerows and open ground areas, including skylarks and meadow pipits throughout the year, and nightingales, swifts, willow warblers and house martins during the late spring and summer months. There have also been occasional sightings of Dartford warblers. A range of Biodiversity Action Plan priority invertebrates can be found in the open ground habitat and woodland edges in encouraging numbers.

CASE STUDY

These include the rare shrill carder bee, brown-banded carder bee and red-shanked carder bee, and nationally notable solitary bee species such as the red bartsia bee. By spring 2021, the heath fritillary – a section 41 and UK BAP priority species – had also been found to be colonising the new woodland habitat following the establishment of its larval food plant, common cow-wheat. Spreading out from the ancient woodland buffer zones, cow-wheat seed dispersal is supported by colonies of wood ants and the presence of the planted and naturally regenerating oaks, which are key in supplying carbon and minerals to the plant through their roots.

Open grown trees in areas of species-rich grassland add an important structural component and habitat niches.

CASE STUDY


Victory Wood
New woodland - Grove
New woodland - Open wooded habitat (Natural colonisation)
New woodland - Glade (Grassland)
New woodland - Glade (Reed bed)
Existing woodland
Paths
Victory footprint
P
N
200m

Regulating services

4.2.2 Climate change

UKFS: Well-designed and managed forests should contribute to mitigating climate change (through carbon capture and long-term storage) and adapting to the impacts of climate change on forests, landscapes and people. Forests should be planned and managed to be resilient to climate change and pests and diseases, to increase ecological connectivity, and to reduce the effects of floods and improve water quality. New forest establishment should avoid deep peat and/or disrupting local hydrology.

Design principles for addressing climate change objectives:

Optimise carbon uptake and storage (mitigate)

Create woods and establish trees to reduce or **replace more climate-damaging land uses** (e.g. on regularly cultivated, fertilised or eroding soils) to reduce carbon emissions. Minimising ground preparation, and making greater use of direct seeding and natural colonisation as methods of establishment, will **reduce soil disturbance** and the risk of releasing carbon. This also removes the carbon cost of propagation in tree nurseries and transport of tree stock. Other land uses, such as semi-natural grassland, heathland and mire, can store significant volumes of soil carbon, and establishing trees may not increase carbon uptake. Trees should not be established on deep peat which can store very high volumes of carbon.

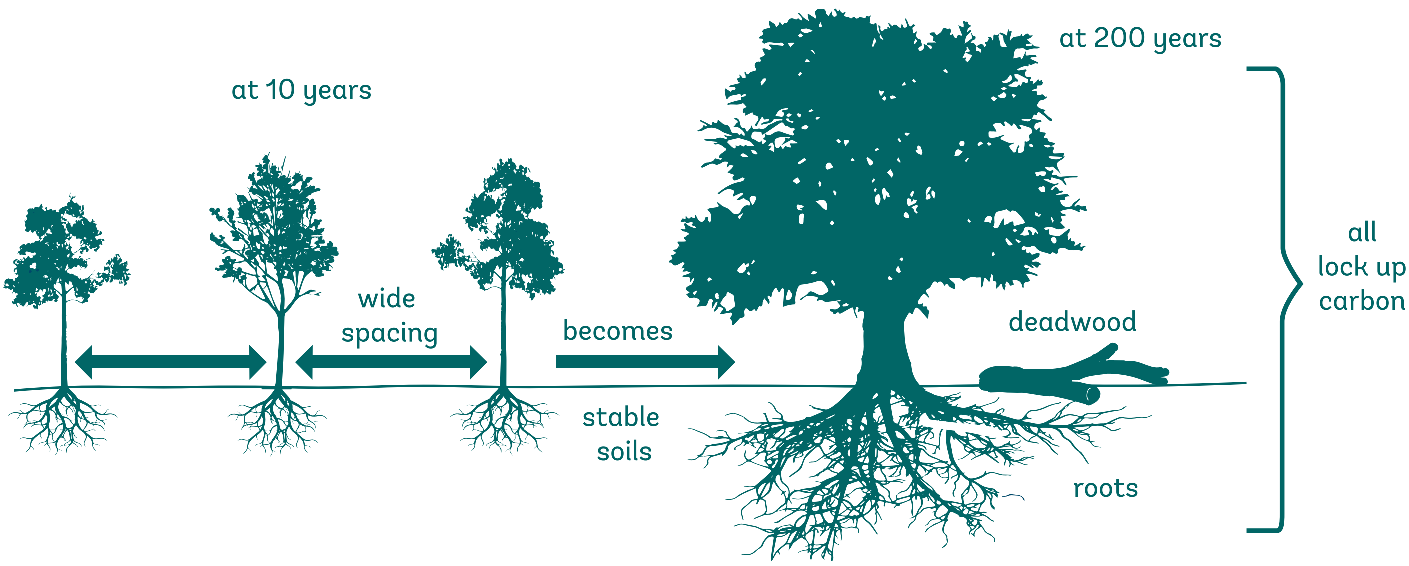


Figure 4.8: Trees continue to lock up carbon throughout their life cycle

Consider the full carbon life cycle in your design and planned management. Carbon storage on the site may be accelerated in the short term by selecting faster-growing trees, but will be optimised in the longer term by **minimising intervention** to reduce soil disturbance and provide time and space for natural processes. Long-lived, open grown trees continue to sequester carbon throughout their lives.

Harvesting wood fuel which **replaces fossil fuel use** and/or timber for use in **long-term products** (e.g. replacing less sustainable materials in construction), can contribute to carbon storage, but may compromise carbon stored in woodland soils.

Enhance the resilience of the woodland habitat network (adapt)

Use a mix of suitable native trees and shrubs to form **diverse woodland communities**. This will help to establish robust woodland habitats, reducing the effect of threats such as disease and extreme weather events. It also creates more resilient woodland better able to recover from threat events, which are unlikely to impact all species equally.

Promote **structural complexity** in woodland by combining the structural elements of groves, open wooded habitats and glades in your design to further build ecological resilience. Structural complexity reduces the risk to wildlife by providing a greater diversity of habitat niches and resources, spreading the risk of climate change impacts on habitat quality.

Promote **adaptation to local site conditions** by using natural colonisation in the initial phase of woodland creation. The resilience of the woodland habitat can be further enhanced by providing space for successive cycles of natural colonisation in the design and by favouring naturally colonised trees in management throughout the establishment phase.

Improve the **functional connectivity** of the woodland habitat network. Larger and higher quality patches of core woodland habitat, along with the establishment of more trees, hedgerows and scrub in the landscape between woods, will enable wildlife to migrate and colonise new habitat as the climate changes. It is possible that enhanced connectivity could also enable the spread of pests and non-native invasive species. Measures to manage this risk should be incorporated into the design and may require collaboration with neighbouring landowners.

Help people adapt to the impacts of climate change

Design and establish woods and trees to **reduce the impacts** of expected extreme weather and climatic events, such as droughts, heatwaves, storms, floods, and increased pollution levels, on the lives and livelihoods of people and communities. Where climate change adaptation is an objective, information on the potential climate change risks should have been gathered during the site assessment phase.

Slowing surface-water runoff to reduce flood risk, prevent soil erosion and improve water quality, is covered in the **design principles for water.**

Woods and trees can also play a vital role by providing **shade and shelter** in a warmer and more volatile climate. Shelterbelts can play an important role in the welfare of livestock (see Design Principles for **Agroforestry**) and shelterbelts and trees can reduce the desiccation and wind erosion of soils (see Design Principles for Soils).

Increasing the tree canopy cover can play an important role in mitigating the heat island effect in urban areas[78]. This **urban cooling** can have a significant impact on people's health and is an important measure in helping urban communities adapt to the impacts of climate change. It also reduces energy use and associated emissions by lessening the need for air conditioning in buildings.

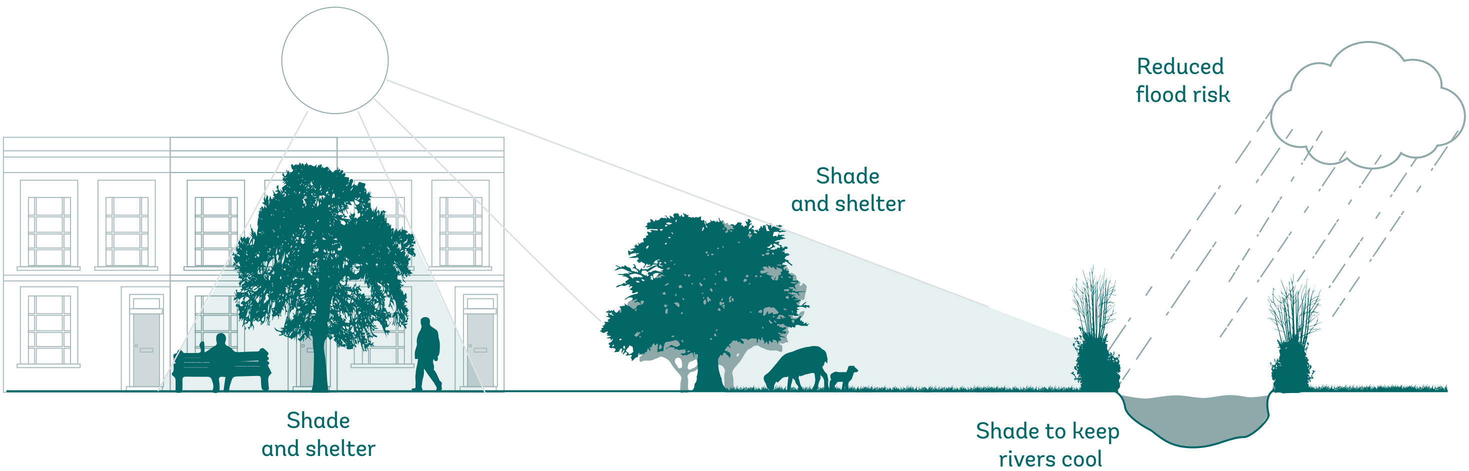


Figure 4.9: Design for climate adaptation

Useful resources

- **Parliamentary research briefing – woodland creation** (UK Parliament office of science and technology, 2021). Evidence summary on creation and carbon under different scenarios.

- **Managing England's woodlands in a climate emergency** (Forestry Commission England, 2019). Useful summary of climate change impacts and practical adaptation measures for creation and management of woodland.
- **UK Woodland Carbon Code** (website with further links). The Woodland Carbon Code is the quality assurance standard for woodland creation projects in the UK that generate independently verified carbon units.
- **Tree species selection for green infrastructure** (TDAG, 2018). Useful for urban projects involving climate adaptation.
- **Understanding the carbon and greenhouse gas balance of forests in Britain** (Forest Research, 2012). The role of forests **in climate mitigation.**

4.2.3 Water (water quality and flood management)

UKFS: New woods and trees should aim to help protect or restore the quality of the freshwater environment by reducing the impact of more intensive land management activities. Well-sited, designed and managed new woodlands should contribute to improved water quality and reduced flood risk. Trees which absorb, block, or divert sediment, excess nutrients or harmful pesticides from entering watercourses and ground water should be considered. New woodland to increase infiltration will reduce runoff and peak flows in flood events in rural and urban locations. Additional features such as wetlands, ponds or leaky woody dams should be considered to support creation activity. Riparian woodland, to provide 50% shade and a source of leaf litter along watercourses, is encouraged – so long as trees do not increase acidification (e.g. many conifers and alder).

Your design for water (quality and flood management) objectives will specifically need to address any of the following if recorded in the site assessment:

Features, W1 – waterbodies and watercourses or W2 – springs and flushes

- the site is within the catchment of a river which floods, affecting people or property
- the site is in a catchment that discharges into a drinking-water source
- waterbodies in the catchment are designated for nature conservation

Design principles for addressing water objectives:

Reduce the rate of surface water runoff (slow the flow)

Establishing woodland that is structurally complex increases the **surface**

texture or '**roughness**' of land and can play an important role in managing surface water flows. Trees and shrubs **intercept rainfall** and their roots **aid soil infiltration**. This increases evaporation from vegetation and soils, and reduces the peak volumes of surface water flows following rainfall. This can be particularly beneficial in upper catchments to reduce flows into watercourses. Broad-scale opportunity mapping for woodland to address flood risk, along with case studies from a range of locations, are provided in the 'useful resources' section.

Significant runoff pathways should have been recorded on the site assessment map, including notes on the rate and volume of water flow and its effects. Trees and shrubs can be established to **interrupt surface water flows**, preventing them from merging and also reducing flow speed and volume. **Woodlands, hedgerows** and **shelterbelts** that are planted **across slopes** can be particularly effective at intercepting surface flows.

Where surface runoff has been accelerated by the construction of **artificial drains and ditches,** digging out or blocking these to **restore the natural hydrology** of the site can greatly reduce surface flows.

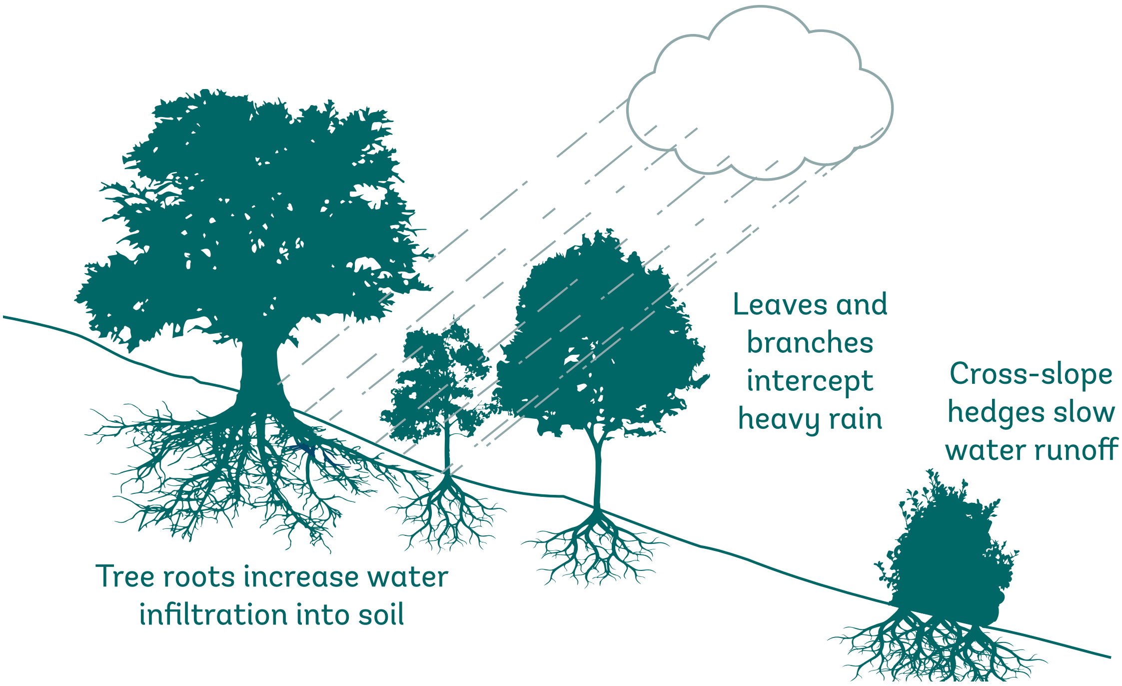


Figure 4.10: Design to reduce surface-water flow

Reduce the frequency and impact of flood events

Flow rates in water courses can also be significantly reduced through the restoration of natural processes. The **re-meandering of canalised watercourses** and development of **large woody debris** in streams, through management or allowing natural processes, can reduce the peak flows which create down-stream flood risk. These methods can be combined with other **natural flood management approaches**, including bunds, overspill ponds and reedbeds, and beaver reintroductions!

Peak flows can be further reduced during flood events by creating **riparian** and floodplain woodland. Increasing the surface texture of vegetation in the floodplain can significantly **reduce flow rates** and **reduce peak flows** which are most damaging to properties and infrastructure.

Improve water quality

Improving the quality of water in our streams, rivers, lakes and reservoirs is important to secure the safe and sustainable supply of drinking water, and is also essential to support the recovery of aquatic wildlife.

Soil erosion and **pollutant sources** (diffuse or point source) should be addressed in the design and, wherever possible, pollution should be tackled at source. Many of the approaches to **reducing surface-water flows** and slowing flood water will also improve water quality by reducing sediment loads and filtering pollutants from surface water. Trees and shrubs can be sited to **intercept sources of sediment and erosion** close to the source.

Riparian woodland and scrub, particularly trees such as **alder** and **willows**, can **stabilise stream sides and riverbanks**, reducing erosion and preventing sediment entering the watercourse. Riverside trees and scrub can also assist in **keeping rivers cool** in hot weather – protecting aquatic wildlife such as spawning fish. The optimal level of shading and of leaf fall into water will depend on the specific situation.

Trees can also contribute to **Sustainable Urban Drainage systems (SUDs)**, which are generally designed to ameliorate the impact of rainfall on large areas of hard surfaces (paving, car parks, roofing, etc.) found in urban areas, by mimicking natural processes.

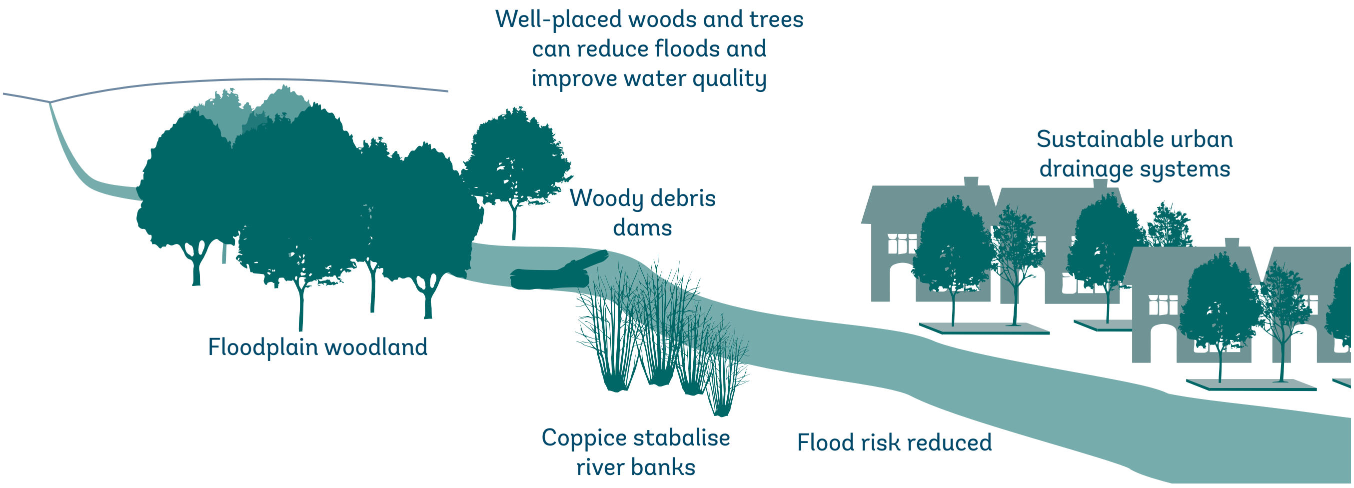


Figure 4.11: Design for water objectives

Useful resources

- **Working with natural processes to reduce flood risk** (Flood and coastal erosion risk-management research and development programme, Environment Agency, 2017). The evidence base for working with natural processes to reduce flood risk. Contains useful diagrams and maps, and the catchment woodland chapter has evidence about role and type of woodland for reducing flood risk.
- **Opportunity mapping – targeting woodland creation for water objectives** (Forest Research, 2017). National maps for England, Wales and Northern Ireland, plus catchment-scale maps for parts of Scotland and other locations across the UK.
- **Natural flood management – Yorkshire Dales Rivers Trust.** Practical guidance on natural flood management, short guides, case studies, useful diagrams.
- **Natural flood management – practical guide for farmers** (Eden Rivers Trust, 2019). Practical guidance for farmers, including diagrams for woodland creation design.
- **Natural flood management – woody dams, deflectors, and diverters** (Sussex Flow Initiative partnership, 2016). Practical guidance on installing woody dams.
- **Assessing risk of using leaky woody structures in flood mitigation** (Forestry Commission, Environment Agency, 2019). How to assess and mitigate risk of installing leaky wood structures.
- **River Otter Beaver Trial – science report** (Devon Wildlife Trust and Exeter University, 2021). Evidence report on impacts of beavers on water quality and flood management at a Devon trial site.
- **Managing forests in acid-sensitive catchments** (Forestry Commission, 2014). Covers woodland creation design.
- **Keeping rivers cool** (The Woodland Trust, 2016). Creating riparian shade for climate adaptation.
- **Planting trees to protect water** (The Woodland Trust, 2012). Evidence and guidance on benefits and design of trees on farms to protect water.
- **Sustainable urban drainage** (website with links, Forest Research). Introduction to evidence and practice of SUDs, with case studies.
- **SusDrain** – the community for sustainable drainage (website – SusDrain). Resources for design and delivery of sustainable urban drainage systems.

4.2.4 Air quality

Your design for air quality objectives will specifically need to address any of the following if recorded in the site assessment:

- Local sources of air pollution from transport industry or agriculture. These may be recorded under IA1 – Infrastructure and Services – or in the landscape appraisal.
- Habitat or species features which may be sensitive to air pollution, including ammonia and nitrogen deposition. This will include ancient woodland and ancient and veteran trees recorded under TW1 and TW2.

Design principles for addressing air quality objectives:

UKFS: There are no UKFS guidelines or requirements regarding air quality.

Woods and trees can play a significant role in tackling air quality issues in both **rural** (on farms, around quarries, alongside transport infrastructure) and **urban** environments (reducing traffic and industrial pollution and reducing noise and odours). They work by creating complex structures which **trap, neutralise and/or disperse pollutants**, as well as producing oxygen through photosynthesis. It is important to consider both the type and source of the pollution and who or what you are trying to protect. Trees and shrubs located to deliver air quality objectives can often provide **other benefits** such as visual screening, or soil and water quality improvements.

Intercept and/or disperse pollution close to its source

Woods, trees and hedgerows can **intercept and/or disperse pollution** close to its source. In the countryside, poultry units, livestock housing or agricultural operations such as slurry spreading, emit ammonia (NH_3).

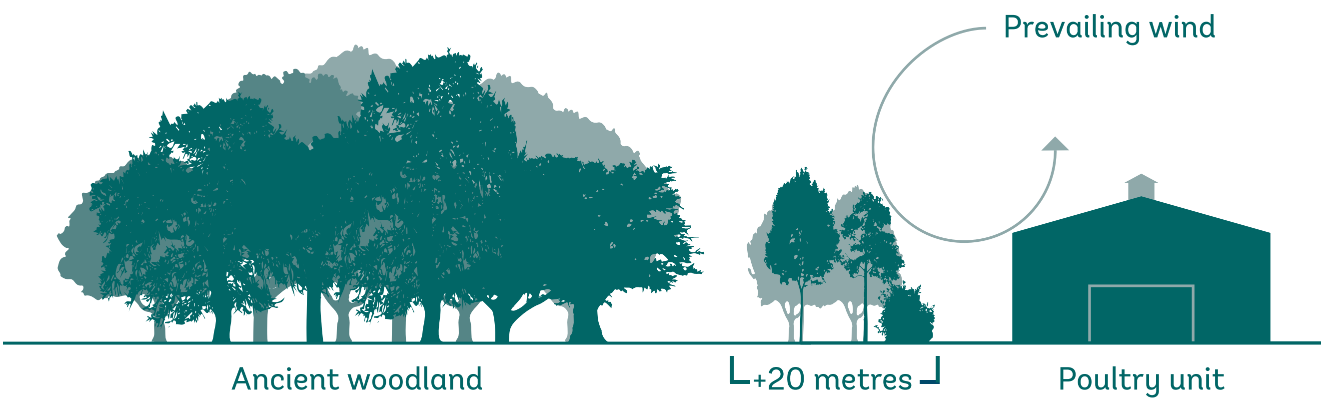


Figure 4.12: Design to reduce air pollution impacts from farm units

Well-designed woodland creation can capture and prevent wind dispersal of ammonia pollution.

In the **urban environment,** trees, shrubs and hedgerows can provide an effective barrier, **reducing people's exposure** to pollution from **traffic** and **industry**. For example, a two-metre high dense hedge separating people from traffic fumes can be effective in dispersing pollutants and protecting pedestrians and cyclists.

Reducing pollution at source will invariably be more effective than interception and dispersal and should be tackled in parallel where possible.

Develop 'green infrastructure' to enhance urban air quality

Increasing green infrastructure, including trees and shrubs, contributes to the health and wellbeing of urban populations in many ways. Trees can screen parks and other recreational spaces from pollution, creating healthier spaces in towns and cities. Conversely, in more polluted areas dominated by hard infrastructure, planting trees creates a **rougher surface texture** which **stimulates greater mixing** of polluted air with clean air from above, **reducing people's exposure** to pollutants.

A sound understanding of 'green infrastructure' design is required, as although street trees can screen and protect low traffic areas from pollution, in **urban 'canyons'** (streets with high buildings on both sides) where there is a steady traffic flow, trees in full canopy can trap pollutants below the canopy.

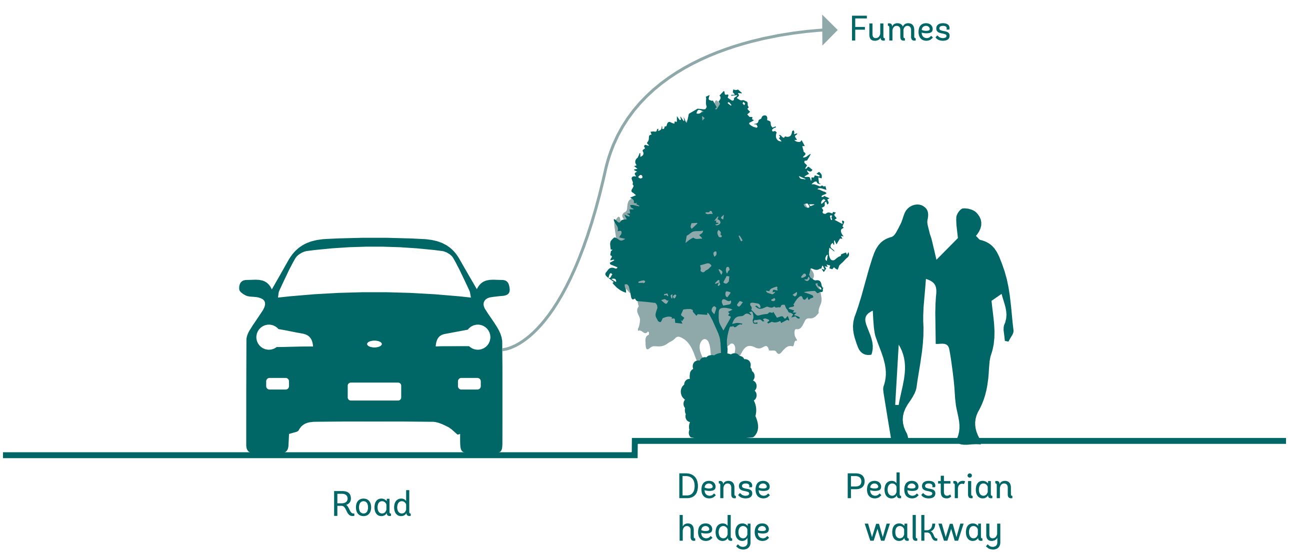


Figure 4.13: Design to disperse risks from vehicle fumes

Buffer conservation features

Woodland creation can also be used to **buffer and protect important conservation features**. For example, ancient woodland, ancient and veteran trees and semi-natural grassland are particularly sensitive to pollution. Buffering these features with 'sacrificial' woods, tree or hedgerows can help to absorb and divert pollutants – **protecting sensitive species** such as lichens and **reducing nitrogen enrichment**.

Design to respond to specific threats

Well-informed design is essential to deliver air-quality objectives. Choice of tree species is important in terms of the functions that different trees fulfil and their ability to thrive in challenging situations.

Where trees are used to intercept pollutants or screen people from sources of pollution, structure is critical. In general, high-density barriers will provide a higher level of shelter, but over a shorter distance, whereas lower-density barriers will create less turbulence and provide a more extensive protected area. Gaps through or under barriers will allow pollutants to pass through and may cause localised concentrations.

In some settings, such as along roadsides, **high-density hedgerows** will provide the most effective barrier. Trees that retain their leaves throughout the year **(beech, hornbeam, holly** and **yew**) can be particularly valuable for this purpose.

Shelterbelts to intercept agricultural or industrial emissions should be as wide as possible (ideally more than 20 metres) and designed with a mix of trees and shrubs to create a **medium-density** shelterbelt with a **complex internal structure**.

The trees and shrubs used will have to tolerate the growing conditions and pollution. **Holly** can establish in exposed conditions and is particularly valuable within shelterbelts where it provides a high-density, year-round component. Some naturalised and non-native trees may be valuable. For example, sycamore is able to withstand high levels of exposure, including to salt-laden air along coasts, and is tolerant of industrial pollution. The non-native London plane is particularly tolerant of urban pollution and a common street tree in the south of England.

Trees and shrubs can **intercept dust particles**, although this is usually a minor benefit compared to their role in intercepting and dispersing pollution. **Conifer species,** especially those that hold their needles year-round, can be particularly effective at capturing particulate pollution due to the high surface areas of their needles. However, deciduous trees are generally able to tolerate higher levels of dust pollution as they drop any solid matter deposited on the leaves when they fall. In some cases, the accumulation of particulate pollution can cause the decline or death of conifers.

Though **birch** can play an important role in design to improve air quality, it is also a source of **abundant pollen** early in the year. This affects some asthma sufferers, and its use should be avoided in potentially sensitive situations such as school playgrounds.

Useful resources

- **Effects of vegetation on urban air pollution** (Air Quality Expert Group, report to Defra and UK Governments, 2018). Review of evidence and useful diagrams of how trees affect pollutants in different scenarios.
- **Green infrastructure for roadside air quality** (BiFor, TFL, BCC, 2021). A free prototype platform to estimate changes in pollutants resulting from different planting schemes.
- **Role of trees in urban air quality** (blog with links, 2019). Good diagrams of trees in urban situations to reduce pollution effects.
- **Trees in hard landscapes – a guide for delivery** (TDAG, 2014). Thorough and detailed design guide, with lots of case studies.
- **Using green infrastructure to protect people from air pollution** (Mayor of London, 2019). Practical advice and evidence reviews.
- **Tree species selection – for informed decision making** (Barcham Tree Nursery). Manual for species selection (native and non-native) in urban and other challenging settings.
- **Tree shelterbelts for ammonia mitigation** (CEH). Calculator and guidance for farmers, planners and tree planters, to maximise the benefits of planting tree shelterbelts for ammonia recapture.
- **The role of trees in free-range poultry farming** (The Woodland Trust, 2014). Practical advice on woodland creation (including buffering existing habitats) to prevent ammonia impacts.

CASE STUDY

Tree planting at Ledbeg is targeted by detailed soil survey. Planting on brown earths and avoiding peaty soils optimises carbon storage.

Woodland creation enabled by corporate carbon finance

Trees are in big demand as a nature-based solution to the climate crisis. Companies and organisations across the UK are planning their transition to net-zero emissions, and investing in woodland creation projects offers them a means to compensate for UK-based emissions that cannot be otherwise avoided. A private funding mechanism, backed by government, allowed the Woodland Trust to realise the creation of 143ha of new woodland in the remote northwest Highlands of Scotland.

The Woodland Carbon Code is the UK's voluntary standard for UK woodland creation projects, with predictions made, and later verified, on the carbon dioxide they sequester. Woodland Carbon Units (WCUs) are issued which represent the tonnes of carbon dioxide equivalent (tCO_2e) removed from the atmosphere by the growing trees. Companies can purchase WCUs from UK woodland creation projects to count towards their net-zero target.

The Woodland Carbon Units mechanism has provided the necessary enabling funds to seize an opportunity for a community woodland at Ledbeg, a 359ha area of land owned by the Assynt Foundation. The foundation manages community land and assets within the Glencanisp and Drumrunie Estates, and has partnered with the Woodland Trust on previous projects. The remoteness of Ledbeg meant that considerable effort and expense would be incurred to

CASE STUDY

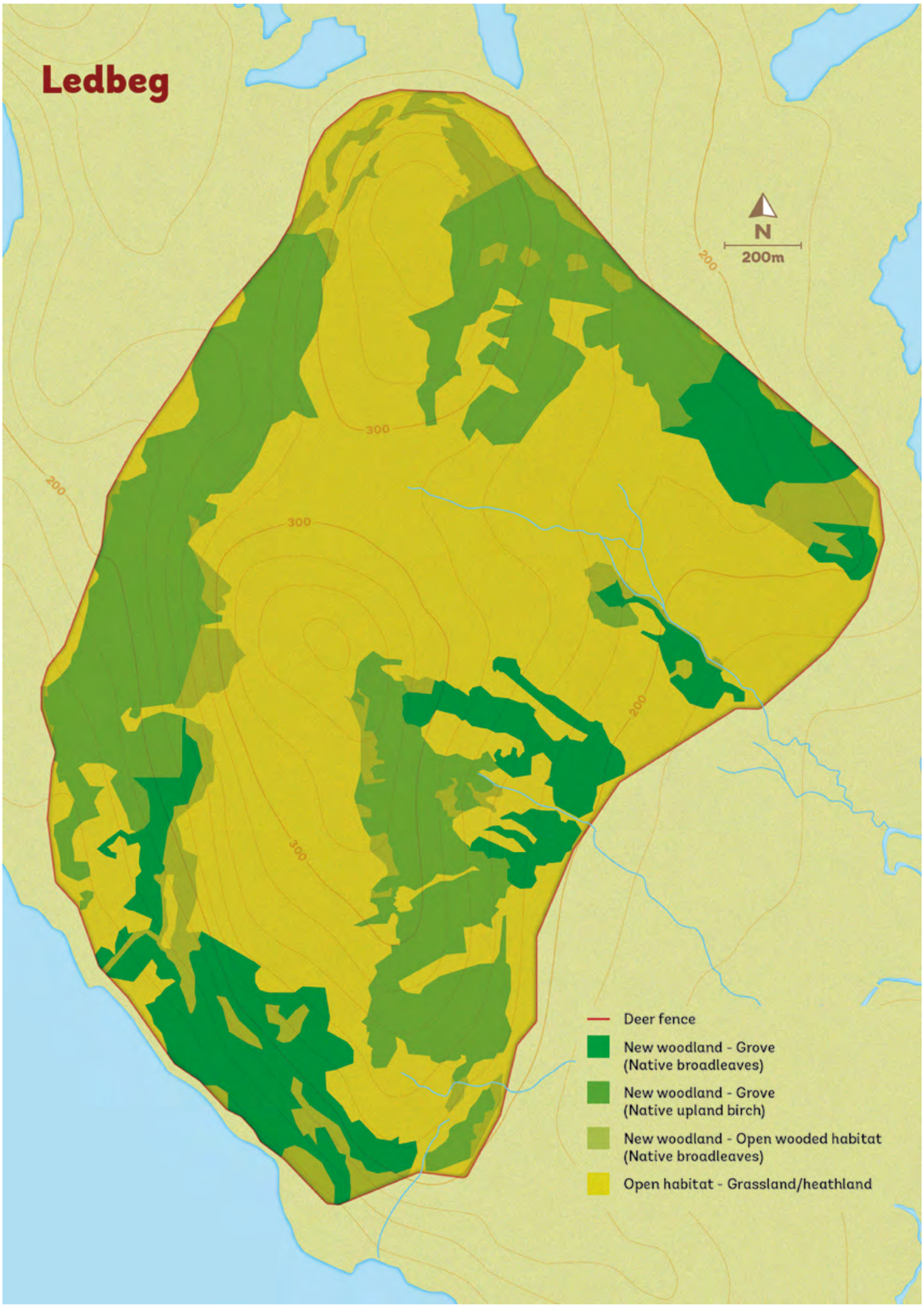
exclude deer from the woodland creation areas and promote rapid tree establishment in a difficult environment. Government woodland grant mechanisms alone would not have provided sufficient funds to cover the initial expense of deer fencing, proactive deer exclusion, ground preparation and tree establishment.

In developing the woodland creation scheme, people and organisations came together around a common socio-economic and environmental vision for the area. The design carefully balances new woodland for carbon sequestration with other conservation outcomes. This was largely driven by the geography of the site; the area is a complex mosaic of peat hags, rocky outcrops and skeletal soils. The protection of peat soils was paramount. These areas are already capturing and storing carbon, and tree planting would disturb the soil, causing carbon to be released into the atmosphere. They were, therefore, excluded from planting and retained as open habitats.

Existing woodlands in the area are primarily birch with purple moor grass, which has been incorporated into the species choice for the new woodland areas. A native species mix was planted, consisting of two thirds downy birch, with the remainder made up of a diversity of species, including hazel, eared willow, rowan, alder, holly and dog rose. Planting density varies over the site from two-metre spacing on the more sheltered areas to wider spacing (up to four metres) on the upper slopes. This provided 1,600 trees per hectare, but due to deer exclusion (a deer fence was erected around the site and deer were driven out before commencing planting), the stocking density will be higher as a result of the natural regeneration which will grow up among the planted trees.

Tree planting was completed in 2019, with five years of maintenance works scheduled to follow. The new woodland is predicted to capture 48,946 tCO_2e over 100 years, which the Woodland Trust purchased (as Pending Issuance Units [PIUs]) from the Assynt Foundation. When businesses contact the Woodland Trust's corporate team to purchase carbon units as part of their strategy to reach net zero, the PIUs are allocated using the IHS Markit Environmental Registry. PIUs are later checked, and if performing well, are verified and converted to WCUs. To protect the investment, the Woodland Trust entered into a 95-year lease with the Assynt Foundation, ensuring successful woodland establishment and carbon capture over the next 100 years. The Assynt Foundation is using the carbon income to reinvest in the site for the benefit of people and to achieve sustainable development of Scotland's natural environment.

CASE STUDY



Ledbeg
N
200m
200
300
300
200
300
200
200
Deer fence
New woodland - Grove (Native broadleaves)
New woodland - Grove (Native upland birch)
New woodland - Open wooded habitat (Native broadleaves)
Open habitat - Grassland/heathland

Cultural services

4.2.5 Landscape

UKFS (landscape): *New woods and trees should be designed to take account of the landscape context and designations. The* ***visual impact*** *of new woods and trees should be considered and the principles of forest design applied. The capacity of the landscape to* ***accommodate change*** *should be considered and the design of new woods and trees should have a positive impact on* ***landscape character,*** *reflecting visual sensitivity and local distinctiveness. Designs should consider and reflect the shapes of landform and enclosure patterns and avoid artificial shapes and lines. The scale and visual diversity of different elements of the design should fit with the scale and character of the landscape. Interlocking shapes should be used to fit the elements together and to tie into the wider landscape to achieve unity in design proposals.*

Design principles for addressing landscape objectives:

To inform the design process, and deliver objectives for restoring and enhancing the landscape character, you will need to build on the information and observations presented in the **landscape appraisal** that provides the wider context component of the site assessment.

Reflect and enhance the spirit of place

All locations have some defining qualities that create a **spirit of place**. These may be intangible qualities such as wildness or tranquillity, aesthetic qualities, or cultural associations and values that make a location special or unique. It is important to identify what factors contribute to the **local distinctiveness** of a place so that **this quality is not lost or damaged** when changes occur.

Dramatic landform or rocks, the presence of water, striking views or a sense of wildness and tranquillity may all define a sense of place. Trees themselves, especially ancient woods, traditional orchards and landmark and veteran trees, can be fundamental to the sense of place. Human influences, such as historical or artistic associations and archaeological features, are also likely to contribute.

Retaining and emphasising local distinctiveness provides identity and helps people to enjoy, remember and value particular places.

Enhance landscape character

Landscape character descriptions provide valuable evidence to inform woodland creation design. Establishing new woods and trees can have a significant impact on the landscape and there may be **resistance to change** from local communities or visitors. However, landscape character should not be seen as a constraint or a barrier to change. **Landscape character assessment** delivers a valuable and integrated source of information which not only can help people understand historic and ongoing change in the landscape, but also provides a basis for a more positive dialogue.

The influence of people and the way we have used and managed the land in some landscapes has resulted in those landscapes becoming **ecologically and aesthetically degraded**. In these situations, woodland creation offers a fantastic opportunity to create a new, distinctive and high-quality landscape character that people will come to value. Engaging people so that they understand the benefits that woods and trees can provide and how they are incorporated in the design process, is important to enable people to understand and embrace change.

A sense of **unity** is achieved when the component parts of a design work together well: nothing looking out of place or unbalanced, with the design fitting harmoniously into the defining landscape character. Building recognised woodland vegetation communities and developing complex vegetation structures will contribute significantly to a sense of unity. Complex boundaries ensure that design components **interlock** – providing coherence by giving shapes a stronger visual connection to one another.

In mountainous, moorland and hilly landscapes, **landform** will usually be the most important factor influencing the design of new woods and trees, which look artificial when shapes and lines are imposed that cut across landform patterns. **Natural patterns** follow landform, soils and associated hydrology. For example, treelines are lower on exposed slopes and ridges and higher in sheltered valleys.

Our eye is drawn through the landscape by directional forces. These flow down from high points, along ridges and convex hillsides and up into valleys, hollows and concave landforms. Linear features, such as a river or winding roads, also draw our eye through a scene. This perception of movement in landform holds true for all but the flattest landscapes where the eye is led across the horizon. Contour maps, aerial and perspective photographs or a digital terrain model of the landscape may be useful to provide a better understanding of landform.

Infrastructure such as access tracks and fencing can be highly visible, so landform needs to be taken into consideration when deciding where to site them. It can be particularly intrusive if they run along or cut the skyline, for example.

Across many of our landscapes, the network of hedges, walls, ditches, fences and trees form a distinctive **pattern of enclosure**. This is a defining feature of many of our most cherished landscapes and is of historic and ecological value. The pattern of enclosure often becomes the dominant influence on the design of new woods and trees on moving from upland to lowland settings.

Ancient countryside is characterised by irregular field boundary shapes, winding lanes, diverse hedgerows and patches of ancient woodland Other landscapes that have been shaped by the Enclosure Acts of the 18th and 19th centuries, and subsequent intensification of agriculture, is characterised as **planned countryside**, with a more geometric and regular patchwork of fields, simple hedges and plantation woodlands. In some areas, modern farming practice has degraded these long-established field patterns, but new woodland can restore the landscape character.

The relative dominance of field patterns and the influence of landform are key aspects to establish early in the design process. New woodland can **restore** and **transform** degraded landscape, creating unity by re-establishing the enclosure pattern. Imposition of extensive groves in landscapes that detract from the distinctive and prominent enclosure pattern should be avoided. Smaller patterns of enclosure and individual field boundaries of high value should be left unplanted with adequate buffering space, or be integrated within appropriately scaled glades or used to create open wooded habitats.

Restore natural complexity in landscapes

Well-designed woodland creation can restore the natural diversity and structural complexity of landscapes. This not only makes landscapes more visually appealing, it is also a good indicator of the habitat quality of a landscape and its value for wildlife. Applying some well-established design principles will help to ensure that designs lead to the establishment of woodland which appears naturalistic, provides multiple benefits to people, and supports a richness and abundance of wildlife.

Shape is a powerful factor that influences how we perceive our surroundings, and it has a major influence on how woods and trees fit into the landscape. The perception of shape is influenced by its overall proportions, how edges are defined and the position it's viewed from.

Landscapes contain many shapes, but there is always an underlying influence which can be used to facilitate integration. Allow the landscape to influence the shapes created by new woods and trees – responding to existing patterns of vegetation where these reflect landform, or differences in soils, hydrology, aspect and exposure. Compatible shapes achieve **harmony** in a composition, whereas incongruous shapes have a visually jarring effect.

People generally respond positively to naturalistic (organic) shapes in natural landscapes and less positively to geometric (human-influenced) shapes. This applies to both the overall woodland shape and to the patterns within them made by species assemblages and compartments, access tracks and edge treatments.

In flat or **urban** landscapes with no vantage point, people perceive shape from underneath or between the trees. In these landscapes it's the internal spaces created between new trees that are most important. In urban environments the interlocking of natural and geometric patterns can also create visual harmony.

Scale describes the relative size of different visual elements in a landscape. The overall sense of scale is dependent on the observer and could range from an elevated hilltop viewpoint to the intimacy of restricted views within a woodland or an urban environment.

Generally, the scale of new woods and trees should reflect the scale of the landscape, both in overall size and in the patterns that occur within and between areas of canopy. In general, smaller elements are more appropriate in valley bottoms, on lower slopes and along the woodland edge and footpaths, where human scale is important. Larger elements fit in higher elevations and on hilltops, where the sense of scale is generally much greater.

Large-scale groves may cause problems in intimate landscapes such as areas of ancient field pattern. Small-scale, unrelated elements at higher elevation also do not fit well into the landscape. The rule of thirds can help to resolve the visual balance between elements such as groves and glades. When a landscape, or a particular view, is seen as divided into two major elements, a ratio between them of one-third to two-thirds is usually the most satisfying visual proportion.

Several small elements can coalesce to create visual harmony. If small woods and individual trees overlap each other when seen from key viewpoints, the landscape appears heavily wooded. If these same elements are too far apart, they will appear isolated and incongruous in a large landscape. Expanding and connecting fragmented woods and trees can greatly improve the landscape fit.

Diversity refers to the number of different visual elements in a design. Diverse landscapes are usually more visually appealing, but the level of diversity should be appropriate to the situation. In general, diversity based on a mosaic of woodland habitats and trees creates visual interest and increases appeal. However, too much diversity can be visually confusing and appear cluttered, chaotic and incoherent. Some landscapes have an intrinsic quality and spirit of place based on simplicity, where enhancing diversity requires careful design to ensure a good landscape fit.

Across landscapes, woods and trees introduce diversity into treeless scenery, but extensive uniform groves can hide landscape features and reduce visual and habitat diversity. Complex structures created by different ages, densities and species of trees create a visual composition of contrasting textures and colours, which changes through the seasons. Historic and landmark features, water, and rocky outcrops, add further to diversity and should be emphasised.

By applying the principles of **shape, scale** and **diversity**, a design can be achieved that integrates woods and trees with other features so that they look as if they belong in the landscape.

4.2.6 Historic environment

UKFS (historic environment): Scheduled Monuments *must be protected, and consent obtained for any design that may impact on them. Proposals should also take account of* ***historic*** *and* ***designed landscapes, battlefield sites*** *and* ***historic parks and gardens*** *and set out how important historic features (including* ***veteran trees****) are to be protected and managed. This will normally include maintaining* ***open space*** *(minimum 20 metres) around important features and protecting long-established boundary features. The establishment of new woods and trees should* ***minimise ground disturbance*** *where evidence suggests historical remains may be present, and* ***avoid altering hydrology*** *where changes may affect preserved remains. Consideration should be given to* ***restoring tree cover*** *on previously wooded sites.*

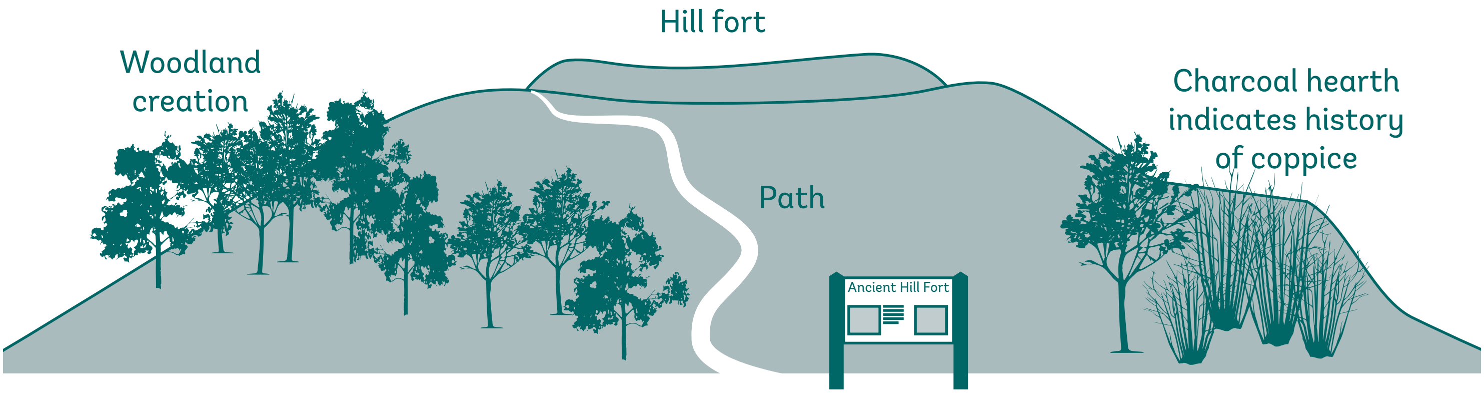
Design principles for the historic environment:

To deliver objectives for conserving and restoring the historic environment, you will need to build on the information and observations made in the site assessment phase and features recorded under HE1 –Archaeology; HE2 – (Registered) Historic or Designed Landscapes; and HE3 – Land Use, Settlement Patterns and Living History.

Protect irreplaceable historic features

Following identification and mapping of archaeological features (or potential features) at your site, you should aim to protect and enhance them through your creation design. For example, **archaeological features** such as burial mounds, ridge and furrow field systems or hillforts may **indicate a deep history of open land** or vantage points which you will want to reflect in the design of new woods and trees. You could use native trees and shrubs to frame or ‘reveal’ these features, particularly where their surrounding landscapes may have been wooded in the past.

A minimum of 20 metres of open ground should be maintained around **scheduled monuments** and other designated heritage assets, including all burial mounds, hillforts, standing stones and rock art. Establishing trees beyond this open ground may be appropriate, but you should consider the setting of the historic feature. Burial grounds and military aircraft crash sites also have legal protection from disturbance and should also be maintained as open ground.



Sensitive woodland creation can be used to accentuate historic features in the landscape.

Figure 4.14: Design to frame and support historic features

Features **indicative of past woodland cover** and industry, such as charcoal hearths, saw pits, and boundary banks, which are now on open ground, could be sensitively re-wooded using site-appropriate native trees and shrubs while ensuring the historic feature itself is kept free of trees. It is advisable to maintain five metres of open ground either side of boundary banks. A five-metre buffer should also apply to ridge and furrow, charcoal hearths, saw pits and military features.

For **arable fields showing evidence of sub-surface remains** (e.g. Roman mosaics or pottery), further advice should be taken as to whether any tree planting or natural colonisation is appropriate, or other habitat establishment such as permanent semi-natural grassland.

Conserve and restore historic or designed landscapes

Important historic or designed landscapes are recorded on the Register of Historic Parks and Gardens. Registration does not place any specific restrictions on woodland creation design, but will inform the statutory consultation process. It is, therefore, important to understand the significance of any registered site so that its historic character can be maintained or enhanced.

In historic parkland, you should retain and restore the **historic configuration** of open parkland pasture and wooded areas. Retaining areas of open parkland and avoiding inappropriate planting will help to retain what is special about your historic park. Fragmentation of open parkland with new subdivisions, such as hedges, should also be avoided.

The establishment of new trees should be **sympathetic to the historic character** of the registered park or garden in terms of location and species. Where possible, this is best grown from existing estate stock. These trees will become the ancients and veterans of the future.

Retain mature, ancient and veteran parkland trees, including dying trees or standing decaying wood, because of their high historic, cultural and biodiversity value. Fallen decaying wood may be left in place as valuable wildlife habitat.

Parkland pasture, which was grazed historically, is of great visual, historic and biodiversity value. Over time, however, agricultural practice may have changed the parkland to arable cultivation. If this has happened, you should **consider reversion to grazed pasture** in keeping with the historic use, character and setting, and to improve parkland habitats.

For historic designed **water bodies, or water features**, it is important that they are not damaged by tree roots, and they may require restoration. Suitable fringing vegetation could be planted (e.g. native wetland shrubs) and invasive non-native species removed.

Restore the woodland features of the historic and cultural landscape

Restoring woods and trees based on **historical evidence** may be appropriate in some situations and can be appealing to many people. This is especially true where there is evidence of relatively **recent loss of woods, trees or hedgerows**.

It can be equally compelling to reveal evidence of woods and trees with greater time-depth. Fragmented remnants of former ancient woodland and wood pasture can be coupled with evidence from maps and written accounts to build a picture of the extent of ghost or shadow woods that might be restored to re-create extensive areas of high ecological and cultural value.

Where direct evidence of the presence of woods and trees does not exist, it is still possible to reflect the historic landscape in the design of new woods and trees. This might include cultural references, such as land use and settlement patterns, place names, paintings, stories or folklore. Taking account of the history of the landscape can enhance woodland creation design and attach greater cultural meaning and significance to your project.

Relating woodland creation to the restoration, extension and buffering of ancient woodland, ancient hedgerows and ancient and veteran trees can provide a clear link between the cultural landscape and nature recovery. This may be particularly important in promoting the establishment and care of open grown trees to provide continuity of veteran tree habitats.

Useful resources

- **National Character Areas (NCAs) profiles – England** (Natural England, 2014). Information and guidance on the English National Character Areas.
- **Landscape character assessment guidance** (Natural England, 2014). Guidance on how to carry out and use landscape character assessments.
- **Landscape character assessment, Scotland.** Advice on landscape characteristics important to consider during design.
- **Managing change to registered historic parks and gardens in Wales** (Cadw, Welsh Government, 2017). Practical guidance on managing change in registered parks and gardens.
- **Woodland siting and design guide, Yorkshire Dales** (Yorkshire Dales National Park Authority). For upland landscape setting, with useful before and after diagrams.
- **Archaeological preservation – selection of tree species** (webpage, Forest Research). Tree root characteristics by species to inform selection and minimise impacts on subsurface archaeology.
- **How to limit damage to historical woodland features** (High Weald AONB). Illustrated guide to protecting woodland archaeology (mainly in existing woodland).

4.2.7 People includes access, recreation, skills and learning, community involvement and employment

UKFS (people): *As well as ensuring compliance with* ***public rights of way and safety legislation****, landowners should consider providing* ***new access opportunities****, both to the woodland, its habitats and any historic environment features. Depending on the likely level of footfall, this could involve installing* ***facilities*** *such as car parks, litter bins and toilets, new paths and physical route waymarkers to manage access in a responsible way, as well as creating opportunities for interpretation and learning. Access provision, including signage, should consider all members of society, including hard-to-reach groups, those with protected characteristics and non-traditional users. Zoning your site may be important if there are likely to be different and potentially conflicting user groups (for example bird watchers, bikers, horse riders and dog walkers) and codes of responsible access.*

Your woodland creation project may offer opportunities for increased **public access** and **community use**, and this may be one of the stated objectives of the project. Where this is not the case, visitors and access will nonetheless need to be addressed in the design. Information on rights of way and existing informal public access should have been recorded in the site assessment, along with an evaluation of visitor infrastructure and public use of surrounding land.

Design principles for addressing people objectives:

Engage and consult existing and potential visitors

Use of the site by visitors, and objectives to promote greater use of the site, can be extremely diverse and varied. These could range from management of rights of way or existing informal access and limited access for defined groups within the local community (e.g. forest schools), to the creation of a large woodland with new access and volunteering or employment opportunities for a big population, requiring significant infrastructure. Whatever the size of your project, it is important to do some research and **engage early with current and potential users** of the site, to find out what is needed and to address any concerns people may have.

Define the access rights

Whether building on existing access to the site or creating new opportunities, access can be provided through a number of mechanisms. In England and Wales, a new **legal right of access** through a section 16 CROW Act 2000 dedication gives visitors a legal 'right to roam' over all the dedicated land. This can help to provide visitors with greater confidence and encourage the more adventurous to explore areas away from the main paths. A **freedom to roam** exists on almost all land in Scotland under the Land Reform (Scotland) Act 2003, subject to the Scottish Outdoor Access Code (SOAC).

New **rights of way** can be created, granting a legal right of access for walkers (footpath) or walkers, cyclists and horse riders (bridleway) along the route.

Alternatively, access can be granted on a **permissive** basis, which means that landowner permission is given for people to use the site, but these rights are not covered by laws relating to Public Rights of Way or Access Land under the Countryside and Rights of Way Act 2000. Permissive access routes are not generally shown on maps because they are not permanent and there might not be a formal agreement in place, so you would need to ensure that the site is well signed so that people know they are welcome.

Provide positive visitor experiences

Anticipated **visitor numbers** and the **types of activities** that may occur (e.g. under the terms of SOAC in Scotland) or will be permitted (walking, cycling, horse riding, etc.) should be built into the design from the beginning. Consideration needs to be given to how the project may change use and how that is best managed.

The design should consider **access points** and **welcoming people** to the site. Obscure and unsigned entrances are a barrier to many visitors. Once on site, consider how people will be guided around the site. Most people will follow a well-surfaced path network, and many will also follow directional waymarking arrows.

Design the **access network** to minimise potential conflict between user groups. This can be achieved through **zoning** areas for activities, providing dedicated paths for different user groups close to access points, and providing infrastructure and signage at intersections (e.g. where mountain biking trails cross footpaths).

Providing **landmarks at key nodes** on the access network will enable visitors to more easily orientate themselves and provides reassurance on larger sites. It may be possible to design the access network around existing landmarks, such as large mature or veteran trees (ensuring that new paths don't cause ground compaction in the root zone!).

Providing **a variety of woodland structures** along the access network will ensure that visitors have both visual interest and a richer experience of nature. Wide, **open rides** are popular with many visitors, especially if the vegetation is flower rich, while **scrub along path sides** brings wildlife, such as birds and butterflies, closer to visitors. The contrast of walking through glades, on sunlit rides and in **shady groves** of trees provides a richer and more varied visitor experience. **Open wooded habitats** with scattered open grown trees, scrub and shorter vegetation are also popular as they combine a woodland experience with the reassurance of wider views and the visual interest of a varied structure.

The design of your site should aim to take **wider landscape** considerations into account, including other opportunities for access to nature and any existing network of access routes close to the site. This may be particularly important where the new woodland is meeting the needs of a new housing development or is part of a biodiversity net gain scheme.

Design and install suitable infrastructure

Once a broad plan for the access network has been created, more detailed plans for visitor infrastructure can be developed. The **numbers of visitors** and **activities** undertaken will determine the **scale and design of infrastructure** that will be needed, such as path widths, path surface, waymarked routes, signage, interpretation, parking, learning zones or links to route networks beyond the site. Minimise barriers to access as much as possible when considering designs and think about including some all-ability routes.

Any access infrastructure will need to be capable of supporting the level of type of use envisaged and should be appropriate to the setting in terms of the design and materials used. Consideration should also be given to the management and maintenance of infrastructure in the long term.

Engaging early with your **local planning authority** is important if you are proposing any **major infrastructure** such as vehicle access or car parks, installing services involving utilities, or creating new business opportunities.

Minimise the potential disturbance of wildlife

Some forms of use by people may compromise wildlife conservation or other objectives for the site. This might include more intrusive forms of recreation, sporting events for large numbers of people, or dogs off leads (particularly, for example, during the breeding season of ground-nesting birds) and game-bird releases for shooting – any of which could cause disturbance to **sensitive species and habitats**. Often, these issues can be addressed through careful and **collaborative planning and design** and subsequent management, including, for example, appropriate routes for footpaths, and zoning areas of higher and lower visitor numbers. Sometimes it will be more practical to accept that a new site may not be suitable for some activities or objectives.

Woodland creation as part of the extension to an existing woodland can help to relieve pressure on woodland and other sensitive habitats already present, especially ancient woodland, and guide people away from species such as ground flora which are sensitive to trampling.

Game bird shooting for recreation is an objective of some land managers in creating new native woodland, where the woodland (generally small, shrubby groves) provides cover for the released birds.

To benefit conservation of native woodland wildlife, woods created to specifically benefit game birds should ideally be structurally diverse, with native trees and shrubs and areas of open habitat. They should be designed to take the pressure off ancient woodlands (where game birds may previously have been released or fed), and the use of non-native and/or invasive evergreen shrubs should be avoided. Ensure released bird densities are within the carrying capacity of the release site and be mindful of nearby woodlands of conservation value where excess nutrients and feeding/scratching on ground flora can damage sensitive plants, fungi and invertebrates. Additionally, adjacent sites with ground-nesting birds or reptile populations which could be predated by pheasants should be avoided.

Manage visitor safety and impact

Designing your site with **public safety** in mind can remove or reduce future problems. The site assessment should highlight any existing hazards, and minimising the risk from these should be addressed in the design, as should any hazards which might be associated with the woodland creation. This should include consideration of long-term tree-safety management and both reducing the risk, and planning for the control of wildfire.

Managing visitors on some woodland creation sites can present **challenges**. Littering, fly tipping, dog waste, vandalism and arson may be issues, particularly close to settlements. Again, these challenges are best anticipated and tackled during site assessment and design phases, and may require on-going attention, with, for example, on-site staff or volunteer wardens, and collaboration with the fire or police services.

Useful resources

- **Public engagement in forestry toolbox** (Forest Research, 2011). Techniques for all scales of project for public engagement and woodland design and management.
- **Community woodland information sheets** (Community Woodlands, 2019). Lots of information about community woodland in Scotland, including setting up, legislation and case studies.
- **The Countryside Code – advice for land managers** (UK Government statutory guidance, 2021).
- **Public rights of way – landowner responsibilities** (England) (Natural England, 2015). Information on responsibilities around public access, including operational practice.
- **Open access land – management rights and responsibilities** (England) (Natural England, 2019). Essential information for land managers and open access.
- **Countryside for all – good practice guide** (Fieldfare Trust, 2005). Lots of detailed advice on design for those with disabilities.
- **Minimising anti-social behaviour through design** (Scottish Forestry). Points to consider in design.
- **Common sense risk management of trees** (National Tree Safety Group, 2011). Manage trees to protect public safety and prolong tree life.
- **Trees, planning and development – a guide for delivery** (TDAG, 2021). In-depth resource with useful diagrams and further links on design in urban areas.
- **When is planning permission required?** (Ministry of Housing, Communities and Local Government, updated 2021). To check whether you require planning permission.
- **Woodland conservation and pheasants** (Game and Wildlife Conservation Trust, 2003).

Provisioning services

4.2.8 Wood products

***UKFS (general forestry practice):** Managers should be aware of the risks posed by **pests and diseases**. They should monitor, report and respond to threats to tree health and comply with statutory Plant Health Act orders. Planted trees should be **protected from damage** and **competing vegetation** managed to ensure successful establishment. Damage should be monitored, and vulnerable trees protected from browsing and grazing animals. Tree and shrub species should be selected, taking account of the **risks of climate change** and **vulnerability to pests and diseases**. Only certified material can be used for species covered by the Forest Reproductive Material Regulations. Woodland design should take account of the r**isks from wind, fire and pest and disease** outbreaks. The use of **pesticides and fertilisers** should be minimised, and **fencing** designed to reduce the impact on wildlife, landscape and public access. New **forest roads** and access onto a public highway may require **planning permission**, and the planning authority must be consulted.*

With good design and effective planning, deriving products from woods and trees can be complementary to other objectives for your new woodland, and vice versa. Production may be a key focus of your new woodland design or may be an important consideration in supporting the sustainable delivery of other objectives.

Design principles for wood products objectives:

Select marketable species

Markets for **sawn hardwoods** strongly favour a small suite of **tree species,** including oak, beech and high-grade birch. Smaller markets exist for cherry, yew and alder. This will need to be reflected in the species mix for timber stands. Planting timber trees in **diverse stands** can reduce the impacts of pests and diseases, and for this reason the timber stands should contain an appropriate mix of at least five tree species, and planted stands of three species or less should be avoided.

In contrast to timber, **firewood** can be produced from a wide range of woodland structures, including grove and wood pasture components as well as coppice management. Certain **tree species**, including oak, beech and birch, are favoured for firewood sales, but most of our native trees will provide acceptable firewood if well-seasoned. Firewood can also be harvested much sooner than timber products, and new woods can begin to provide fuel during the establishment phase of woodland creation. Although demand for firewood has grown, and markets are robust, it remains a relatively low-value product, and local markets are important to minimise the financial and environmental costs of transport.

Plan for future conditions

The economics of timber production are a function of the investment in establishment, the time taken to realise that investment in marketable products, and the value of the products harvested. Hardwood timber production is a long-term process, and ensuring that trees are well-matched to the **current and future conditions** of the site (average temperatures, aspect, elevation and exposure, geology, soils and hydrology) is essential to optimise **growth rates**. Some elements of the site assessment, such as understanding of soils and hydrology, may need to be more in depth where timber production is an objective.

Plan and resource long-term management

The production of **hardwood timber** is a long-term objective for a woodland creation project. It is likely to take 80–150 years to produce timber of sufficient diameter for sawmills. Management for timber production will require **regular thinning of stands** over this timescale, and this can provide an interim income through the production of small-diameter timber and firewood.

The **management of timber stands** requires a high level of silvicultural knowledge and skill. Professional contractors may be required to carry out planting to a suitable standard and manage the establishment of the stands.

Design and establish to promote tree form

Tree form strongly affects timber value. Tall, straight stems with minimal branching will generally provide higher-grade timber of greater value. Trees should be planted at close spacings. Two-metre spacings may be sufficient, but closer initial spacing of one metre or less between stems will promote straighter growth form. This will generally restrict timber production to groves in the woodland structure.

Browsing of lead shoots and damage to bark will negatively affect form and future timber potential. Preventing damage will require thorough **control of deer, rabbits, hares**, etc. and/or protection of stands or individual trees. Tree protection methods will not prevent damage by grey squirrel which usually occurs as trees reach the pole stage. **Grey squirrel control** can be targeted in stands of susceptible age and at key times of year; however, it can require a concerted effort over many years to enable the establishment of a timber stand.

The control of both deer and grey squirrel will be most successful if carried out collaboratively at landscape scale.

Design and install necessary infrastructure

Access will be required to timber stands to enable regular management, along with sufficient infrastructure to be able to extract timber from the site. The design should include establishing permanent racks and rides within the stand to enable **access for thinning and extraction** without damage to establishing trees and woodland vegetation. Forest roads and turning circles for timber lorries are likely to be required and should be included in the design. It is also highly preferable to include the installation of such infrastructure in the initiation phase of the project.

The **management** and **infrastructure** requirements will depend on the intended scale of production. This could range from access for forestry machinery and timber lorries to unsurfaced access routes for off-road vehicles and trailers for small-scale firewood production. Even for small-scale firewood projects the access requirements for management and extraction should be addressed in the design. If on-site processing and drying of firewood is planned, then sufficient space will need to be allowed for this.

Incorporating necessary infrastructure into your design to **manage threats** is also vital. This could include **deer management** rides and high seats, plans for tackling grey squirrel damage, **fencing or barriers** against mammal/livestock impacts (e.g. from voles, sheep, cattle and wild boar), **firebreaks** where there is a risk of wildfire, and **biosecurity measures** such as vehicle and/or bike wash facilities and disinfection points for visitors.

4.2.9 Food production (agroforestry)

Standards and regulations: *Agroforestry lies at the boundary of farming and forestry. In terms of standards and regulations, the UK Forestry Standard requirements will usually begin if the definition of woodland is met (over 20% canopy cover at final tree height). Claiming agricultural support (and adhering to support standards) will be feasible for many agroforestry projects.*

Trees can play an important role in agricultural production. This includes products derived directly from trees and shrubs, such as **timber, firewood, fruit, nuts**, or **foliage** (e.g. for animal fodder), or indirectly where trees improve the productivity of other crops or livestock systems, such as in **pollination services**, **shade** and **shelter**.

Design principles for food production (agroforestry) objectives:

Promote livestock productivity and welfare

Well-designed native hedgerows, shelterbelts and silvopastoral schemes provide **shade** and **shelter**. This can reduce the negative impacts of extreme weather on **livestock productivity, health** and **welfare**. When positioned correctly, hedgerows, shelterbelts and windbreaks can reduce wind speeds in an area up to 30 times their height. Shelter increases soil temperature in early spring and late autumn – extending the growing season for grass, and in times of drought, reducing wind speeds – which helps to slow the drying of surface soils.

Woods and shelterbelts should be established with a mix of native trees and shrubs to create a **medium density, semi-permeable barrier** with a complex internal structure. This will minimise air turbulence and provide a reduction in wind speeds over an extensive area. Care should be taken in design and establishment to avoid gaps through or underneath shelterbelts or hedgerows as this can funnel winds – creating higher speeds and increased turbulence.

Protection of trees from livestock damage needs to be considered in the design of silvopastoral schemes and boundary agroforestry. Decisions need to be made as to whether the system can exclude livestock while the trees establish, and utilise the cultivated area for conservation, grass or cropping, or whether individual and small clumps of trees need to be protected by guards and tree cages or larger areas by fencing. Electric fencing can be used in an alley design where livestock are moved daily. The cost of protection and the environmental footprint of materials used need to be considered when designing schemes. The use of invisible fencing systems is an option in wood pasture systems. Benefits will accrue as trees develop from as early as five years.

Support sustainable arable production

In **silvoarable** systems, objectives are typically to maximise the combined productivity of the tree and annual crops. Hedgerows, shelterbelts and alley cropping can reduce wind speeds and crop damage and can enhance the environmental and ecological interactions, such as maintaining soil temperature and improving crop water efficiency.

Design considerations include tree species in respect of end market for tree products and mature tree height, which will have an impact on an annual crop grown in the alley. Alley width should aim to **minimise impact from shade** on the alley crop as well as ensure space is left for **farm machinery access** to the cropped area. Typical alley widths in the UK are 24 metres with a 2–4-metre uncultivated tree row. In the UK, **north to south** or **northwest to southeast orientation** is likely to be most effective when combining the need to maximise light and the benefits of reducing wind speed. Under-sowing the tree row with a wildflower mix can enhance habitat for pollinators and beneficial insects.

Support pollinator populations

There are over 1,500 species of pollinating insect in the UK. Native woods and trees in the farmed landscape can be very important for these pollinators, particularly some species of bees and butterflies. Trees and shrubs provide an important food source, particularly early in the year; shelter to enable movement around the landscape; and as important hibernation sites for some species of pollinating insects.

Woodland edges and **bushy hedgerows** can be particularly important early in the year (e.g. goat willow, blackthorn) and late in the year (particularly with ivy), and they provide important structural diversity (tree crevices, undisturbed soils, etc.) in agricultural landscapes for overwintering, thus supporting pollinators throughout their lifecycle. Other important sources of pollen and nectar at the woodland edge include bramble, wild cherry, crab apple, hawthorn and rowan. Use of a wildflower mix in the understorey strip in alley cropping will create additional habitat for pollinators and beneficial insects.

Fruit and nut production

As well as providing fruit and nut crops, less intensively managed **orchards** can support pollination services, provide habitat for birds and insects (as long as few chemicals/barriers are used), rapidly develop 'veteran' features which deliver habitat for 'saproxylic' insects (associated with decaying wood), and enhance landscape connectivity. It takes 5–15 years for first fruit and nut crops and annually (seasonal) thereafter for 80–100+ years (depending on species and care).

Design in terms of soils, water, shelter and spacing are important (planting in a north to south grid will maximise sunshine) as is the relationship with other land use such as crops or pasture. Regular pruning is required as is mulching to control weeds and promote production and protection from pests and disease. Processing facilities may also be needed on site. Products must be harvested and processed immediately, so investigating markets is important prior to planting. Traditionally managed orchards can be highly effective for engaging local communities, and volunteer tasks are possible, but may require specialist supervision.

Support agricultural diversification

In addition to the **wood products** described in the previous section, other **niche food products** such as fungi (e.g. high-value truffles) can be the aim of some agroforestry projects. Edible fungi grow in association with tree species like pine, poplar, willow, beech, birch and oak. Because of their specialist nature, there is relatively little information or guidance on cultivation, harvesting and reliability of cropping. As with other perishable, high-value crops, they must be processed or preserved quickly, suggesting the need for on-site or nearby infrastructure.

Use predominantly native trees

Native trees have a wide range of uses in agroforestry systems. Beech, oak, hornbeam and wild cherry can provide timber and firewood. A wider range of species provide craft and coppice products for niche markets. Examples include whitebeam, wild service and limes for fine joinery woodturning and carving; fast-growing alder for charcoal production; limes as hosts for mistletoe production; and coppiced hazel for hurdle making.

Native trees can also be used in **food production**. Examples include hazelnuts, juniper berries and the flowers and berries of elder which are used in the production of the 15 million litres of natural-flavoured elder-based drinks (mostly elderflower cordial) consumed each year in the UK [79].

In addition, native trees and shrubs, such as hawthorn, hornbeam, holly and willow, can provide a varied source of **fodder for livestock** [80], while beech and oak produce mast and acorns which can be used to feed pigs. Willows (including goat, almond and grey) may be especially beneficial for livestock as there is evidence that they have medicinal benefits and that livestock feeding on these willows may produce less harmful ammonia and nitrous oxide pollution [81].

In some circumstances, **non-native trees or cultivars** may also be important components of agroforestry systems. Our rule of thumb guidance is as follows:

- Schemes where the trees are planted to deliver 'services' should be native to the UK, and ideally native or naturalised to the geographic region. 'Services' include, for example, shade, pollution abatement, shelter, water management, soil health, wildlife habitat, tree fodder and landscape aesthetics. These may be provided as shelterbelts, hedgerows, riparian strips, wood pasture, clumps and copses.
- Schemes where the trees are planted to deliver food products, such as fruits or nuts, can include non-natives. The aim should be to include a minimum of 50% native trees across the scheme and avoid any invasive non-native species, such as *Robinia pseudoacacia*. Some trees should be avoided in certain systems due to being highly poisonous, such as yew, or toxic to livestock if eaten in large quantities, such as acorns.

Design access and management

Woods and trees, especially those providing services such as shade, shelter and water management, are likely to become long-term or permanent features on the farm. Although these trees are unlikely to be harvested themselves, access may be required to enable pruning and cutting. These components should be designed around the **access and management infrastructure of the farm** to minimise the need for frequent management. Trees that will be harvested annually, or are growing within arable, orchard or silvopastoral fields will need to be laid out to enable access for tractors and farm machinery.

Ideally, **hedgerows** should be designed so that they can be managed on rotation, with each length of hedge cut on a roughly three-year cycle. This allows hedgerow trees and shrubs to produce flowers, fruit and seeds and increases the shelter they provide for wildlife. Ideally, a proportion of the open grown trees established on the farm should be placed in locations where they can age naturally without impeding access infrastructure. This will help to ensure a succession of **open grown mature trees**, and in time, veteran tree wood-decay habitats.

Useful resources

- **Highlands and islands woodlands handbook** (The Woodland Trust, 2019), for crofters, communities and small woodland owners. Reforestation for rural development, from community woods to woodland crofts.
- **Growing birch in Scotland for higher quality timber** (Forest Research, 2012). Information on planting and thinning of birch to produce high-quality grades of timber, with a summary of end uses.
- **Selecting tree seeds for current and future climates in order to maintain productivity** (Forestry Commission, 2020). A climate-matching tool for productive forests.
- **Forest school training – sustainable woodland management** (Forest School Trust, 2014). Introduction to sustainable forest management.
- **Why manage deer?** (British Deer Society, webpages with links). Includes advice on legal requirements and management, venison production, and training courses.
- **Best practice deer management** (Deer Initiative for England and Wales, website). Various best practice guides for deer management and venison production.
- **The agroforestry handbook** (Soil Association). An essential guide to agroforestry and how to implement it on your farm. Includes practical advice on system design and case studies.

- **How trees benefit your farm business** (Forestry Commission, 2020). Useful diagram of where to locate trees at a farm/landscape level for production benefits.
- **Agroforestry and the Basic Payment Scheme** (Rural Payments Agency, 2021). Requirement and opportunities for England (with similar requirements in the other countries).
- **The Orchard Project – guides and advice** (The Orchard Project, website, 2021). Short guidance notes on establishing and managing orchards.
- **Windbreaks and shelterbelts** (Alba trees, website). Advice on windbreaks and shelterbelts on farmland.
- **Trees on hen ranges – research briefing** (The Woodland Trust, 2020). Comparison of the effects of different designs on hens and wildlife.
- **Silvopasture planting designs to suit your farm** (Innovative Farmers website). Trial results of silvopastoral scheme designs.
- **Hedgerow advice for farmers, land managers and advisers** (Hedgelink, website). Advice on hedgerow creation, protection and management.

Supporting services

4.2.10 Soils

UKFS: *All woodland operations – from planning to harvesting – should aim to* ***minimise soil disturbance, compaction or contamination****. New forests and trees can play a significant role in reducing sediment runoff or wind erosion.* ***Site conditions*** *such as soil type, slope, hydrology, existing habitats and climate variables will influence necessary measures for soil protection.* ***Roads and other infrastructure*** *should be designed to reduce harvesting impacts on soils, and their construction should minimise disturbance. Tree species selected should not require fertiliser (other than short-rotation forestry).* ***Deep peat*** *(over 50cm) should be avoided for new forest establishment, as should* ***any sites*** *that would compromise hydrology of adjacent wet habitats.*

Design principles for addressing soils objectives:

When designing your woodland creation site, your initial **soil assessment and mapping** will have identified the basic soil types present, recorded notable soil features (S1 – Deep Peat and S2 – Other geological or soils feature) and identified and mapped areas of **erosion, compaction, degradation** or **pollution**. These should be carefully considered during design. Trees and woods may be used to improve or protect **soil fertility**, **soil structure** (e.g. by reducing compaction), **soil biodiversity**, and **soil stabilisation** (preventing erosion and loss).

Locate and structure woods and trees to conserve soils

Locating woods, trees and hedgerows to **reduce erosion by surface water** is discussed in the design principles for water. As well as affecting water quality, erosion by surface water can degrade soils, especially on upland arable sites and those prone to gully erosion.

Establishing woods, shelterbelts and hedgerows can **lessen wind erosion** of soils by reducing wind speeds over the ground surface. Lower wind speeds also **reduce evaporation** in drought-prone areas, slowing desiccation of surface soils. This can be especially important for exposed soils in arable systems, particularly in flat, exposed landscapes prone to wind-blow such as the Fens of East Anglia. Woods and shelterbelts should be established with a mix of trees and shrubs to create a **medium density, semi-permeable barrier** with a **complex internal structure.** This will minimise air turbulence and provide a reduction in wind speeds over an extensive area.

Mixing deciduous and evergreen trees and shrubs (such as holly and yew) will enhance the year-round function of shelterbelts. To maximise the effectiveness of hedgerows in reducing surface wind speeds, they should be designed to be as wide as possible and managed to allow them to develop a good height. Cutting agricultural hedgerows on a three-year cycle will also significantly increase their value to wildlife. Incorporating frequent standard trees in the hedgerow will further enhance their effect on wind speeds.

Establish suitable tree species to stabilise soils

Most native trees and shrubs provide some useful **soil stabilisation** properties and **increase water infiltration** capacity [82]**.** This is a result of the relative permanence of trees, their generally greater **rooting depths** compared to other vegetation, and the **protection from soil disturbance** that trees afford. Different tree and shrub species do however have different physical, chemical and biological properties which will influence their effectiveness for soil conservation aims. **Rowan** is characteristic of upland areas with high erosion rates and is often used for soil bioengineering to increase the stability of slopes and mitigate erosion. It is also useful for **deep reinforcement and soil strengthening** [83]. Similarly, bird cherry, which has tendency to form thickets through root suckering, can reduce soil erosion and increase the stability of slopes [84].

Evergreen trees can make an important contribution to soil stabilisation due to their year-round contribution to **intercepting rainfall**. However, many conifers (often non-native), are relatively shallow rooting and can make soils and water runoff more acidic. They may also be more subject to wind-throw, resulting in further soil disturbance as root plates are lifted.

Establish woods and trees to enhance soil structure and fertility

Trees and shrubs have **deeper roots** than most other plants and can access otherwise unreachable soil nutrients. This can **increase soil nutrient** levels and productivity, as well as **protect soils** from loss. Deciduous trees also add **organic material** to the soil surface through annual leaf fall. Some trees such as alder are **nitrogen fixing** and can build soil fertility over time.

Establishing trees on agricultural land can **protect and enrich soils in arable and pasture systems** and reduce the need for artificial fertilisers. The specific design of an agroforestry scheme (including the basic spatial arrangement of trees and species choice) will vary depending on objectives and local environmental factors, such as slope, soil type and prevailing climatic and weather conditions. Further advice on design of agroforestry systems and the vital relationship with soils can be found in the Agroforestry Handbook.

Soil will, of course, be fundamental to the success of your new woodland/trees, partly because of the presence of **soil fungi**. Certain groups of fungi have critical roles in the establishment of tree seedlings: pathogenic fungi are detrimental to survival, while **mycorrhizal fungi** are beneficial to the seedlings. This latter group (especially the ectomycorrhizae) are essential for the survival and longer-term growth of most trees. Some species of tree are best established alongside plants that share associated beneficial fungi, or nearby existing trees of the same species that are growing strongly – particularly in challenging upland or urban situations – although the science and advice is still evolving on practical interventions. Introductions of commercially available mycorrhizae treatments are not advisable as they often contain fungus species that are not native to an area.

Establish trees and shrubs to mitigate pollution

In some specialist situations, such as **brownfield sites with toxic mineral soils**, tree species selection needs to be carefully researched, based on what will survive and how it will affect stabilisation of toxic materials in the environment. This may include land adjacent to the contaminated site where there are runoff or air pollutant implications. Native trees such as birch, willow, Scots pine and poplar have all shown good survival rates in some contaminated land situations. Willows (goat and osier) are used on contaminated sites for their ability to **absorb heavy metals**.

Useful resources

- **Guidance on cultivation and UKFS compliance in England** (Forestry Commission, June 2021). Operations note 53.
- **Opportunities for woodland on contaminated land** (Forestry Commission, 2002). Species selection advice.
- **The agroforestry handbook** (Soil Association). An essential guide to agroforestry and how to implement it on your farm. Includes practical advice on system design and case studies.
- **The identification of soils for forest management** (Forest Research, 2002). Field guide and keys for rapid soil identification.
- **Ecological site classification – decision support system** (Forest Research). Provides advice on conducting field surveys (vegetation and soils).

CASE STUDY

SAUL HERBERT

Natural flood management is an important objective for the project at Mallerstang. Alder planted in the stream valleys will play a key role in slowing surface flows.

Revitalising common land

When the agri-environment scheme at Mallerstang came to an end, it provided an opportunity to consider how well the project had delivered for wildlife and people, and what would be needed in the next scheme iteration. Very little wildlife gain was visible from the previous scheme, so a new, significantly different offer was required. With advice from the Woodland Trust, a new plan was designed that met the needs of farmers and local people, and significantly increased the site's wildlife value.

West Mallerstang in southeast Cumbria is an area of common land in excess of 1,200ha. It is privately owned, but has an area of common which is subject to the rights of grazing by local (usually adjoining) farms, and public access. The situation is complex, yet the land is still able to qualify for agri-environment schemes which require land managers, including farmers, to implement environmentally beneficial management and demonstrate good environmental practice on their land.

CASE STUDY

An initial design as a part of a new ten-year agri-environment scheme was developed with the farmers in mind – looking at fences, good grazing and difficult grazing areas, how the land was managed and how gathering of sheep was done. New fences and tree planting areas were designed to minimise impact on farming while maximising the potential for woodland creation.

Alongside the farming considerations and requirements, the design had to be sensitive to any ecological features present, such as black grouse lekking sites, breeding wading birds and characteristic flora, and consider underlying soils and geology. The common consisted of semi-natural vegetation which had not been ploughed or fertilised. However, it had been drained with multiple cuttings to dry the soils, and years of heavy sheep grazing had resulted in a degraded and species-poor habitat. The establishment of trees and scrub, along with the restoration and enhancement of the ground-layer vegetation, presented an opportunity to greatly enhance the ecological value of the site. Scrub is an amazing habitat and much undervalued – its scruffy edges, differing densities, thickets and flowers creating numerous habitat niches of value to insects, small birds, black grouse, and migratory birds alike.

Our work culminated in a scheme design that would convert 20% of the common area to scrub, as well as reduce grazing pressure through stock reductions over the remaining area. The scheme would cover the cost of tree planting and fencing, and compensate for the loss of grazing, thereby underpinning the incomes of affected farms.

Proposed design plans then went out for public and statutory consultation. Consultees included the local access forum, open spaces society, rights of way officer, national park officers and local residents. New fences are usually hotly contested so design and siting are key components of a good scheme. The plans were amended based on consultation responses to bring all stakeholders into broad agreement, and an application to the Secretary of State was made to gain the planning permission required for fencing on a common. The scheme took two years in planning and a further two to implement.

Trees and shrubs like hawthorn, gorse and rowan now dominate, with small groups of willow, aspen and oak emerging – supporting a small, but new, black grouse colony, four short-eared owl pairs and many more small birds and butterflies.

4.3 The concept design stage

The **synthesis** of the project objectives, site assessment and design principles will be expressed through one or more **concept designs**.

As a minimum, this should provide a simple illustration of the **proposed layout** of woods and trees, along with other key features of the site. Your design should reflect the application of the **landscape design principles** (spirit of place, unity, landform, pattern of enclosure, shape, scale and diversity) to ensure that it contributes to and enhances the character of the landscape.

Any relevant **features and context** of the site should be represented in the concept design to ensure that it provides an **integrated approach** to elements which could include: the components of the habitat mosaic, public access, visual amenity and beauty, the historic environment, soils, hydrology, topography, land use and proposed management. The concept design will require sufficient annotation or supporting notes to ensure that it can be interpreted and understood by all stakeholders.

For larger and more complex sites, or projects that require more extensive stakeholder engagement, additional elements can be added to the concept design. A series of concept maps to illustrate options can support a more engaging consultation process, while photographs (including aerial), artistic illustrations of the vision, a cross-section of habitat structure and larger-scale maps to illustrate landscape context, are also all worth considering.

DESIGN EXAMPLE

Smithills Estate – concept design

Figure 4.16 Option 1: Higher proportion of open woodland and glades

Key

Glade/open ground: to be managed as open space or to allow natural colonisation

Open woodland A: grey willow, alder, downy birch
Open woodland B: hawthorn, downy birch, grey willow, goat willow (5%), rowan (5%), alder buckthorn (5%)

Grove/closed canopy: sessile oak, downy birch, silver birch, aspen, goat willow, rowan (5%), crab apple (5%), hawthorn, blackthorn (5%)

DESIGN EXAMPLE

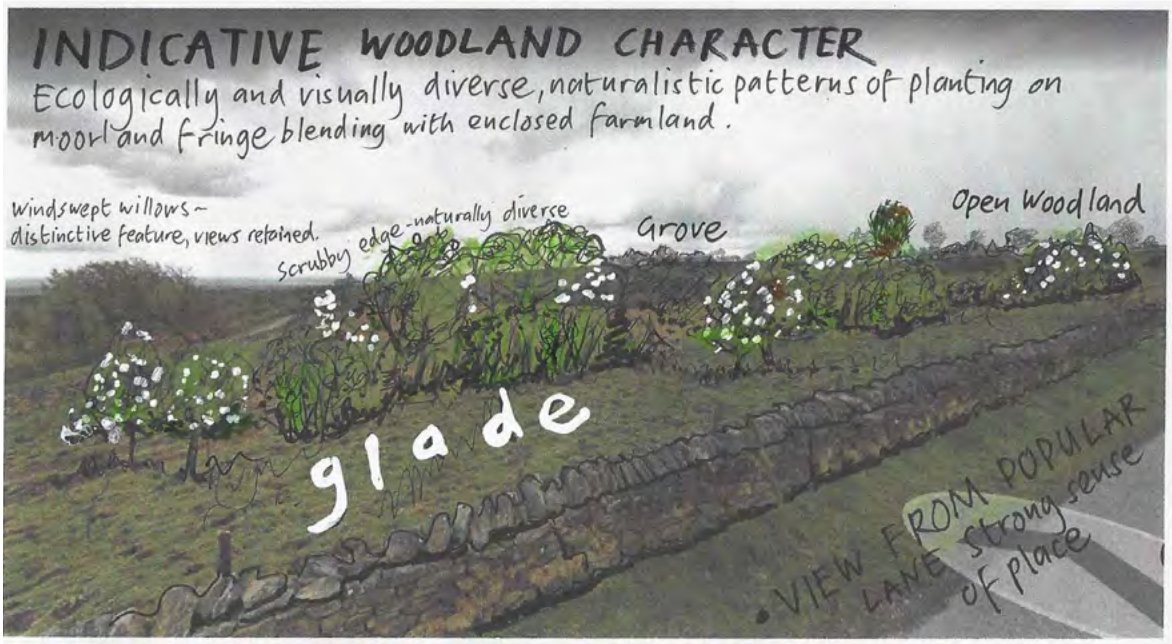


Figure 4.17 Smithills Estate, 3D visual showing view from the long-distance footpath

Figure 4.18 Smithills Estate, woodland structure at the moorland edge shown in bird's-eye view/axonometric

DESIGN EXAMPLE

Figure 4.19 Option 2: Larger planting area with greater proportion of grove woodland

Key

 **Glade:** to be managed as open space or to allow natural colonisation

 **Open woodland A:** willow and alder dominated

 **Open woodland B:** hawthorn and downy birch dominated

 **Natural colonisation:** open woodland and scrub established through natural processes

 **Grove:** sessile oak, downy birch, silver birch, hawthorn, blackthorn and rowan on edges

DESIGN EXAMPLE

Pepper Wood – concept design

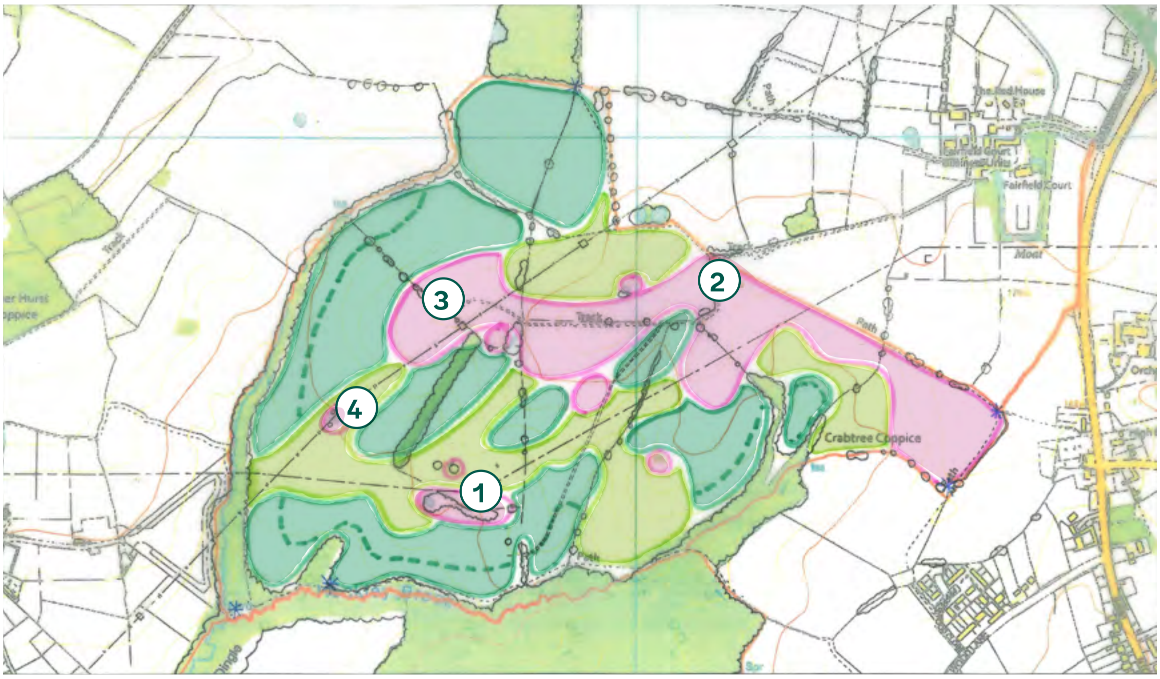


Figure 4.15 Pepper Wood extension, concept design map

Key

- Groves. To include both natural colonisation along existing woodland boundaries and new planting. New planting to use variable spacing to soften edges. Existing features such as ponds and hedgerows to be integrated.
- Open wooded habitats (wood pasture). Emphasis on providing diversity of habitat, integrating existing trees and mitigating utility corridors.
- Glades. Major areas of open ground – focus on retaining long views and enclosed field pattern on higher ground.

Elements and priorities of the design

1. Buffer and extend the ancient woodland of Pepper Wood.
2. Respond to the local landform and retain open ground on the ridgeline to maintain long views.
3. Reflect the pattern of enclosure, by building on the existing network of hedgerows, boundary trees and copses.
4. Integrate the infrastructure constraints (powerline and gas-main corridors) into the design to reduce their visual and structural impact.

4.3.1 The finalised design

The presentation of the finalised design will need to meet the requirements of the grants or other key funding. Generally, it should include a **map** showing the proposed spatial arrangement of woods and trees, along with sufficient **annotation** and **supporting information**.

This supporting information will need to include how **site features** have been incorporated and enhanced in the design, how **constraints** have been addressed, details of proposed **access arrangements** and any **infrastructure** required, along with an overview of the **management** that is planned or required during the establishment phase.

You will probably want to include information on the target **composition of tree and shrubs** and **methods of initial establishment** in the design. Detailed guidance on compiling a target species list, based on an understanding of the woodland vegetation community appropriate to the site characteristics, is given in the following chapter on **initiation.**

DESIGN EXAMPLE

Smithills Estate – final design

Figure 4.23 Smithills Estate – final design
The final design, increasing the woodland edge and with more open space around farmsteads. Vistas increased through woodland from public routes

Key


Glade: Fallow for 10 years, then light grazing. Stock fencing required.


Open woodland A: Low-density planting in varied clumps to create naturalistic open woodland structure. Downy birch (30%), alder (30%), grey willow (30%).

Open woodland B: Low-density planting in varied clumps to create naturalistic open woodland structure. Sessile oak (5%), alder buckthorn (5%), goat willow (10%), rowan (10%), hawthorn (15%), grey willow (15%).


Grove: Higher-density planting. Downy birch (30%), sessile oak (20%), silver birch and rowan (10%), aspen and goat willow (5%), hawthorn and blackthorn (10%).


Natural colonisation: Open woodland and scrub established through natural processes. Existing willows provide initial structure.

DESIGN EXAMPLE

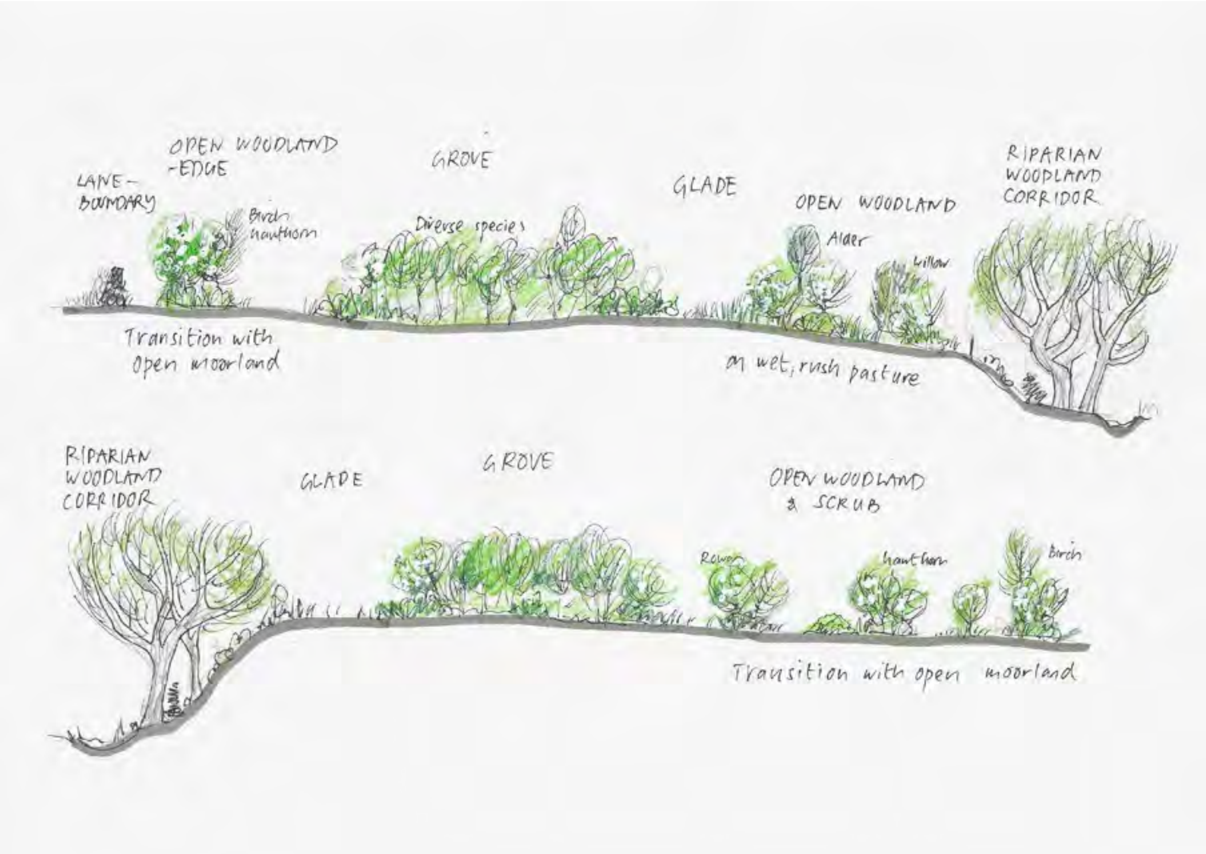


Figure 4.24 Cross sections indicating structure in the final design

Pepper Wood – final design

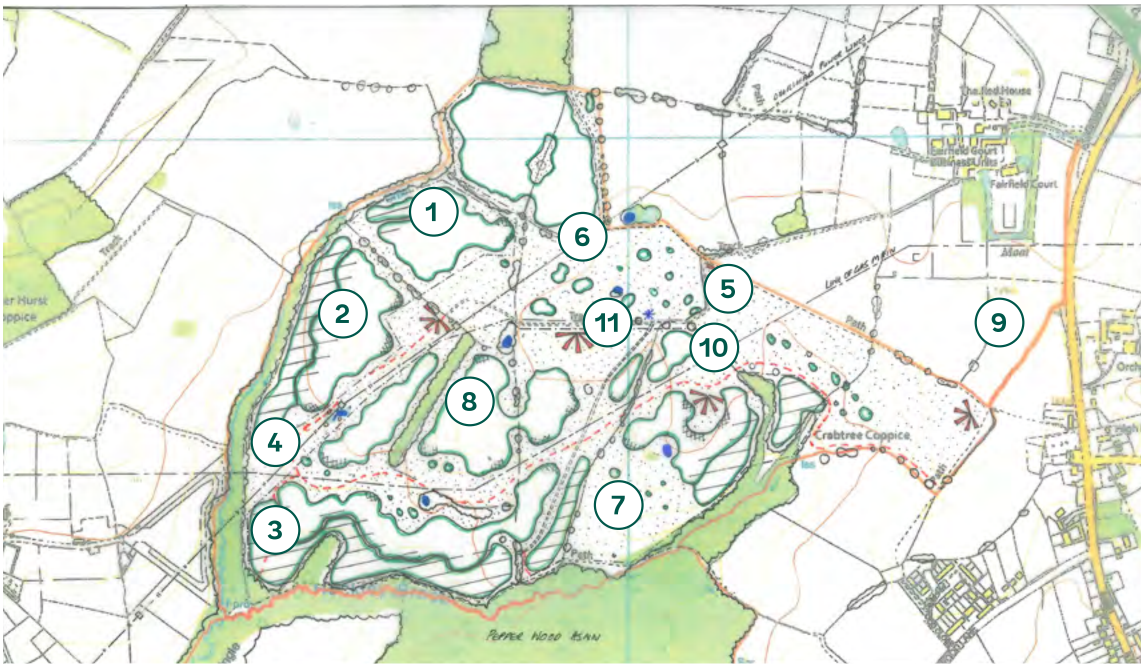


Figure 4.20 Pepper Wood – final design map

1. Woodland planting areas to be planted using a variable spacing matrix to create diverse graded edges, shaped to respond to the local characteristics and features.
2. The interface between the planted and natural colonisation areas to be blended using the same variable spacing approach.
3. Natural colonisation to be used as the principle method of establishment within 50 metres of the ancient woodland edge. Some ground prep and ongoing management of competitive vegetation may be required.
4. The corridor effect of the overhead powerlines and gas pipeline reduced by interlocking areas of tree cover and more open ground.
5. The open habitat (glade) designed to reflect landform and the pattern of field enclosure, and to retain expansive views out from the site.
6. Ponds, hedgerows and hedgerow trees to be integrated within the glades and retained as features.
7. Open wooded habitats (wood pasture) area to be managed by cattle grazing.

DESIGN EXAMPLE

8. Two large areas to be deer-fenced to enable the establishment of woods and trees.
9. Access for management and vehicles.
10. Path network extended to create circular routes from main access points.
11. Existing Second World War track and buildings to be retained as a feature of local cultural interest.

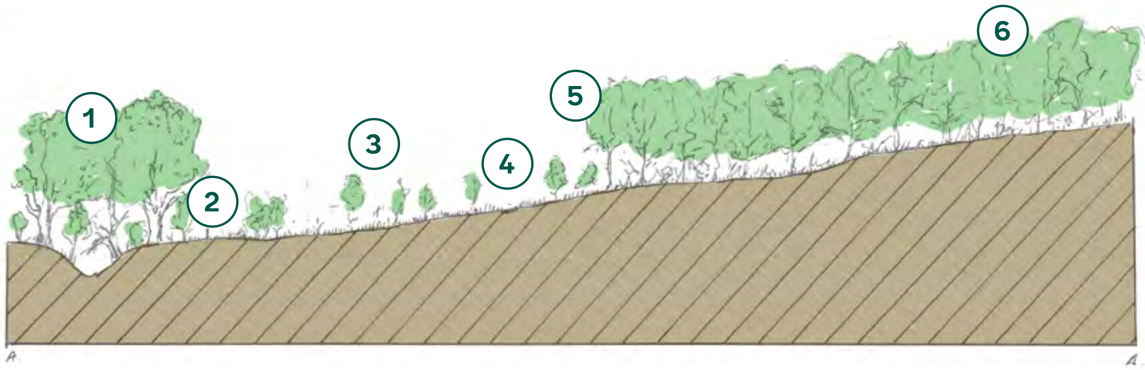


Figure 4.21 Pepper Wood – final design, cross section 1

1. Ancient semi-natural woodland, along stream
2. Field boundary fence
3. Area of natural colonisation
4. Informal path
5. Varied planting spacings to create a blended edge
6. Woodland planting with varied spacings to provide structural complexity

Pepper Wood – final design, cross sections

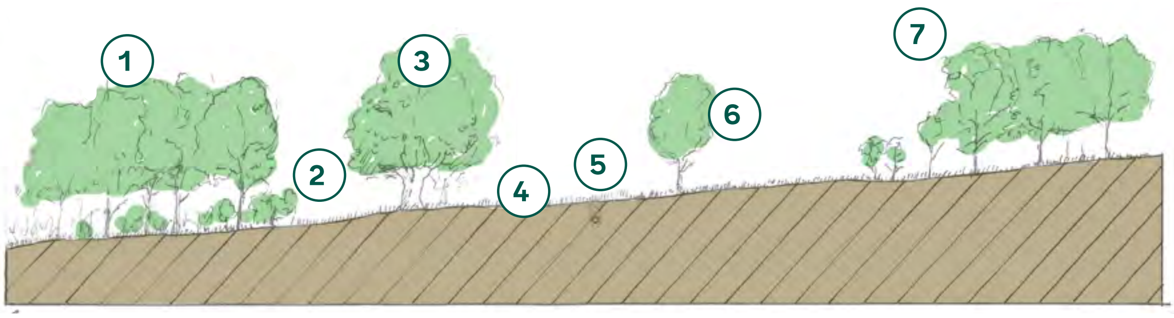


Figure 4.22 Pepper Wood – final design, cross section 2

1. New planting
2. New planting kept at least eight metres from the canopy of existing mature trees
3. Existing mature hedgerow tree
4. Informal path
5. Underground gas pipeline
6. Open wooded habitat – wood pasture
7. New planting with shrubs and wide spacing to create a wide transitional edge zone

Initiate

JUDITH PARRY/WTML

Vision → **Assess** → **Design** → **Initiate** → Establish

- Tree species
- Creation methods
- Tree provenance
- Managing threats

5: Initiate

In the design phase you will have set out your plans for creating new woods and trees. You have considered your objectives, site characteristics and features, and the landscape context of your site. Your design has brought these together and mapped out habitat mosaics and structures (groves, open wooded habitats and glades). You may have planned for the restoration of natural processes and the habitat requirements of important species.

In the **initiate phase,** further key decisions are required to start the practical elements of creating new woods and trees. To establish a functioning woodland ecosystem will take many decades, but the conditions and structures created at the outset will shape the development of the site. The 'fingerprint' of the initiate phase will still be seen many years later, so it is important to get this phase right to avoid corrective management later.

In putting your design into practice, you may come across issues which require its modification (for example, the design implications of tree-species selection or fencing for herbivore management). This **iterative approach** is encouraged until you find the best design to meet your project objectives that is also practical to implement.

Key decisions at this stage include **tree and shrub species selection** and the **method** of initiating them. **Planting, seeding and natural colonisation** each have benefits and limitations. Making informed decisions on method(s) will be fundamental to the success of your project.

For planting or direct seeding, you need to **source suitable material**. For decisions about the **provenance** of trees and seed, consider suitability to the site conditions and minimising the risk of introducing pests and diseases to the site.

Whether planting, seeding or encouraging natural colonisation, consider the **threats** to successful initiation. These may include **site characteristics** (degraded soils, exposure), **competition** from other vegetation and the impacts of **herbivores** (such as voles, rabbits, deer and livestock).

Based on **assessment of risks**, decide on the necessary interventions to **protect and promote** new trees and shrubs. These could include ground preparation, control of competitive vegetation (weeding), herbivore control, stock or deer fencing, or protecting individual trees.

If your project requires the creation of **infrastructure** for conservation management, farming, forestry or public access, then this should be identified in your design and installed during the initiation phase. As you progress through the initiation phase, temporary infrastructure may be required for site access.

5.1 Tree species selection

When selecting tree and shrub species for your project, the aim is to develop woodland **ecological communities** that are appropriate for the local landscape context and engender a **strong sense of place**. Species composition should be well matched to the location and conditions of the site, as described in the site assessment.

The selection of tree and shrub species should result in a **species list** which is an integral part of the overall design. This list will inform the purchase of seed and trees for **direct seeding** and **planting**. However, the species list should not be viewed as a fixed target to be achieved during the initiation stage. Instead, it provides a reference – guiding interventions as the composition and relative abundance of tree species develops through **natural colonisation**, and shaped over time by the characteristics of the site.

UKFS: Species selection *should establish a* ***diverse composition*** *and encourage a representative mix of native species associated with the woodland type. The risks and opportunities of* ***climate change*** *and* ***vulnerability to pests and diseases*** *should be considered for each species. Locally native trees and shrubs should be favoured in riparian zones, and invasive non-native plants controlled. Tree species should be well suited to the soils and fertility of the site and should not require continued input of fertilisers.*

The descriptions and tables below illustrate the range of **woodland communities** and provide a simple framework for building a species list for your site. **Woodland types** are categorised according to broad definitions of location, soil type and hydrology. For each type, tree species and field-layer positive indicator plants are listed for the three structural components of **groves, open wooded habitats** and **glades**. The open wooded habitats list will also provide a useful starting point for considering **hedgerows**, while the glades lists provide a handy reference when considering **open grown trees** in any context. If there are significant differences in geology, soils, hydrology, aspect, elevation or exposure across the site, then the species list will need to be adjusted to reflect this. A **shorthand key** for use on maps is provided for the different categories of woodland.

The information in the tables is supplemented by the **Tree Species Handbook**. The handbook provides detail on 50 tree species of most relevance to woodland creation projects, including maps showing where they are most appropriate, along with information on dispersal characteristics, ecology and suitable methods for establishment. For species **labelled 'local'** in the table below, the maps in the species handbook are an essential reference as they to help inform whether particular species are likely to be appropriate to a site.

Some species, such as whitebeam and elm microspecies, have **very localised native ranges** and are not included in the lists below. Only consider them as part of a design with specialist advice and support. Some included species, such as wild service tree and our two native limes, also have well-defined distributions [85]. Respecting the locally native ranges of these species will protect their genetic integrity and historical context [86].

Consider both the **current site conditions** alongside the **potential impacts of climate change**, and factor these into your species selection. For example, avoid including species prone to drought stress on shallow, drought-prone soils. However, almost all UK native tree species will grow in a wide range of climatic conditions, and projected climates for 2080 remain within their climate range. In some cases, their available 'climate space' will expand [28]. Native woods with high ecological integrity are best able to mitigate and adapt to climate change [87–89] and meet global and local biodiversity objectives [90]. Climate change is not a justification for including trees far outside their native range (although this is sometimes advocated for enhancing timber productivity), or for a simplistic approach to maximising the diversity of species used. Trees planted well outside their native range, where they do not form part of the characteristic woodland type, may reduce habitat quality and hinder nature recovery.

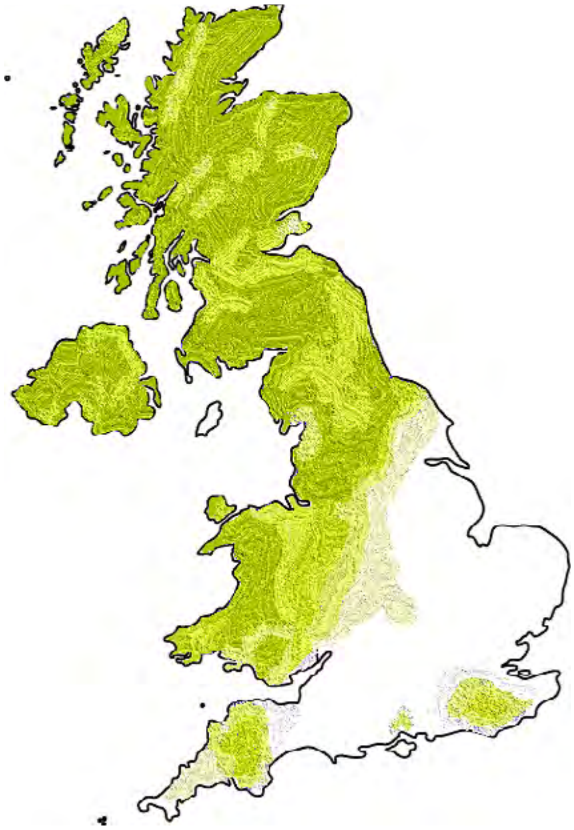
Tools which provide an indication of possible growth rates (yield classes) under predicted future environmental conditions, such as the Ecological Site Classification system [91], should be used with caution. This tool will support decision making on sites where timber production is a priority objective, but elsewhere it may lead to the conclusion that species integral to the conservation value of a site are in some way unsuitable.

Woodland communities

Eighteen woodland communities are described, divided according to broad descriptions of site characteristics and structural components (grove, open wooded habitats and glade). They are intended to support the establishment of locally appropriate and distinctive woods and trees without constraining this to specific National Vegetation Classification (NVC) communities. The relative proportions of different species needs to be site specific, with scope for natural processes (and time) to shape the composition.

The maps and descriptions in this table are original to this guide and informed by a range of sources on semi-natural habitats and vegetation in the UK, including but not limited to the NVC system [92]. Corresponding woodland NVC communities are listed for reference under the appropriate structures. The open woodland habitats and glades have affinities with non-woodland parts of the NVC (e.g. heaths and mires, grassland).

Acidic Upland (AU)



Wooded habitats on acidic, relatively dry and infertile soils, mostly in upland regions or more northerly and westerly areas, typically on acidic brown earths and podzol soils.

Many priority species are associated with these habitats. Open wooded habitats support priority birds, including redstart, tree pipit, spotted flycatcher, black grouse, woodcock and lesser redpoll. Denser young groves support willow warbler, while older groves might support pied flycatcher and wood warbler. In open wooded habitats, red wood ants and adder can occur. In the far west, rainforest groves and open wooded habitats support rich oceanic bryophytes (mosses and liverworts) and filmy ferns, with invertebrates like the blue ground beetle. Acid-barked trees, such as birch, holly, rowan and Scots pine, each support distinctive lichen communities, while the occasional willow or hazel can provide important variation to support *Lobarion* lichens. Open wooded habitats and glades support lizards, colourful waxcap fungi, and insects like the bilberry bumblebee and tormentil mining bee. The combination of these wooded habitat structures will support many more widespread species, including those associated with the tree species and wider vegetation.

Acidic upland grove (AU-gr) – relatively dense and largely closed canopy grove

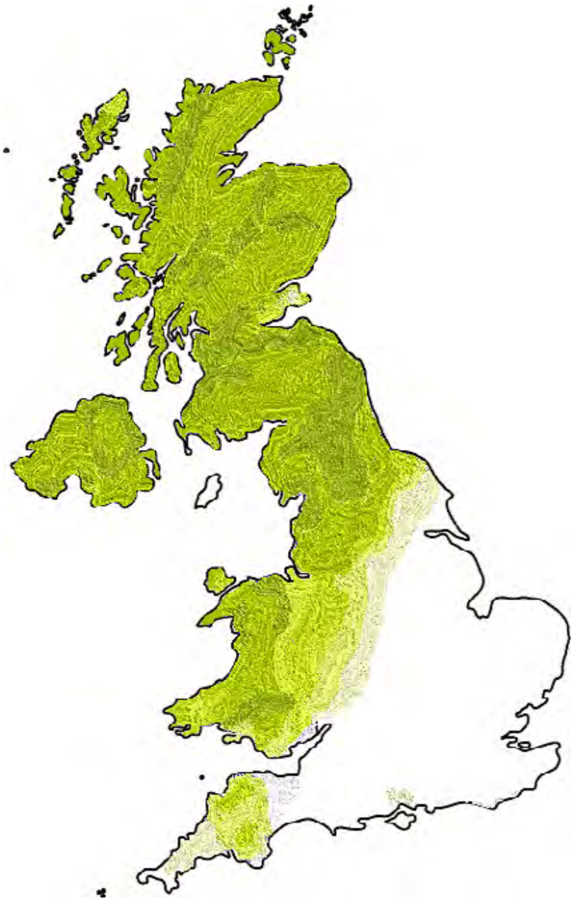
Acidic upland open wooded habitats (AU-owh)

Acidic upland glade (AU-gl)

Table 5.1

Acidic Upland – groves (AU-gr) >70% canopy cover	Acidic Upland – open wooded habitats (AU-owh) 20–70% canopy cover	Acidic Upland – glades (AU-gl) <20% canopy cover
Trees: **sessile oak, downy birch, hazel, holly, Scots pine (local), small-leaved lime (local)** Field-layer positive indicator examples: bluebell, wood sorrel, wood anemone, honeysuckle, bugle, yellow pimpernel, ivy, creeping soft grass, bilberry, scaly male fern, male fern, broad buckler fern, hard fern; and mosses, including *Mnium horum*, *Leucobryum glaucum*, *Plagiothecium undulatum*, *Hylocomium splendens*, and *Thuidium tamariscinum* Relationship to NVC: predominately closed canopy W11, W17, transitional to W10 and W16 on edge of range.	Trees: **sessile oak, downy birch, hawthorn, rowan, holly, aspen, hazel, goat willow, grey willow, bird cherry (local), Scots pine (local), small-leaved lime (local)** Field-layer positive indicator examples: pignut, common dog violet, betony, bitter vetch, honeysuckle, bluebell, raspberry, slender St. John's wort, heather, bilberry, cowberry, chickweed wintergreen, goldenrod, heath cudweed, foxglove, heath speedwell, common cow-wheat, climbing corydalis, greater stitchwort, red campion, broom, wild roses, brambles, greater wood rush, hairy wood rush, wavy hair grass, tufted hair grass, bracken; and mosses, including *Plagiothecium undulatum*, *Rhytidiadelphus loreus*, *Hylocomium splendens*, *Psuedoscleropodium purum*, and *Pleurozium schreberi*, plus any additional species from either AU-gr or AU-gl lists Relationship to NVC: more open canopy NVC W17, W11, in mosaic and transition to scrub (e.g. W23), acid grassland and ferns (e.g. NVC U4. U5, U16, U19, U20, U21) and acidic heath vegetation (e.g. transitional to H4, H8, H10, H12, H18).	Trees: **hawthorn, rowan, holly, sessile oak, downy birch, aspen, hazel, goat willow, grey willow, bird cherry (local), juniper (local), Scots pine (local)** Field-layer positive indicator examples: heath bedstraw, tormentil, heather, bilberry, gorse, wild roses, heath speedwell, mat grass, sheep's sorrel, betony, common bird's-foot trefoil, crowberry, changing forget-me-not, bitter vetch, common dog violet, harebell, sheep's fescue, common bent grass, sweet vernal grass, wavy hair grass, early hair grass, *Cladonia* lichens; and mosses, including *Psuedoscleropodium purum*, *Pleurozium schreberi*, and *Rhytidiadelphus squarrosus* Relationship to NVC: scattered trees and scrub among more open, semi-natural vegetation, including acid grassland and ferns (e.g. NVC U2, U4, U5, U20) or ericoid heath (e.g. NVC H4, H8, H9, H10, H12, H18). Might occur as scattered trees in more human-modified land uses, such as agriculturally modified grassland (e.g. NVC U4b).

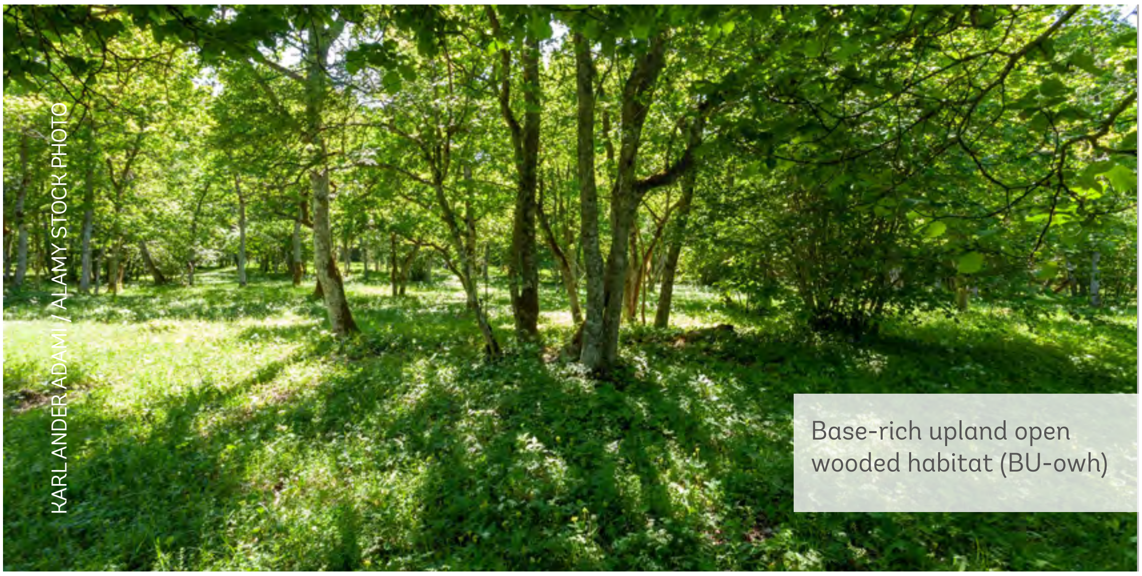
Base-rich Upland (BU)



Wooded habitats on base-rich, calcareous to neutral soils in upland areas or more northerly and westerly regions, typically on flushed brown earths, surface-water gleys or associated with base-rich geologies and rock outcropping.

Many priority species are associated with these wooded habitats. In relatively clean-air sites, *Lobarion* lichens are an important feature on base-rich tree bark of ash, elm, oak, aspen, hazel (including *Lobaria, Sticta, Nephroma*, etc.) as are the smooth-bark lichens on young ash and hazel. Birds of denser groves include song thrush and marsh tit, with dormouse occurring in groves with well-developed understorey. Open wooded habitats and glades can support butterflies like pearl-bordered fritillary, and birds, including spotted flycatcher and garden warbler. Older groves support molluscs, such as the ash black slug, while open wooded habitats and glades support insects, including forester moths, oil beetles, and a wide array of bees, true flies and other invertebrates. The combination of these wooded habitat structures will support many more widespread species, including those associated with the tree species and wider vegetation.

Base-rich upland grove (BU-gr)



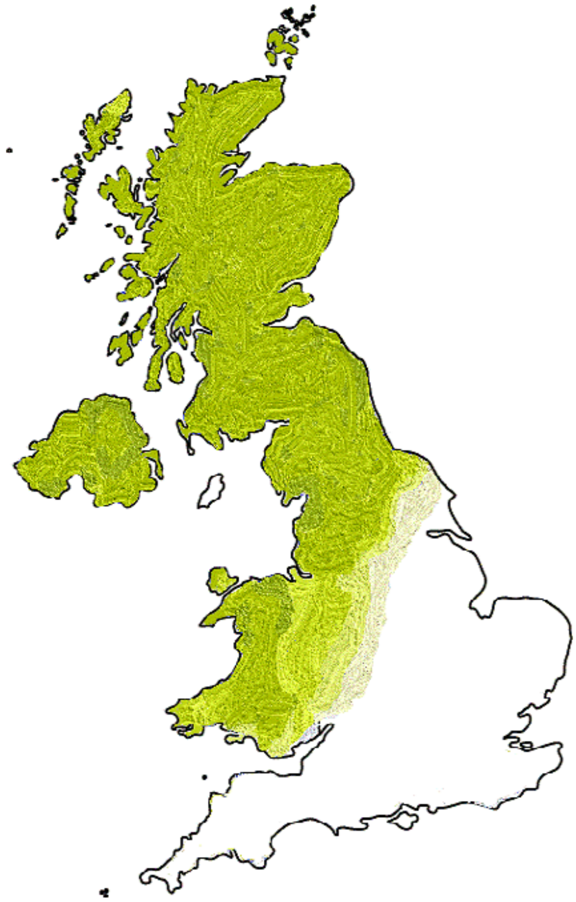
Base-rich upland open wooded habitat (BU-owh)

Base-rich upland glade (BU-gl)

Table 5.2

Base-rich Upland – groves (BU-gr) >70% canopy cover	Base-rich Upland – open wooded habitats (BU-owh) 20–70% canopy cover	Base-rich Upland – glades (BU-gl) <20% canopy cover
Trees: **ash, wych elm, downy birch, silver birch (local), aspen, pedunculate oak (local), small-leaved lime (local), sessile oak, hazel, holly, yew (local).** Field-layer positive indicator examples: dog's mercury, wood sorrel, enchanter's nightshade, bluebell, sanicle, herb-robert, woodruff, toothwort, common dog violet, wood sedge, ivy, wood avens, wood anemone, wood melick grass, broad buckler fern, scaly male fern, male fern, lady fern, and mosses, including *Atrichum undulatum. Eurhynchium striatum* Relationship to NVC: predominately closed-canopy NVC W9, W8, sometimes in transition to W7, W10, W11, W17,	Trees: **ash, wych elm, downy birch, silver birch (local), aspen, rowan, bird cherry (local), alder (damp areas), holly, hazel, wild service (local), pedunculate oak (local), small-leaved lime (local), sycamore (local), sessile oak, Scots pine (local), crab apple (local), juniper (local), yew (local)** Field-layer positive indicator examples: wild roses, red campion, common dog violet, bush vetch, barren strawberry, wild strawberry, hogweed, wood cranesbill, globeflower, bluebell, saw-wort, wild basil, nipplewort, wild angelica, cow parsley, garlic mustard, lesser burdock, raspberry, brambles, foxglove, ground ivy, hedge woundwort, tufted hair grass, false oat-grass, water avens, meadowsweet, Devil's-bit scabious, wood false-brome, plus any additional species from either BU-gr or BU-gl lists Relationship to NVC: more open canopy W9 and W8 in mosaic with scrub (e.g. NVC W25) and transitions to more open grassland and heath vegetation (e.g. U4, H10, CG9, CG10, U17. MG1, MG2, MG5, MG6, W19, W20).	Trees: **downy birch, silver birch (local), hawthorn, blackthorn, grey willow, goat willow, aspen, rowan, bird cherry (local), alder (damp areas), holly, sessile oak, wild service (local), ash, sycamore (local), elder, wych elm, Scots pine (local), crab apple (local), juniper (local).** Field-layer positive indicator examples: bird's-foot trefoil, meadowsweet, common sorrel, Devil's-bit scabious, betony, harebell, common knapweed, oxeye daisy, meadow vetchling, tufted vetch, zig-zag clover, cowslip, yarrow, ribwort plantain, lady's bedstraw, rough hawkbit, wild thyme, sheep's fescue, wild roses, brambles, burnet saxifrage, hogweed, Yorkshire fog, sweet vernal grass, crested dog's-tail, quaking grass, bent grasses, cock's-foot, false oat-grass Relationship to NVC: scattered trees and scrub among grassland vegetation (e.g. U4, H10, CG2, CG3, CG9, CG10, U17, W25, MG1, MG5, W19, W20). In poorer condition, scattered trees might occur among agriculturally modified grassland (MG6 and MG7 with ryegrass, white clover, etc.) or other land uses such as arable.

Wet Upland (WU)



Wooded habitats on very damp or seasonally waterlogged soils in upland or more northerly and westerly areas, typically on gleys (but not deeper peats) and alluvial soils beside watercourses or waterbodies, in floodplains or other land with high water tables.

Many priority species are associated with these wooded habitats. Birds of denser young groves include willow tit, while reed bunting might occur in more open wooded habitats. Damp, open wooded habitats and glades can support butterflies and moths, such as small pearl-bordered fritillary, chequered skipper, marsh fritillary, Scotch argus and argent & sable. The moist conditions in denser groves are important for invertebrates like craneflies, including specialists of damp decaying wood, while damp transitions to more open glades are important for soldier flies and rare pot beetles. Rare plants include northern hawk's-beard, elongated sedge and yellow star-of-Bethlehem. The combination of these wooded habitat structures will support many more widespread species, including those associated with the tree species and wider vegetation.

Wet upland grove (WU-gr)

ADAM BURTON / WTML

Wet upland open wooded habitat (WU-owh)

GUS ROUTLEDGE

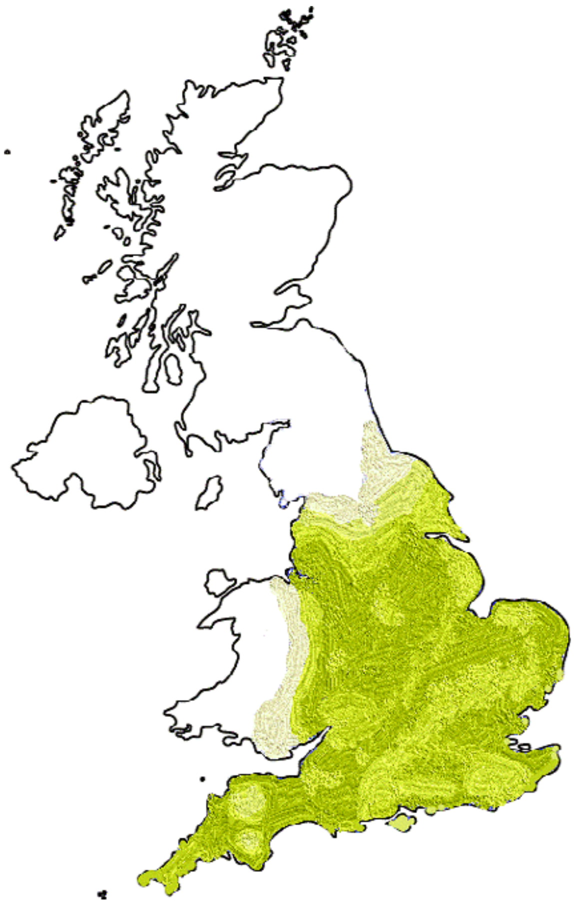
Wet upland glade (WU-gl)

ALASTAIR HOTCHKISS

Table 5.3

Wet Upland – groves **(WU-gr) >70% canopy cover**	**Wet Upland – open wooded habitats** **(WU-owh) 20–70% canopy cover**	**Wet Upland - glades** **(WU-gl) <20% canopy cover**
Trees: **alder, downy birch, sessile oak, Scots pine (local), ash, holly, wych elm, crack willow (local) and white willow (local) on some alluvial or riparian areas** Field-layer positive indicator examples: tufted hair grass, creeping soft grass, yellow pimpernel, remote sedge, wood horsetail, broad buckler fern, ivy, narrow buckler fern, smooth-stalked sedge, purple moor-grass, wood sorrel, wood avens, moschatel, bugle, enchanter's nightshade, opposite-leaved golden saxifrage, bearded couch, and mosses, including *Brachythecium rutabulum, Thuidium tamariscinum, Sphagnum spp.* Relationship to NVC: including a number of the wetter woodland NVC communities (e.g. W3, W4, W7), but often with transitions to drier communities (e.g. W9, W11, W17).	Trees: **alder, downy birch, grey willow, goat willow, bird cherry (local), aspen, holly, elder, guelder rose (local), bay willow (local), eared willow (local), alder buckthorn (local), sessile oak, ash, purple willow (local), dark-leaved willow – riparian (local)** Field-layer positive indicator examples: wild angelica, purple moor-grass, tufted hair grass, hogweed, cow parsley, meadowsweet, water avens, common valerian, hemlock water dropwort, narrow buckler fern, bittersweet, yellow flag, red currant, purple loosestrife, greater wood rush, red campion, butterbur, wood cranesbill, melancholy thistle, garlic mustard, stinging nettle, marsh thistle, globeflower, marsh hawksbeard, marsh marigold, reed canary grass, greater bird's-foot trefoil, marsh bedstraw, tufted vetch, and mosses, including *Brachythecium rutabulum, Thuidium tamariscinum, Sphagnum spp.* plus any additional species from either WU-gr or WU-gl lists Relationship to NVC: more open wooded habitats in transition between wooded communities (e.g. W3, W4, W7, W9, W11, W17) and some open mire and damp grassland vegetation (e.g. MG9, MG13, M15, M23, M25, M27, M28, M36)	Trees: **grey willow, goat willow, bay willow (local), eared willow (local), holly, elder, guelder rose (local), alder buckthorn (local), bird cherry (local), aspen, purple willow (local), dark-leaved willow – riparian (local), alder, sessile oak, downy birch** Field-layer positive indicator examples: meadowsweet, marsh thistle, greater bird's-foot trefoil, Yorkshire fog, marsh bedstraw, ragged robin, yellow flag, cuckooflower, common sorrel, hemp agrimony, soft rush, jointed rush, sharp-flowered rush, marsh marigold, bottle sedge, Devil's-bit scabious, great burnet, tufted vetch, purple moor-grass, tufted hair grass, and *Sphagnum spp.* Relationship to NVC: scattered trees and scrub among damp open mire vegetation (e.g. NVC M15, M23, M25, M27, M28, M36), damp grasslands (e.g MG4 [rare]), or wetter swamp vegetation (e.g. NVC S4, S9). In poorer ecological condition it might include some seasonally flooded, agriculturally modified grassland (MG6, MG7, MG10) or arable.

Acidic Lowland (AL)



Wooded habitats on relatively acidic, dry and infertile soils in the lowlands, particularly in the drier southeast, typically on moderately acidic brown earths, podzols, base-poor groundwater gleys, sands, gravels and old alluvium.

Many priority species are associated with these wooded habitats. In more open wooded habitats, butterflies include white admiral, heath fritillary, pearl-bordered fritillary, and green hairstreak. Sunnier, open wooded habitats and glades could support red wood-ant colonies, adder, lizards, and solitary bees and wasps on lighter soils. Birds of denser wooded groves might include nightingale and marsh tit, while more open wooded habitats and glades may support tree pipit and woodlark. Colourful waxcap and coral fungi might occur in open grassier glades. The combination of these wooded habitat structures will support many more widespread species, including those associated with the tree species and wider vegetation.

Acidic lowland grove (AL-gr)

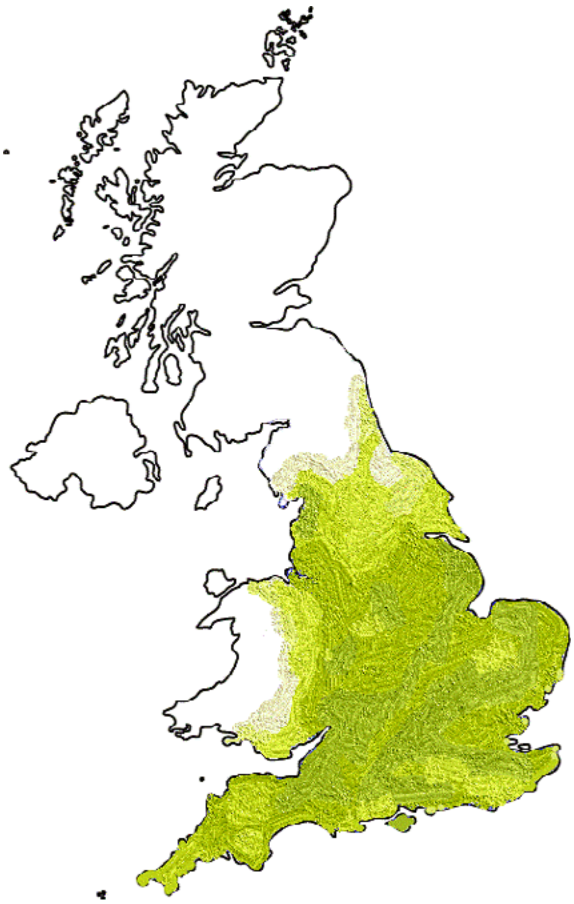
Acidic lowland open wooded habitat (AL-owh)

Acidic lowland glade (AL-gl)

Table 5.4

Acidic Lowland – groves **(AL-gr) >70% canopy cover**	**Acidic Lowland – open wooded habitats** **(AL-owh) 20–70% canopy cover**	**Acidic Lowland – glades** **(AL-gl) <20% canopy cover**
Trees: **pedunculate oak, sessile oak (local), silver birch, downy birch (local), hazel, beech (local), hornbeam (local), holly** Field-layer positive indicator examples: bluebell, creeping soft grass, wood anemone, honeysuckle, scaly male fern, male fern, ivy, broad-buckler fern, wood sorrel, butcher's-broom, and mosses, including *Mnium hornum, Plagiothecium undulatum, Thuidium tamariscinum* Relationship to NVC: the denser wooded groves (e.g. NVC W10, W14, W15 W16, transitional to W11 and W17 on edge of range).	Trees: **pedunculate oak, sessile oak (local), silver birch, downy birch, hawthorn, rowan, holly, aspen, hazel, goat willow, grey willow, crab apple, wild cherry, beech (local), hornbeam (local)** Field-layer positive indicator examples: wild roses, brambles, pignut, heather, bilberry, raspberry, wavy hair grass, heath speedwell, common dog violet, betony, heath cudweed, bitter vetch, honeysuckle, bluebell, wood spurge, common cow-wheat, slender St. John's-wort, goldenrod, greater wood rush, false oat-grass, Yorkshire fog, cock's-foot, climbing corydalis, greater stitchwort, tufted hair grass, hairy wood rush, creeping soft grass, hogweed, rosebay willowherb, gorse, broom, bracken, foxglove, red campion, wood sage, plus any additional species from either AL-gr or AL-gl lists Relationship to NVC: more open wooded patches (e.g. NVC W10, W16) in mosaic and transition to scrub (e.g. W23, although some scrub ecotones not well described by NVC), acid grassland and ferns (e.g. NVC U4, U2, U20) and acidic heath vegetation (e.g. transitional to H4, H8, H9, H12, H18).	Trees: **pedunculate oak, sessile oak (local), silver birch, downy birch, hawthorn, rowan, holly, aspen, hazel, goat willow, grey willow, crab apple, wild cherry, beech (local), hornbeam (local), blackthorn, elder, guelder rose** Field-layer positive indicator examples: heath bedstraw, tormentil, heather, bilberry, Yorkshire fog, sheep's fescue, red fescue, common bent grass, sweet vernal grass, common sorrel, heath speedwell, gorse, wild roses, wavy hair grass, sweet vernal grass, early hair grass, sheep's sorrel, changing forget-me-not, trailing tormentil, betony, bitter vetch, common dog violet, harebell, Cladonia lichens, mouse-ear hawkweed, and mosses, including *Rhytidiadelphus squarrosus* Relationship to NVC: scattered trees and scrub among more open semi-natural acid grassland and fern vegetation (U1, U2, U3, U4, U20) and acidic heath vegetation (e.g. H4, H8, H9, H12, H18).

Base-rich Lowland (BL)



Wooded habitats on dry, base-rich, calcareous to neutral soils in the lowlands or more southerly regions. Typically on soils overlaying limestones, calcareous shales and clays and heavy lime-rich deposits like boulder clay. Soil types include rendzinas, calcareous brown earths, basic brown earths and some base-rich groundwater gleys. These may range from infertile to more fertile soils.

Many priority species are associated with these wooded habitats. Denser groves might support species such as nightingale, marsh tit and song thrush, while scrubby or open-structured areas support bullfinch, tree sparrow, turtle dove, barn owl and yellowhammer. Open wooded habitats and glades might support butterfly priorities, including Duke of Burgundy, grizzled skipper, brown hairstreak, black hairstreak or bees, such as the shrill carder bee. Rare plants like wood calamint, spreading bellflower, and crested cow-wheat are also generally associated with more open wooded habitats and transitions to glades, while some denser groves might support rare helleborine orchids. More transitional mosaics of open wooded habitats and glades might support insects, including various blue butterflies, woodland grasshopper and glow-worms. The combination of these wooded habitat structures will support many more widespread species, including those associated with the tree species and wider vegetation.

Base-rich lowland grove (BL-gr)

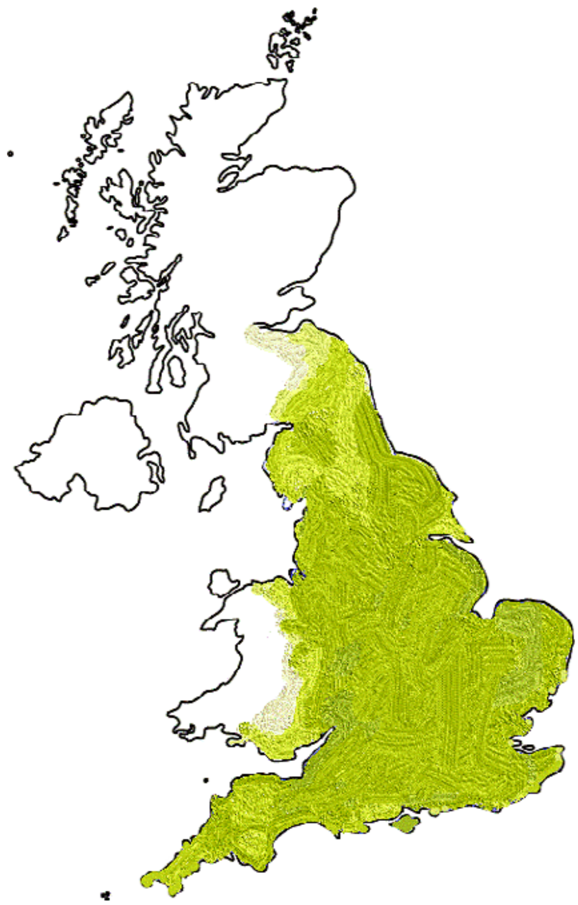
Base-rich lowland open wooded habitat (BL-owh)

Base-rich lowland glade (BL-gl)

Table 5.5 Table 5.5

Base-rich Lowland – groves (BL-gr) >70% canopy cover	Base-rich lowland – open wooded habitats (BL-owh) 20–70% canopy cover	Base-rich Lowland – glades (BL-gl) <20% canopy cover
Trees: **ash, wych elm, field maple, silver birch, pedunculate oak, downy birch (damper), hazel, beech (local), hornbeam (local), small-leaved lime (local), large-leaved lime (local), sessile oak (local), Midland hawthorn (local), yew** Field-layer positive indicator examples: dog's mercury, lords-and-ladies, ramson, bluebell, wood anemone, primrose, early dog violet, yellow archangel, wood avens, herb paris, toothwort, enchanter's nightshade, ivy, woodruff, three-nerved sandwort, wood sedge, sanicle, black bryony, herb-robert, wood avens, spurge laurel, hairy brome, wood melick, male fern, broad buckler fern Relationship to NVC: the denser wooded groves (e.g. NVC W8, W12, W13).	Trees: **downy birch, silver birch, holly, crab apple, rowan, aspen, grey willow, pedunculate oak, ash, wych elm, field maple, wild cherry (local), common whitebeam (local), hornbeam (local), beech (local), sycamore (local), small-leaved lime (local), wild service (local), sessile oak (local), hazel, yew, Midland hawthorn (local), spindle, privet, hawthorn, guelder rose, dogwood, purging buckthorn (local), wild service (local)** Field-layer positive indicator examples: red campion, greater stitchwort, wild roses, brambles, giant fescue, garlic mustard, white bryony, wild clematis, hogweed, deadly nightshade, wild liquorice, cow parsley, foxglove, common calamint, wild basil, hedge woundwort, lesser burdock, wild strawberry, saw-wort, wild marjoram, perforate St John's-wort, nipplewort, agrimony, wood sage, herb-robert, ground ivy, early dog violet, sweet violet, nettle-leaved bellflower, wood spurge, pignut, bush vetch, false brome, hairy brome, cock's-foot, tufted hair grass, false oat-grass, plus any additional species from either BL-gr or BL-gl lists Relationship to NVC: more open wooded habitats in mosaic and transition between denser wooded groves and scrub (W8, W12, W13) to more open neutral grassland (MG1, MG2, MG5) and calcareous grassland (CG2, CG3, CG4, CG5).	Trees: **blackthorn, elder, silver birch, downy birch, guelder rose (local), goat willow, privet (local), dogwood (local), spindle (local), wayfaring tree (local), purging buckthorn (local), holly, crab apple, rowan, aspen, grey willow, pedunculate oak, ash, wych elm, field maple, wild cherry (local), wild service (local), common whitebeam (local), beech (local), sycamore (local), common barberry (local), hornbeam (local), small-leaved lime (local), hazel, hawthorn, yew** Field-layer positive indicator examples: bird's-foot trefoil, common knapweed, oxeye daisy, cowslip, sweet vernal grass, crested dog's-tail, common sorrel, meadow vetchling, tufted vetch, yarrow, wild thyme, sheep's fescue, red fescue, ribwort plantain, lady's bedstraw, rough hawkbit, salad burnet, field madder, fumitories, quaking grass, cock's-foot, ploughman's spikenard, wild parsnip, wild roses, hogweed, field scabious, Devil's-bit scabious, false oat grass, tor-grass, upright brome Relationship to NVC: scattered trees and shrubs among dry, neutral and calcareous grassland vegetation (MG1, MG5, CG1, CG2, CG3). Poorer condition glades may include scattered trees in more agriculturally modified vegetation (e.g. NVC MG7 or arable).

Wet Lowland (WL)



Wooded habitats on wet or seasonally waterlogged soils in the lowlands, particularly in the south and east – typically on alluvial soils, floodplains, beside waterbodies, and on gleys or other soils with high water table (but not deeper peats)

Many priority species are associated with these wooded habitats. Birds of denser young groves include willow tit, while reed bunting and Cetti's warbler might occur in more open, scrubby habitat, and barn owl, snipe and woodcock might be found in mosaics with open glades. Damp, open wooded habitat structures can support butterflies such as the small pearl-bordered fritillary. The moist conditions in denser groves are important for invertebrates like craneflies, including specialists of damp decaying wood. In areas with ponds, damp wooded habitats support great crested newts and other amphibians, while damp transitions to more open glades are important for soldier flies and rare pot beetles. The combination of these wooded habitat structures will support many more widespread species, including those associated with the tree species and wider vegetation.

Wet lowland grove (WL-gr)

Wet lowland open wooded habitat (WL-owh)

Wet lowland glade (WL-gl)

Table 5.6

Wet Lowland – groves **(WL-gr) >70% canopy cover**	**Wet Lowland – open wooded habitats** **(WL-owh) 20–70% canopy cover**	**Wet Lowland – glades** **(WL-gl) <20% canopy cover**
Trees: **alder, downy birch, ash, black poplar (local), holly, crack willow, white willow. Where frequency of inundation is lower: pedunculate oak, wych elm, small-leaved lime (local), hornbeam (local)** Field-layer positive indicator examples: yellow pimpernel, remote sedge, opposite-leaved golden saxifrage, wood sorrel, honeysuckle, dog's mercury, wild garlic, wood anemone, moschatel, bugle, enchanter's nightshade, wood avens, ivy, tufted hair grass, broad buckler fern Relationship to NVC: including some of the wet woodlands (e.g. W2, W5, W6, W7), but sometimes transitional to drier woodland NVC types (e.g. W8, W10) in areas with less frequent inundation.	Trees: **alder, downy birch, grey willow, guelder rose (local), alder buckthorn (local), pedunculate oak, ash, black poplar (local), small-leaved lime (local), goat willow, aspen, holly, elder, hornbeam (local), purple willow (local), crack willow, white willow, osier willow, almond willow, bay willow (local)** Field-layer positive indicator examples: wild angelica, hogweed, cow parsley, meadowsweet, water avens, hemlock water dropwort, butterbur, common valerian, purple loosestrife, creeping Jenny, hemp nettle, marsh thistle, yellow flag, stinging nettle, greater bird's-foot trefoil, bittersweet, hedge bindweed, red currant, marsh bedstraw, garlic mustard, yellow loosestrife, tufted vetch, red campion, marsh marigold, common nettle, tufted hair grass, reed canary grass, plus any additional species from either DL-gr or DL-gl lists Relationship to NVC: more transitional between the woodland NVC communities listed for groves, and patchy mosaics grading into damp grasslands (e.g. MG8, MG9, MG10, MG13) and other tall-herb open vegetation (e.g. OV26, OV24), mire (e.g. M23) or swampy pockets (e.g. NVC S17).	Trees: **goat willow, grey willow, guelder rose (local), aspen, holly, elder, alder buckthorn (local), purple willow (local), osier willow, almond willow, bay willow (local), crack willow, white willow, alder, downy birch, pedunculate oak, ash, black poplar (local), small-leaved lime (local)** Field-layer positive indicator examples: wild angelica, meadowsweet, marsh thistle, greater bird's-foot trefoil, marsh bedstraw, tufted hair grass, hemp agrimony, common fleabane, ragged robin, cuckooflower, common sorrel, yellow flag, Devil's-bit scabious, great burnet, meadow foxtail, marsh marigold, tufted vetch, Yorkshire fog, soft rush, jointed rush, sharp-flowered rush Relationship to NVC: scattered trees and shrubs among damp or seasonally wet grasslands (e.g. NVC MG4, MG8, MG9, MG10, MG11, MG13), other open vegetation (e.g. NVC OV26, OV24, OV30, OV31, OV32), or more open swamp communities (e.g. NVC S26, S28) and mires (M23, M24, M28). Agriculturally modified vegetation (e.g. NVC MG7 or S5, or arable).

5.2 Methods: natural colonisation, direct seeding and planting

There are three distinct methods which can be deployed to initiate new woods and trees – natural colonisation, direct seeding, and planting – either as the sole method across a site, or in combination.

The advantages and limitations of each method of initiation need to be weighed up to decide on the balance of **planting, seeding** and **natural colonisation**. This decision is influenced by **what's possible** in terms of site characteristics based on your site assessment, and the **degree of control required** over the spatial configuration, tree species and speed required to deliver your objectives (e.g. for carbon capture, or to meet grant requirements). With careful design and execution, any of the methods can initiate the development of **quality habitats** with **structural complexity**. However, seeding and natural colonisation help to create a more **naturalistic** appearance and can be used alone or **blended** with tree planting.

The chosen method(s) will also influence how **well adapted** the trees will be to current and future site conditions. Adaptation is key to building healthy woodland ecosystems and landscapes that are resilient to locally prevalent threats such as climate change, extreme weather and pests and diseases. For this reason, you should seek to include **regular pulses of natural colonisation** in your plan wherever possible. This can be as either the main component, with some enrichment planting or direct seeding to increase diversity if a few tree species dominate the colonisation, or as smaller pockets near established seed trees. Small-group planting may also increase the speed of establishment, providing a seed source for future expansion by natural colonisation, and perches for seed-dispersing birds.

5.2.1 Natural colonisation

Trees initiated naturally from seed carried onto the site by wind or animals must cope with the environmental conditions, competition from other vegetation (including other new trees and shrubs) and other challenges such as the impacts of pests, diseases and browsing pressure. This introduces **selection pressure** and ensures that survivors are **better adapted** to soils, environmental conditions and other challenges [93].

UKFS (biodiversity): *Encourage natural colonisation of native tree and shrub species to promote natural selection and climate change adaptation, and conserve distinctive genetic patterns – especially in and around semi-natural woodlands.*

This has a spatial dimension – trees and shrubs will best initiate and establish on those parts of the site which are most favourable for them. Natural colonisation also has a genetic dimension as competition drives selection of the best adapted trees from the available seed stock. It is, therefore, the best way of establishing new woods and trees which are more **resilient to the impacts of climate change** [94,95].

Natural colonisation can lead to **average stem densities** that are equivalent to, or higher than, those achieved by planting. However, the distribution of stems across the site will usually be more **clumped or patchy** – varying from multiple stems per square metre to widely spaced individual trees with an associated variation in stem diameters [96]. This can make an important contribution to **initiating structural complexity** [54,55].

For these reasons, you should always seek to include natural colonisation in your plan to initiate woodland creation where possible, whether as the primary method for a range of species, or a smaller component alongside planting and/or direct seeding.

The pattern and composition of natural colonisation will be dependent on several factors:

An available **seed source is essential**. How close the seed source needs to be will depend on the tree species and its method of **seed dispersal**. Some wind-blown seeds may disperse over great distances, others may be dependent on birds or other animals to disperse the seeds, while those tree and shrub species which spread mostly by vegetative growth (suckering), or direct seed fall, may have limited dispersal ability [97]. Further information on the dispersal characteristics of individual species is provided in the **Tree Species Handbook**.

In some locations, such as exposed upland sites, a lack of available seed sources may limit the establishment of new woods and trees through natural colonisation [98]. For sites adjacent or very close to **ancient woodland**, then natural colonisation is almost always more achievable and appropriate [26]. In general, stem density is likely to be higher close to existing woods, trees or hedgerows [99–101] and lower at a greater distance from the seed source [102].

Seed germination and the emergence of saplings can be limited by the **site characteristics, soils** and **existing vegetation**. Environmental conditions, including exposure and variation in soil moisture, will affect natural colonisation. Colonisation is likely to be limited on both nutrient-rich soils, where competition from other plants inhibits establishment, and on degraded soils. Soils of low to moderate fertility are likely to be considerably more favourable for tree establishment through natural colonisation [103]. Dense grass swards and bracken litter can prevent seed from reaching the soil surface, thus colonisation is likely to be more successful in scrub and tall herb where suitable 'microsites' occur at higher frequency [98,104]. **Ground preparation** (scarification or other disturbance) could create suitable conditions in dense swards.

Seed predation and **browsing pressure** will also affect the density and species composition of natural colonisation. Seeds and emerging and young seedlings are particularly vulnerable stages in the life of a tree. An assessment of the vole, deer and livestock pressure is required to inform decisions at the initiation phase. Management – via culling, fencing and/or tree shelters – is likely to be required on many sites to promote successful colonisation.

Other considerations of colonisation

Natural colonisation requires an acceptance of some unpredictability and relinquishment of control. The **species composition** is likely to differ from planted trees. Pioneer species – for example, birch, willow, and hawthorn – are likely to dominate in the early years of establishment [105], with a gradual transition to more shade-tolerant species as the site develops [106].

Timescales for the establishment of some tree species and structures can be considerably longer than planted trees, as open areas and scrub persist [55]. These **early successional habitats** provide high floristic diversity [106] and can be valuable for bird and invertebrate life. Colonisation progresses in stages as pioneer trees change the site conditions, creating microclimates favourable for other tree establishment, and attracting (seed dispersing) birds and animals to the site [103]. Thorny and unpalatable pioneer species also protect the second wave of colonisers from large herbivores [70,107].

5.2.2 Direct seeding

Direct seeding (i.e. broadcasting or sowing tree and shrub seed onto prepared ground) can be an effective method for initiating new woods and trees, although it is relatively untested in the UK compared to other methods.

Direct seeding shares many of the benefits and challenges of natural colonisation. Seeds will be subject to a range of environmental pressures, such as waterlogging, drought and frost, which will affect their germination and early seedling survival [108]. These pressures drive competitive selection and ensure the establishment of trees that are **well adapted to site conditions.** The **initial distribution** of trees and shrubs through direct seeding can be shaped according to your design and will also be influenced by natural processes and selection pressure.

Seeding is not dependent on the presence of an existing seed source. This can help to overcome one of the main barriers to natural colonisation and gives the potential for greater control over the **species composition** of new woods and trees. Pioneer species can be mixed with longer-term species to form naturalistic looking young woodlands with relatively high early structural diversity. Some tree species will establish more successfully through direct seeding than others and this will influence the species composition of the resulting woodland. Seed size, susceptibility to predation and browsing, and germination stimulus (stratification), will influence the success of establishment. Oak, birch, rowan, alder, wild cherry, ash and field maple, along with a wide variety of native shrubs, can all establish successfully from seeding [109].

Seeded trees may overtake planted counterparts due to their more robust root to shoot ratio and the absence of 'transplant shock'. They can provide early structure and cover, enhance site microclimate and build soil and carbon levels.

Seeding can produce average stem densities similar to planting [110], but distribution is almost invariably **patchy** across a site [111,112]. This can result in a more natural and complex woodland structure [113], including more varied patches of open ground and scrub [114].

Like natural colonisation, successful seeding is dependent on **site characteristics** and **existing vegetation** for germination and emergence. Significant **ground preparation or vegetation management** may be required, especially on sites dominated by grasses or bracken, to reduce competition during germination and emergence [113]. There are examples of successful use of direct seeding in the uplands, although these are more often for restocking clearfelled plantation sites than the creation of new woods and trees [114].

Seed predation can reduce the success of seeding, especially where seed is **broadcast** onto the surface rather than **sown** into cultivated soil. Seed predation by small mammals is variable between sites. Dense ground vegetation, especially grasses, can provide ideal habitat for small mammals. Trees with smaller seeds, hard seed cases or chemical defences, including hawthorn and wild cherry, will be less affected [115]. Seed is often sown at high density to mitigate the losses from seed predation. This can be costly, and sowing density and method should be informed by an assessment of the small mammal population.

Consider protecting emerging trees and shrubs from **browsing pressure** through site preparation, individual tree protection and/or rabbit or deer fencing [113].

Direct seeding can be tailored to meet different **site conditions** and **objectives**:

Seeding is potentially cheaper and more sustainable than planting nursery-grown saplings. For example, it can have low handling, storage and transport costs; lower ground preparation and tree protection costs (e.g. shallow cultivation); low sowing costs; and no stake or tube protection required. It may provide a good option in **upland situations** with difficult terrain for planting/deep cultivation, or with reduced soil biota where seeding pioneers can help restore soil fertility. Where browsing animals are present, direct seeding sites will need to be protected (see 'Planting', page 233).

In areas planned as **groves**, where a rapid establishment of trees and a high stem density is desirable, then more intensive **ground preparation** may be required. Competitive vegetation can be reduced by scarification and even by combining this with herbicide treatment on more fertile sites [116]. Direct seeding can work very well on poor mineral soils – with seed sprayed on bare soils.

On **arable sites**, sowing with a cover crop of wheat, barley or wild flowers may reduce seed predation, weed competition and herbicide use. This also has the potential for application in **agroforestry** where agricultural seed drills can sometimes be used for tree seed in row cultivation. Cover crops can add a short-term pollinator resource and reduce soil erosion.

In areas planned as **open wooded habitats** or **glades**, a random strewing of a seed mixture across a site with limited ground preparation is more likely to produce a naturalistic woodland with a stratified structure [117] and a wide variety of stem densities [113]. The range of microclimates and varied light conditions can provide a diversity of niches and enable early colonisation by other plants [117].

The **timescales** for direct seeding are more predictable than for natural colonisation and its success can be evaluated as early as the second or third year after seeding. This means that further interventions can be planned where necessary to meet short-term site objectives or funding requirements [117].

Example of a direct seeding area and a planted area at Comfort's wood in 2003

Comfort's Wood, Cranbrook, Kent

Several lowland arable fields were **directly seeded** in 1991, alongside a conventionally planted area. The site had only just come out of arable use and seed was sown onto recently ploughed bare ground with no additional ground preparation. The mix contained 35% oak, 30% ash, 10% hornbeam, 5% sweet chestnut, 10% field maple, and 10% shrubs. Couch grass developed and dominated the area after sowing. This appeared to be slowing the development of seedlings and was treated with herbicide during the first winter. No further management of vegetation was required. The site was fenced to exclude rabbits, but deer fencing was not considered necessary on this site.

The direct seeding area developed into dense woodland of a random, natural appearance, dominated by oak after 15 years, with a good shrub understorey of guelder rose, hazel and hornbeam, with naturally regenerating ash and goat willow. Stocking and form are very good (2–5 trees per square metre and 5–6 metres tall), with a greater degree of canopy closure than the adjacent conventionally planted area.

In 2011, an additional area of grassland (9.1ha) and ancient woodland (2.4ha) was acquired adjoining Comfort's Wood, and named Barnett's Wood. Secondary woodland was created either side of the ancient woodland on the grassland in Barnett's Wood between 2012 and 2013 by a combination of tree planting by volunteers at public planting events and by allowing areas to develop naturally.

CASE STUDY

Sixty-nine species of flowering herbs have been found in the new woodland and wide-ride habitat at Comfort’s and Barnett’s Woods, including angelica, common bird’s-foot trefoil, creeping cinquefoil and common fleabane. Grasses, such as Yorkshire fog and rough meadow grass, dominate the rides and there is a good array of other wild flowers, including thistles and common knapweed, to provide pollen and nectar sources for invertebrates. Seven ancient woodland indicator species have been found along the new woodland edges, including bluebell and pendulous sedge. The mix of ancient woodland and young developing woodland has provided habitat for 18 species of butterfly, such as common blue, gatekeeper, large and small white and small copper; and the 37 species of birds, including nightingale, turtle dove, bullfinch, linnet, willow warbler and goldcrest, which have been recorded on site.

CASE STUDY

Penguin Wood, Derbyshire

An area of mixed pasture and arable was **directly seeded** in 2004. The existing vegetation was treated with a single herbicide application and the site was deep ploughed. The **soil inversion method** was supplemented by the sowing of a no-grass wildflower mix. The site was fenced to exclude rabbits, but deer fencing was not considered necessary on this site. A raptor perch was also installed.

The site remained free from colonising competitive plants during initial establishment, but the wildflower cover crop may itself have suppressed the emergence of some trees and shrubs.

Establishment rates were lower and trees smaller than in an adjacent planted area and varied between species, with oak, cherry and birch establishing more successfully than ash and field maple. No rabbit or vole damage was observed during establishment.

Canopy cover is patchy, and the site is forming a diverse, open wooded habitat structure with a random spacing of trees and shrubs. Wild flowers continue to dominate in some open areas and others have been colonised by heathland species and scrub. There has been a significant wildlife response and the biodiversity benefits are apparent.

Penguin Wood, Botany Bay

5.2.3 Planting

Planting is the most widely used method for establishing new woods and trees and is the approach that offers the greatest **degree of control**. Planting can be matched to a detailed spatial design and can deliver against many objectives quickly and effectively.

Planting is likely to be the most appropriate method where **rapid establishment** is required, when **particular tree species** are needed in **specific locations**, and where there is **no suitable seed source** [118]. Planting is also a great way of getting **people involved** in a project.

Planting layouts can be adapted to increase variation in groves, while maintaining an overall density of 1600–2500 stems per hectare (variable density planting diagram based on approach by James Russell, Forest of Marston Vale).

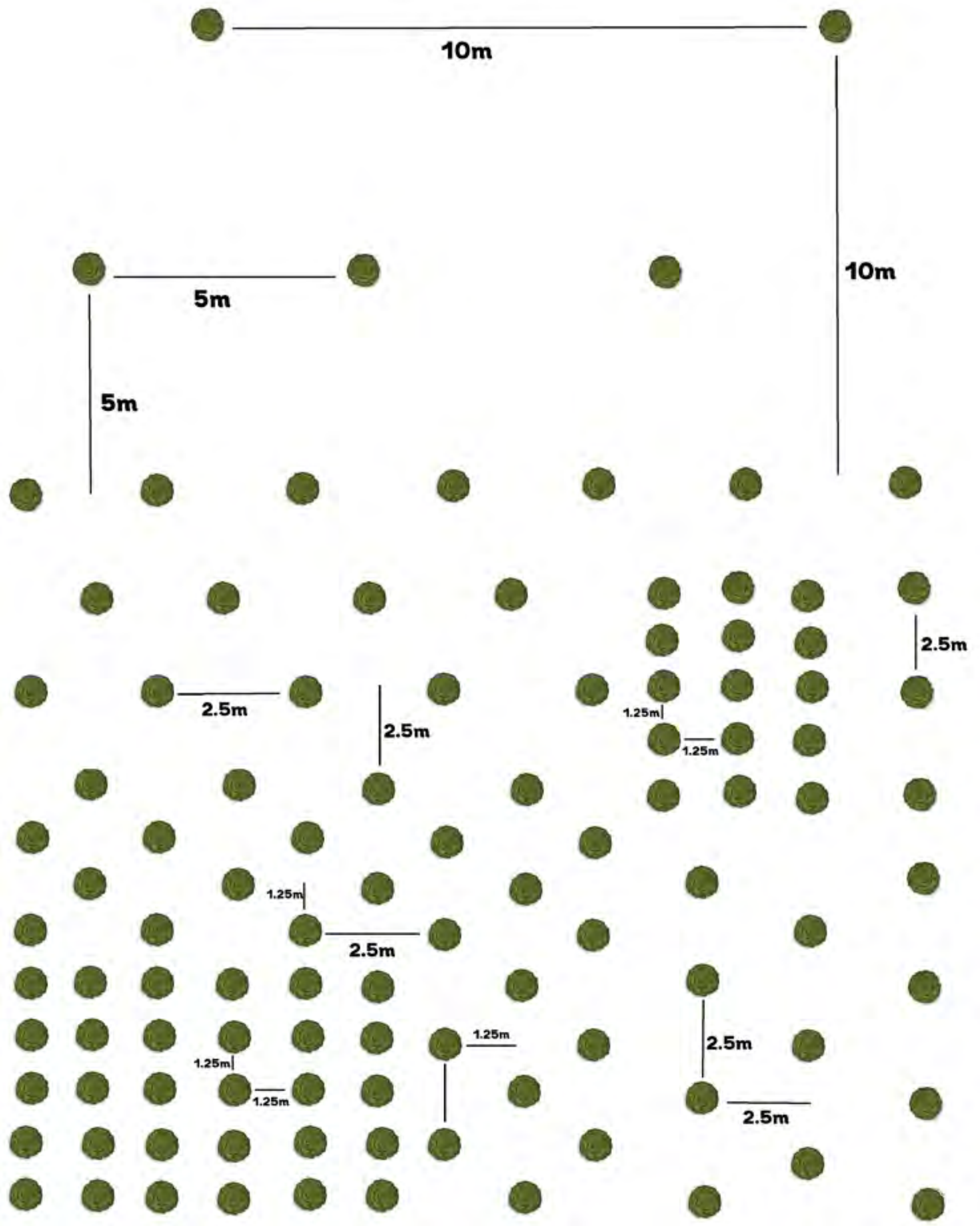


Figure 5.1

Propagation of trees in controlled conditions in a tree nursery **eliminates site-specific competitive selection** at the germination and emergence stages. Ground preparation, weeding of competitive vegetation, and protection of planted trees and shrubs from browsing, further eliminate competitive selection in the young trees. For this reason, planted trees will be **less well adapted to site conditions** than trees and shrubs established through natural colonisation or direct seeding. It may be possible to mitigate this to some extent through the selection of local provenance tree stock and careful matching of tree species to soil types, but this will not replicate competitive selection achieved with natural colonisation from a genetically diverse seed source.

All young trees are susceptible to **browsing pressure** and damage from vole, rabbit, grey squirrel, deer and livestock. Planted trees are introduced with greater height and stem size than naturally colonising and direct-seeded trees, thus the period of risk is theoretically shorter. However, planted trees may exhibit slower growth rates – especially if they are poorly matched to the site, are suffering 'transplant shock', or experience extreme weather before they are well established.

The production of planting stock is **resource intensive**, requiring seed collection, controlled germination, care in tree nurseries and transportation. It is important that tree planting is planned and carried out to maximise tree survival rates, although some loss of planted trees is almost inevitable and should be anticipated. A combination of deer culling, tree shelters, tree tubes and/or fencing is likely to be required on most sites to protect trees from browsing pressure and ensure successful initiation.

The **spatial pattern** of planted trees can, in theory, be delivered according to any design. Trees can be planted at any density and spatial configuration from three or more trees per square metre through to widely spaced individual trees. Densities of between 1,600 and 2,500 stems/ha (or higher) are designed to aid early canopy closure. These are appropriate for the establishment of **groves**, where regular management is anticipated to promote the development of structural complexity, and as areas where limited intervention can enable competitive exclusion – promoting decaying wood development and other processes.

Where more **patchy spatial patterns** are required, such as in **open wooded habitats** and **glade** areas, planting will need to be carefully planned and carried out to mimic the patchy establishment achieved through natural processes.

The **species composition** of planted trees can be precisely controlled according to the agreed design. It is possible to create species-rich woodland reflecting the local woodland character and the objectives of the project. Planting can combine pioneer and climax species, and through a combination of careful design and well-planned initiation it is possible to provide a foundation for the development of structural complexity with patches of different successional stages [119]. Planting can also be used to restore tree and shrub species which have been lost or are at risk in the landscape, such as montane scrub [120].

5.2.4 Choosing the right method(s)

Different methods of initiation can be **combined or blended** based on the:

- **site characteristics** (soils, hydrology, aspect, elevation or exposure, which should be matched to the method of initiation to create patchiness across a site as characteristics vary)
- existing **features** of the site (e.g. land adjacent ≤ 50 metres to existing native woodland or large seed-bearing trees, which will often indicate that woodland expansion through natural colonisation is both highly achievable [26] and most appropriate)
- different **structural components** in your design (for **dense groves**, planting may be the default option on many sites, but direct seeding and natural colonisation can often produce a higher density of trees. For more **open wooded habitats**, patchy natural colonisation can be ideal, and blended approaches with planting may also work well. For individual open grown **trees**, particularly where they are required in a specific location (street trees, avenues, agroforestry, etc.), then planting is usually needed.

Time sequence (top to bottom) showing tree cover expanding via tree growth and colonisation in three different scenarios: natural colonisation (left), applied nucleation planting or seeding (middle), and plantation (right) (Based on Corbin and Holl[121]).

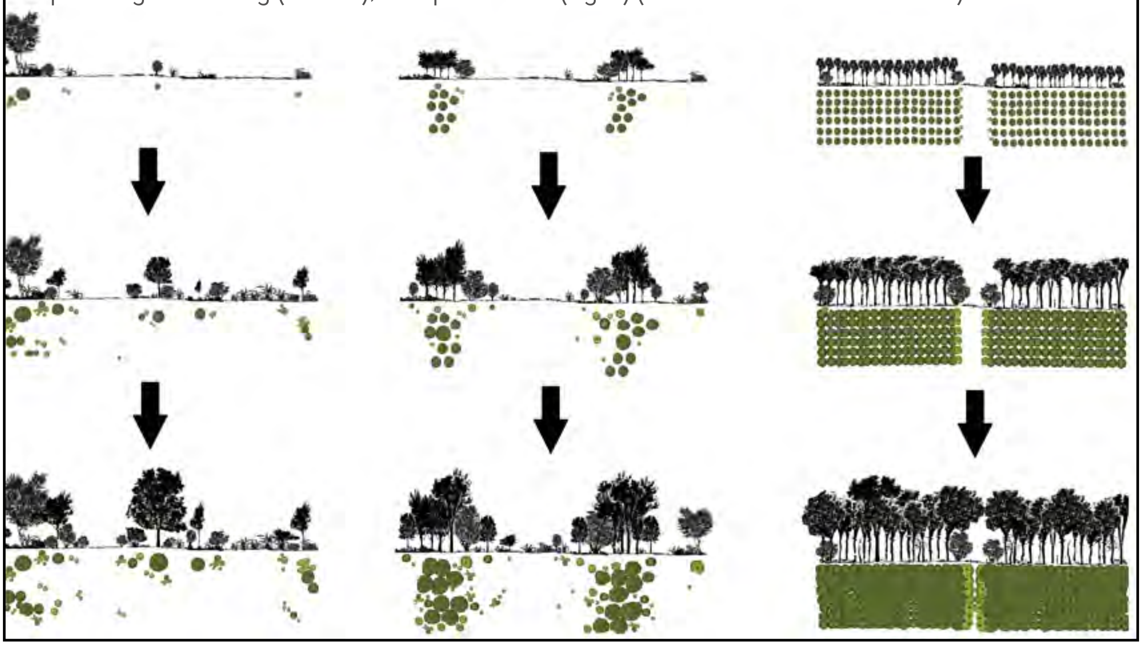


Figure 5.2

Different **tree species** may be suited to different methods of initiation. Distinguish between pioneer species (birch, willow, hawthorn, rowan) and those tree species representative of more mature woodland. Pioneers can disperse large numbers of seed over longer distances and naturally colonise ground where conditions are favourable. Direct seeding can be most successful for small seeded trees, including alder and rowan [114].

Planting may be the only realistic way to initiate poor dispersers like aspen, small-leaved lime or spindle, or species such as oak and hazel where they do not occur near a site. Generally, where tree species are well represented in the vicinity, it may be unnecessary and inappropriate to plant. The **Tree Species Handbook** provides information on the dispersal and establishment characteristics of 50 tree species of most relevance to woodland creation.

It may not be desirable to initiate the whole of the creation design in a single moment. A naturally functioning ecosystem will take time to develop following the initiation of new woods and trees. **Phasing the initiation** of trees on the site over, say, 10 years, provides time and space for further natural colonisation. This may also allow other habitats and species to emerge as the vegetation changes. Decisions on further *planting* can be made later in the establishment phase, based on observations of site development.

Planting a much smaller number of trees, at a low stem density or in widely spaced clumps is a technique described as **facilitation, framework** or **nucleation planting**. Such trees create microclimates and provide perches for birds – kick-starting natural colonisation – and over time provide a localised seed source themselves [121,122]. These are well-established methods for tropical forest restoration and building evidence of their efficacy in creating our native woodlands is a priority. Facilitated planting sites may develop more quickly than natural colonisation alone and help to accelerate the creation of valuable complex habitat structures.

Useful resources

- **Creating new broadleaved woodland by direct seeding** (Forestry Commission, 2004). Useful technical guide to amounts of seed required by area and other aspects.
- **Direct seeding for the restoration of upland native woodland** (Willoughby et al. 2019). Evidence and advice on direct seeding in upland situations.
- **Wood Wise: Woods in waiting** (The Woodland Trust, 2020). Articles exploring the pros and cons of natural colonisation.

CASE STUDY

BEN HARROWER

Mixed arable and pasture with established hedgerows and mature trees. An extension to the ancient woodland of Pepper Wood.

Expanding Pepper Wood – putting principles into practice

A new project is currently underway to expand woodland northwards from Pepper Wood, an ancient woodland and Site of Special Scientific Interest on the outskirts of Bromsgrove. The Woodland Trust has owned and managed the existing 60ha Pepper Wood, with its important botanical features, since the 1980s. Using the structural components of groves, open wooded habitats and glades, and by blending different establishment methods, a rich mosaic of woodland habitat will be created to extend and buffer Pepper Wood by a further 50ha.

The design for the woodland expansion onto currently mixed farmland has been achieved through a systematic process. A site assessment was undertaken which identified the locations of service lines, such as a gas pipeline and overhead power-cables. Existing features, including hedgerows, veteran trees, groves, ponds and viewpoints, were recorded and mapped. Checks with Worcestershire County Council ensured there were no negative impacts of woodland creation on archaeological features and landscape character. Ecological surveys were conducted to record existing habitat value and the presence of any species that would need special consideration. The tree sparrow was one of the species identified. An independent landscape designer led the design process to ensure rigour and objectivity.

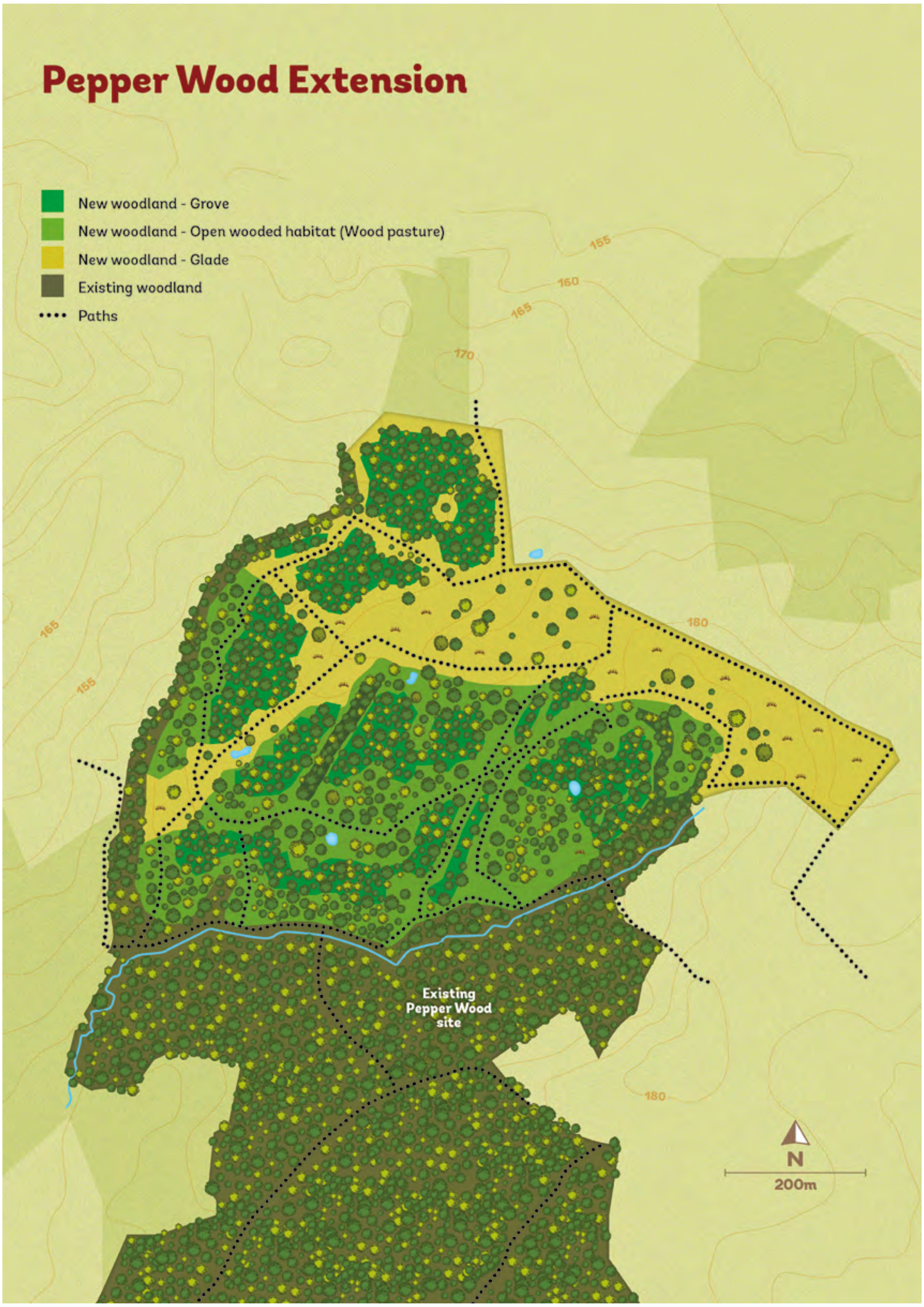
CASE STUDY

The resulting design includes denser woodland on lower ground and more open wooded habitats on higher ground, preserving long-range views to the Malvern Hills. Overall, it seeks to create a woodland with a diverse structure of groves, open wooded habitats and scrub-rich glades.

A proportion of the woodland habitat will be initiated via natural colonisation, making full use of the seed source from Pepper Wood and existing seed trees present on the land. The interface between open ground and woodland habitat will be 'soft' – achieved through a variable 'naturalistic' tree-planting matrix and developing scrub. There will be a substantial amount of woodland edge habitat, which will conserve existing hedgerows and groves. This will especially favour tree sparrow populations as well as a variety of other species. Deer and rabbit fencing will be installed to reduce browsing pressure and help establish the young trees for the first 5–10 years.

The design has been through a consultation process with local people and relevant stakeholders. On-site walks with local people were conducted to explain the design concept and invite opinion through these and an online questionnaire. Statutory organisations such as the Forestry Commission and Natural England, as well as local bodies, including Worcester Wildlife Trust and Worcester County Council, were also consulted. The sympathetic and ecologically based design has been very well supported by stakeholders.

CASE STUDY



Pepper Wood Extension
New woodland - Grove
New woodland - Open wooded habitat (Wood pasture)
New woodland - Glade
Existing woodland
Paths
155
160
165
170
180
165
155
180
Existing Pepper Wood site
180
N
200m

5.3 Provenance choice

Selecting seed and planting stock

At the start of the initiation phase you will have selected the tree and shrub species to include in your project. You will also need to make decisions about the provenance (origins) of any seed or planting stock to be used.

There are two important considerations at this stage: **selecting provenances** that will be well adapted to site conditions and **minimising the risk of introducing pests and diseases**.

UKFS: *Choose trees or shrubs that are well adapted to the site and are drawn from a sufficiently wide genetic base to promote future adaptation. Use the information provided under the Forest Reproductive Material Regulations to establish the origin or provenance of available planting material.*

Provenance

The **provenance of seed and planting stock** describes the geographic locality of a stand of trees from where the seed or cuttings were collected. If these parent trees were planted, their parent seed source or wild ancestors may have originated elsewhere and this may be recorded [123]. Selecting an appropriate provenance is an important decision which can influence tree survival, 'performance' (for any given objective), longevity and reproductive potential.

A key aim of provenance selection is to find seed that will be well adapted to the **prevailing conditions** in which it needs to grow (including soils, elevation, exposure, length of growing season and local disease pressures). More recently, likely future climate projections (such as an increasing average temperature, rainfall fluctuations and more frequent extreme events like droughts and floods) have also led to considerations of whether provenance selection can influence the extent to which trees may be adapted to **future conditions**.

During their lifetime, individual trees can adapt to changes in environmental conditions; for example, by reducing leaf and stomata (pore) size to conserve water in drier years. This ability to respond to changing environmental conditions is known as **phenotypic plasticity**. An individual tree's phenotypic plasticity is finite and if conditions exceed the plasticity limits of the individual, it will die.

Most UK tree populations contain high levels of **genetic diversity** [95]. Common characteristics of trees promote this diversity. The prolific and frequent production of flowers produces a seed crop which is the product of many father trees. The flowers and seed are held high above the ground, and pollen and seed can be dispersed over long distances between sites with very different environmental conditions from those of the mother tree. This continual mixing of local and long-distance geneflow ensures that genetic diversity within a population of trees remains high.

When trees grow through natural regeneration or colonisation from this seed crop, large numbers of seedlings are produced, all of which are individuals that subtly differ from one another in a range of **adaptive traits**. Natural selection promotes the survival of individuals that are best suited to the site conditions they find themselves in. These individuals then breed and produce the next generation. This process allows the tree population to become adapted to the site on which it is growing, even if these conditions change. The end result is locally distinct populations that become differentiated from one another while continuing to maintain a high level of genetic diversity.

This has two important consequences: populations are **adapted to the local site conditions** and yet maintain high levels of **adaptive variation**, which provides them with the means to genetically adapt to novel threats and conditions.

Trees sourced from **local UK provenances** are usually the best option when creating new woods and planting trees in UK landscapes, given the wide genetic diversity within native tree populations. This will help achieve conservation objectives, long-term resilience to climate change, and enhanced biosecurity [95].

Ensure that a range of local provenance seed is utilised to **avoid genetic bottlenecking** that may occur if seed is collected from a small number of trees. As an indicative guide, seed collected from 50 individual trees would be enough to conserve the adaptive traits in tree species that occur as scattered individuals (e.g. yew or wild service), while for stand-forming species, such as oak or beech, 500 individuals is a suitable benchmark, equating to a stand area of around 3–6ha. Some trees propagate vegetatively (e.g. cherry and aspen), producing trees that are clones and, therefore, one individual for the purposes of seed collection [124].

In addition to adaptation to site conditions, the **risk of introducing pests and diseases** (such as ash dieback or *Phytopthoras*) must be considered when selecting provenances of seed, cuttings or planting stock. **Importing planting material into the UK poses a significant biosecurity risk.** Trees should be sourced from within the UK and transport of seed and stock minimised to prevent further introductions or long-distance movement of pests and diseases. It is also important to ensure that planting stock is grown in peat-free substrate.

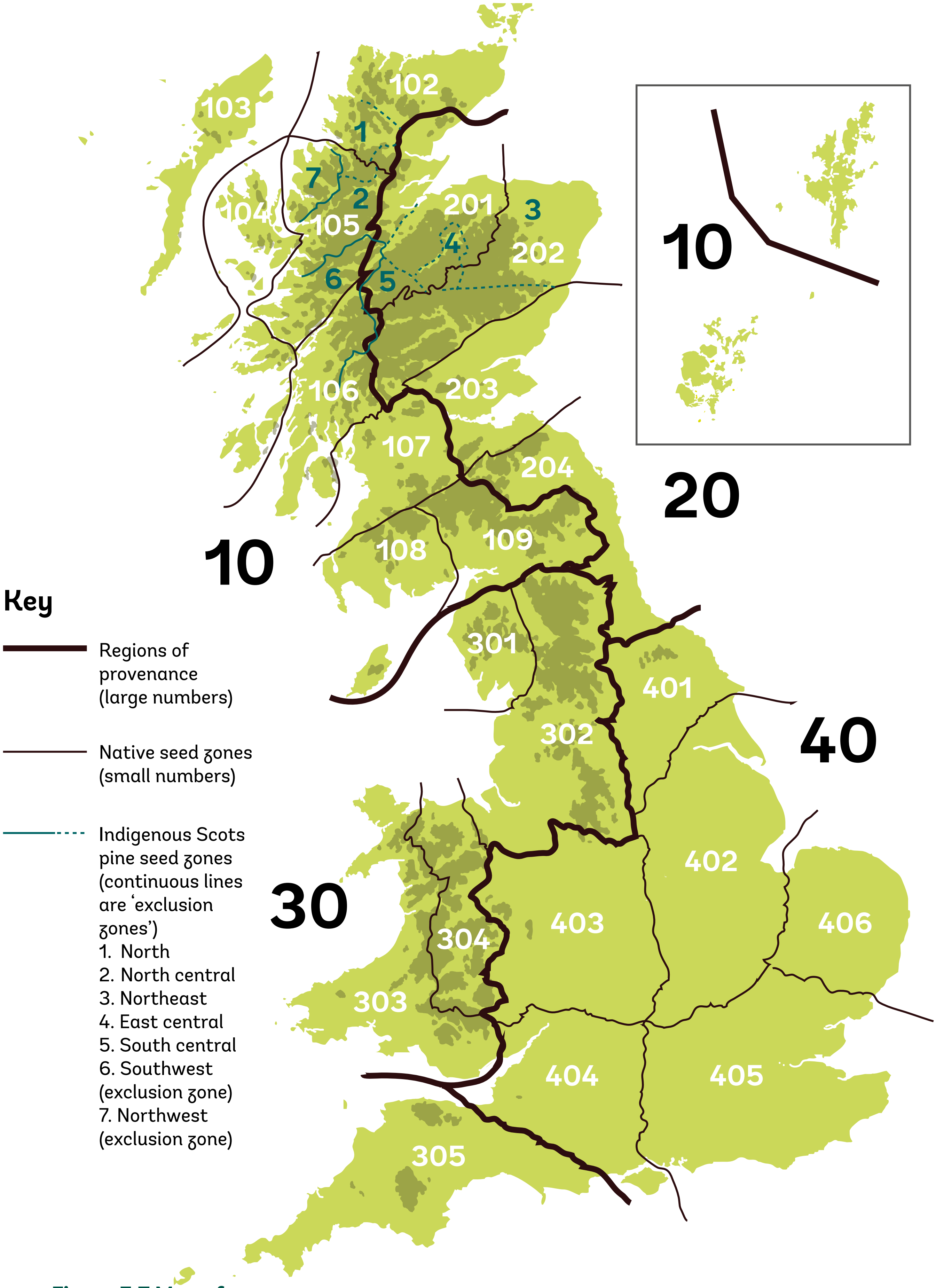


Figure 5.7 Map of provenance zones

Provenance choice hierarchy

Great Britain is divided into four **regions of provenance**. These are defined areas within which broadly similar ecological and climatic characteristics are found. They provide a framework for specifying sources of seed, cuttings and planting stock.

For native species, regions of provenance have been split into 24 smaller native **seed zones,** along with seed zones for indigenous Scots pine which are separately mapped. Seed zones themselves are divided into two **altitude bands**, below and above 300 metres.

- Ideally, seed, cuttings and planting stock will be **locally sourced** from a neighbouring area which closely matches the recipient site conditions (soil, elevation, aspect, exposure). Stock supplied by local or community tree nurseries or grown specifically to meet the needs of larger-scale projects, would be most likely to meet this need.
- For **commercially sourced** planting stock, the best option is **UK and Ireland Sourced and Grown (UKISG) certified stock**, sourced from the same **seed zone and altitude band** as the creation site.
- Where this is not possible, **UKISG certified stock** from the same **provenance region and altitude band** remains a good option and is a frequently used specification for our tree procurement.
- Where selection by altitude band is not possible, then **UKISG certified stock** sourced from the same **provenance region** remains a sound choice for sites which are not at the extremes of elevation or exposure.
- The fall-back option, where planting stock from the same provenance zone cannot be sourced, is **any UKISG certified stock** of the required tree species.

Provenance choice for timber production

If the production of high-quality timber is a priority objective for your project, this may introduce additional considerations on provenance choice.

Growth form can significantly affect the volume of high-value timber that is produced in a stand. Using **specially selected or improved planting stock**, while following the provenance hierarchy, can contribute to the development of stands of trees with clean and straight growth form. This should also be from a range of sources to avoid genetic bottlenecking.

There is some evidence that selecting native trees from provenances 200–550km (2–5 degrees of latitude) further south may help to enhance the future timber yield by matching the trees to the projected climatic conditions 50 years in the future, as the trees reach maturity [123]. This can be a high-risk strategy where it involves planting trees which are not particularly well suited to the current conditions on the site. Tree survival and form may be affected by climate and weather events during the establishment of the trees. The different phenology of the trees (flowering and seeding dates) could limit their value to local wildlife. Introducing trees from distant provenances also increases the risk of introducing pests and diseases. Biosecurity must never be compromised to achieve timber-production objectives, and only UKISG seed and tree stock should be considered [95].

UK and Ireland Sourced and Grown Assurance (UKISG-A)

The Woodland Trust has developed its own bio-security standard known as UKISG Assurance. All Woodland Trust trees are grown under this scheme, ensuring that seed is sourced, and trees are grown entirely within the UK and Ireland. We currently use rolling three-year contracts with the 30 or so UKISG-accredited nurseries to ensure we have trees ready to meet our planting aspirations. When needed, we will set up ad hoc contracts and use spot buying or forward reservations to meet increased demand.

On a few occasions, we may need to use stock that does not meet the full UKISG specification, such as fruit trees for agroforestry and other trees not grown from seed. We have guidance to ensure that due diligence is followed and endeavours are made to use appropriate stock. Early discussion of your anticipated needs will help secure provision of the stock that you need at the right time, to support the outcomes of each project.

Plant Healthy

The wider plant production industry has also recently introduced their own standard, known as **Plant Healthy**. This voluntary standard will hopefully raise awareness of biosecurity responsibilities across industry and beyond. However, UKISG remains the only standard that directly addresses the pest and disease risk from imported trees.

CASE STUDY

Extending and enhancing a small farm woodland through a MOREwoods planting scheme in Devon

Creating farm woodland for wildlife and future generations

George Atkin is a sixth-generation farmer who decided to repopulate his farm with native trees that were sourced and grown in the UK. Through the Woodland Trust's MOREWoods scheme, George planted 0.5ha of trees on his 283ha mixed farm as a block of woodland close to the farmhouse, and as part of an existing small wood to fill gaps in the canopy. The main motivations for planting trees on the farm were to capture carbon and create habitats for wildlife – hence the desire to plant native trees. The trees also act as windbreaks for the productive areas of the farm – offering the sheep protection from the wind – and have greatly enhanced the landscape character, bringing a lot of joy to George and his family.

The two woods were linked up by a 400-metre hedge – an important corridor for wildlife to move between them. A traditional orchard has since been planted, full of local varieties, and more tree planting is planned. In future plantings, to reduce the use of plastic spiral guards, small areas will be fenced off, or trees will be planted more densely to offset losses. Finally, George plans to start collecting tree seed from some of the farm's oldest trees in order to propagate some truly locally sourced and grown trees.

CASE STUDY

Flower-rich sward sown ahead of tree planting on the Lowther Estate. This provides suitable conditons for tree establishment.

Forest of Flowers

Imagine swathes of wild flowers among thousands of young, flourishing trees, visited by a kaleidoscope of bees and butterflies. This is the stunning creation from a pioneering conservation technique to turn degraded land into a beautiful wildflower woodland.

Forest of Flowers is a method of initiating woodland creation and involves sowing a mixture of wildflower seeds on prepared ground. A one-metre deep plough is used to invert the soil profile – burying the fertile, chemical-laden topsoil and bringing up less fertile subsoil – key to reducing surface fertility and weed-seed load. Then, seeds from a suite of between 16 and 20 once common wild flowers, such as agrimony, knapweed, meadowsweet, oxeye daisy, red campion, plantain, yarrow and yellow-rattle, are sown across the site with either tree seed or young saplings.

While the initial investment is high, both in terms of seed costs and soil carbon loss from ploughing, it is thought that the Forest of Flowers approach stores carbon quicker than other woodland creation approaches by accelerating both tree growth and the development of biodiversity-rich habitat. The technique is best used for degraded arable land, which research has shown contains less soil organic carbon than semi-natural habitats, and has already been ploughed. Conversion of arable land to woodland results in huge soil carbon gains.

CASE STUDY

In addition, the wild flowers dominate the ground flora, so no chemical pesticides or fertilisers are applied and manual weeding is not required – eliminating these emission sources from the carbon footprint of the woodland creation project.

The Forest of Flowers process was first trialled by the Woodland Trust in 2005 at a site in Cheshire. Since then we have used the approach many times. A lovely recent example is Home Farm in Yorkshire, a 32ha site now in its fifth year and thriving. The wild flowers start to arrive by May of the year following seeding, peaking in year three. They provide incredible colour and great enjoyment for people. The trees are slower to grow, but by the end of year two their growth rate accelerates.

By year three or four, the tree growth is double the normal rate due to a combination of enhanced mycorrhizal fungal activity, soil moisture balance, decompacted and mineralised soils, and reduced competition.

Wildlife is quick to colonise in huge abundance and diversity, illustrated by ecological surveys at Lowther – a Forest of Flowers site planted in 2019. The field planted with Forest of Flowers had 7–8 times greater abundance of nectar-feeding insects (butterflies, bees and hoverflies) in 2020 than two other fields planted conventionally. Numbers grow as the flowers continue to establish, with many butterfly species increasing in abundance (such as small tortoiseshell and peacock), in contrast with national declines. Flocks of up to 140 small seed-eating birds were also noted over winter. Research into this approach will continue, and hopefully show long-term and sustained increases in biodiversity. It is imperative that new woodlands become established as natural habitat with vibrant wildlife.

PETE LEESON

Flower-rich sward sown ahead of tree planting on the Lowther Estate. The Forest of Flowers methodology creates stunning scenes in the early years of woodland establishment.

5.4 Soils

In the assessment phase you have identified which soil types you have on site, have understood how they will influence your woodland creation, and developed your design accordingly. During the initiation, phase your focus will be on **looking after your soil** and **addressing soil conditions** to enable successful woodland creation.

***UKFS (soils, water and climate change): Soil disturbance**, the risk of pollution to water courses from **cultivation,** and the use of **inorganic fertilisers** should all be **minimised**. Regulatory authorities must be consulted before **applying wastes,** such as waste soils, wood chip or bark, to soils. On **brownfield sites,** particular care should be taken with existing **contaminants** and specialist advice sought on dealing with them. The incorporation of alkaline materials may be necessary to ameliorate excess soil acidity.*

Any intervention on site should minimise soil damage or disturbance from compaction, erosion, pollution and oxidation of carbon [125,126]. The aim is to maintain and, if necessary, restore the biological, chemical and physical processes involved in healthy soils which are required to underpin your new woodland. This means careful consideration of how soils will be affected, protected and managed.

The **construction of infrastructure** such as roading, tracks, hardstanding and foundations for buildings, will require specialist site assessment and the following of any specific guidance to protect soils and water courses.

Ground preparation for the initiation and establishment of trees and wider vegetation could include practices which might damage sensitive soils, such as harrowing, ploughing, subsoiling or mounding. Any cultivation comes with risks, including soil erosion, runoff polluting water courses, nitrification, acidification, oxidisation of carbon and the disruption of complex soil ecosystems. Advice and steps should be taken to minimise soil damage. Natural colonisation or direct seeding could avoid the need for cultivation (but are still likely to need some form of ground disturbance). Use lightweight or low-ground pressure machinery (or horses) to avoid damaging soil structure and soil biodiversity, particularly on wetter or steep sites.

The **addition of materials** onto the ground may affect soils. These include mulches, soil improvers, fertilisers, mycorrhizal preparations, or waste disposal. Knowledge of what you are applying and how it will affect soil properties is essential.

On-going **management practices**, such as weeding, thinning, harvesting and burning, have potential to impact soils. The time of year, along with the current condition of the soil, can be critical. Avoid working in waterlogged or drought conditions, minimise the use of any chemical applications, and burn on raised platforms wherever possible.

Your woodland creation project could provide opportunities to support **peatland restoration** activity, and this will be identified in the site assessment and incorporated in your design. Increasing the water holding and infiltration capacity of any deeper peaty soils which have been drained can be achieved during the initiation phase by blocking drains or adding small-scale dams in gullies to hold back water and re-establish peat formation. Reducing herbivore activity – primarily deer or sheep – through fencing or herbivore population management will enable vegetation recovery on overgrazed peatland habitats[127], as well as benefitting the young trees.

Land which is challenging to farm due to poor drainage and heavy soils, or floodplain land subject to crop-damaging floods, may be a target for woodland creation. Most native tree species can survive **winter waterlogging** when they are dormant, and their deeper roots can also help to lower the water table and protect flooded soils from erosion. During the initiation phase, planting or ground preparation should be undertaken when soils are not waterlogged, as resulting soil compaction can prove difficult to reverse. **Permanently waterlogged soils**, such as spring heads or seepages, should be protected as open glades.

Compacted soils can be caused by arable plough pans (a smoothed surface at 15–30cm depth which can be impermeable to water), heavy machinery, high footfall (people or animals), and urban development. Compacted soils limit tree root depth and thus tree growth beyond a certain size. Decompacting the soil to restore soil processes and structure will enable deeper rooting and stronger growth. Simply reducing the source of compaction and mulching the soil can help, but for more severe compaction, techniques such as very deep ploughing or ripping to break the plough pan, or specialist air-blast decompaction (e.g. in urban parks) can be effective [128].

Some tree species have the potential to thrive in **polluted or toxic soils** where other vegetation cannot, thus restoring contaminated land such as landfill sites or quarries. Such sites will usually require specialist advice to ensure your trees thrive and toxic waste is not released into the environment.

Useful resources

- **Guidance on cultivation and UKFS compliance in England** (Forestry Commission, 2021). Useful information to enable you to meet standards for sustainable soil management.
- **Cultivation guidance for upland productive woodland creation sites** (Scottish Forestry, 2021). As above, for Scotland, with a focus on peat soils.
- **Revegetating landfills and waste contaminant areas** (US Environmental Protection Agency, 2006). Useful guide on revegetating landfill sites (from USA).

5.5 Water

Where your objective is to **improve water quality** (including reducing sediment load, pollutants and providing suitable light levels and water temperature for wildlife), and/or to **reduce local or downstream flood risk** by influencing the quantity and speed of runoff from the site, then your initiation methods can make a difference to short and long-term success. Methods will vary depending on your starting point and specific objectives, which may be combined with nature recovery objectives to **maintain or restore water-based wildlife and habitats.**

For nutrient-rich sites, such as former arable land, clay-rich soils, or on deeper upland soils, a challenge will be initiating tree growth alongside competing vegetation (e.g. a thick grass sward or bracken) without the use of ground disturbance or spraying chemical herbicides which could hamper your water objectives, at least in the short term. Bare ground can lead to soil erosion (especially on sloping or windy sites), faster water runoff, and drought conditions for new trees. Herbicides may pollute rivers and groundwater. In these circumstances, options include:

- adopting herbicide-free buffer zones around water courses
- avoiding using ploughing and mounding planting techniques close to water features
- use of suitable mulches for weed suppression or higher-density plantings.

Interventions that **hold standing water** on the land for longer, such as pools, scrapes and bunds, will help reduce downstream flooding at peak flows (as well as being a great temporary resource for wildlife), and should be undertaken alongside initiation of the trees, ideally using natural materials (e.g. woody dams) where possible. Blocking field drains on former farmland will also enable more natural hydrology to be restored to your site and hold more water on site.

Removing invasive plants from open water and watercourses – usually by cutting and hand pulling (e.g. Himalayan balsam) – will enable native biodiversity to flourish.

Useful resources

- **Managing forest operations to protect water environment** (Forestry Commission, 2019). Useful UK-relevant guidance, with clear diagrams, covering a range of situations.
- **Managing forest operations to protect the water environment – operator cab card** (Forest Research). Summarised practical guidance aimed at commercial forestry, but some relevance to native woodland creation.
- **Keeping rivers cool** (The Woodland Trust, 2016). Creating riparian shade for climate adaptation.

5.6 Managing competitive vegetation

Sapling growth on woodland creation sites may be suppressed by other plants competing for moisture, nutrients and light [129]. In addition, tall vegetation can become wet and heavy in the autumn, collapsing onto and smothering small trees [130]. The vegetation surrounding a tree can also affect the likelihood of damage by small mammals, as dense grass provides ideal cover for voles which can 'ring-bark' and kill young trees [131].

In the initiation phase, high light levels favour competitive 'weed' plants, such as tall, dense grasses and bracken, and their control or 'weeding' may be necessary. If trees are being initiated in an existing semi-natural habitat, such as heath, moor or species-rich grassland, then controlling competitive plants must be balanced with the impact on the existing habitat.

Vegetation control encourages stronger growth of trees and shrubs, and their more rapid and reliable establishment [132]. It can reduce the risk of drought impacts and the level of herbivore browsing by promoting faster tree growth, although it has **only a small direct effect on survival rates**, other than in very dry conditions [129,133–135]. For lowland broadleaved planting, vegetation control may be required for up to five years [130].

There are a variety of methods to manage competitive vegetation around young trees and shrubs. Each has advantages and limitations and is appropriate in particular conditions. They may be **combined** to optimise their effects.

Ground preparation

The first step to manage competitive vegetation is to assess existing vegetation on site and consider ground preparation in advance of planting, seeding or natural colonisation. Where competitive plants dominate (which could be highly seasonal), cultivation of the existing vegetation can reduce their dominance.

On **infertile soils**, especially in the uplands, **ground cultivation** alone may be sufficient to control competitive vegetation and promote tree establishment [132] and subsequent 'weeding' may not be required. On northerly and upland sites characterised by low soil temperature and a high water table, **mounding to create elevated spots** for planting can be as effective as multiple herbicide treatments for promoting tree growth [136] and removes the need for further vegetation control.

In contrast, on **fertile lowland soils,** such as brown earths, cultivation may exacerbate issues with competitive vegetation by creating conditions that favour ruderal and competitive plants [132].

Any cultivation comes with risks, including soil erosion, runoff polluting watercourses and the disruption of complex soil ecosystems. Of the various methods of cultivation, **ploughing** presents the most risks, while less intensive techniques such as **mounding** or **scarification** carry less risk [132].

Ex-arable soils are often highly fertile due to the addition of artificial fertilisers or manure, resulting in vigorous growth of competitive vegetation. On highly fertile soils, **cover crops** such as wheat, barley or clover may help to slow the establishment of competitive plants until trees have established. While this can play a role in establishing new woods and trees on ex-arable land, herbicide treatment or mulching may also be necessary as cover crops can provide hiding places for problematic small mammals [137].

Soil inversion is a relatively new technique for ground preparation, suitable for some large lowland ex-arable sites. Soil inversion involves sowing deep-ploughed soil with a grass-free mix of uncompetitive native wild flowers to provide first-year ground cover [138]. Fertile topsoil is buried, and infertile subsoil brought to the surface, resulting in a significant reduction in nutrient levels at the soil surface for at least five years [139]. The result is visually appealing (see 'Case study: Forest of Flowers', page 246) and can provide opportunities for colonisation as the sown plants are gradually shaded out by the developing tree canopy. Potential issues include the release of soil carbon, low availability of specialist machinery and damage to subsurface archaeology.

Physical removal

Physical removal of competitive plants can be a very effective method of promoting tree establishment, but has many practical limitations.

Mowing or strimming around trees prevents tall, dense vegetation collapsing onto, and crushing, small saplings especially, when wet [130]. Forestry practice often encourages mowing of grass areas between 'weeded' patches to reduce seeding into the weed-free areas [132]. Mowing, however, can result in dominance of grasses which compete with trees, and it can cause ground compaction and direct damage to young stems [132]. Mowing or strimming should be used only where there is a high **risk** of **tall vegetation** collapsing onto young trees.

Manual weeding can deliver the best results, but is only likely to be possible on very small sites or for specific trees within a project, such as open grown trees planted into semi-natural habitats. Hand weeding may also be an option where larger numbers of people are engaged in the project, such as schools or volunteer community woods.

Mulching

Mulching offers an effective alternative to herbicide treatment [135,137,140,141]. There are a variety of organic and synthetic sheet mats as well as biodegradable materials that can be spread on the ground, providing options for different site conditions and budgets. Biodegradable materials include straw, bark, wood chip, wool fleece and paper slurry. Mulches need to be in place for at least three years (initial applications may need topping up) and cover a circular area with a diameter of at least 1.2 metres around each tree [132]. The sustainable use of forestry (or other) by-products may aid the development of woodland soils, but the origin of the material and biosecurity must be considered.

Planting density and stock

Trees planted at **higher densities** are likely to result in earlier canopy closure. Light levels below the developing canopy are reduced, supressing the growth of competitive vegetation. This can provide an effective method for managing competitive vegetation in **groves**, reducing the need for other interventions and delivering some contingency for higher losses of trees in the initiation phase.

The use of **larger planting stock** (60–90cm) can also be effective in reducing the effect of competitive vegetation on the establishment of trees. This may be particularly effective where the height of competitive vegetation is the main issue, enabling trees to compete for light and withstand the weight of collapsing vegetation around them.

Herbicides

UKFS (soils and water): *Minimise the use of pesticides and consult appropriate regulators where designated sites or priority habitats or species might be affected, or if using pesticides in or near water.*

Herbicides (chemicals targeted to kill or reduce the vigour of vegetation) are an effective and commonly used method of vegetation control. **Glyphosate** is the most widely used herbicide in a range of agricultural, forestry and urban green space situations. There are some concerns about the impacts of glyphosate on human and environmental health (including experimental evidence showing reductions in earthworms, invertebrates and root mychorrizal associations in agricultural situations) [142]. There is an evidence gap around impacts and risks in **woodland settings**, where usage and dosage is far less; however, it is known that glyphosates, even in 'sub-agricultural' doses, can affect human health and immunity [143].

Herbicide use should, therefore, be minimised by replacing it with alternative methods of vegetation control where these are appropriate and achievable (see above). Assessments should be made prior to herbicide use to establish the suitability and effectiveness of alternative methods. This is particularly important where there is no evidence of previous use of herbicides at a site (i.e. organic farmland or semi-natural habitats), where their use could affect existing plants or soils of conservation value. In areas with high levels of human use (i.e. visitor hotspots or urban settings) herbicide use should be avoided on a precautionary basis.

When the decision to use herbicide has been made, application should be carried out by **suitably trained operators** in accordance with best-practice guidelines. For glyphosate, manual 'spot spraying' around saplings in suitable weather conditions using handheld, low-volume sprayers, is a very targeted means of application, and if used correctly, the effects on the wider environment are minimised [144]. In most cases, such treatments are limited to two per year for a period of three years and as such, is a temporary phase in woodland creation.

At the Woodland Trust we have instigated a **'best practice plus'** approach – going beyond recognised best practice for the sector. This involves undertaking a **full environmental and social risk assessment** prior to herbicide use and additional measures, including adopting larger **buffer zones** between a spray area and public rights of way, and **closure of areas** to the public during any spraying operations. We encourage the landowners we work with to follow our example, or the industry best practice as a minimum.

Combined methods

The efficacy of each of the methods described for managing competitive vegetation will depend to a great extent on the site characteristics, including the fertility of soils, hydrology, exposure and previous land use. Interventions can be tailored and used in combination to match variation in conditions across a site; for example, using mulches near water courses and sensitive habitats, targeted application of herbicides on drought-prone soils, and use of larger tree stock with minimal weeding in wood pasture areas and wet woodland. Although this will require more detailed planning, it can also reduce the impacts and costs involved in successful initiation of new woods and trees.

5.7 Protecting from browsing and grazing

Saplings and young trees are susceptible to damage and death from grazing, browsing and bark stripping. In many landscapes, deer, livestock, rabbits, hares or voles present a threat to the successful establishment of new trees [145]. Deer are present in very high population densities in many regions [146], and their numbers are likely to increase with expanding woodland cover [3]. Damage from animals affects tree growth rates and tree form. Frequent and severe damage increases the chance of mortality and extends the exposure of the saplings to other risks, such as drought stress, and some protective measures are likely to be required on most sites [147].

Herbivore management

Reducing herbivore impacts to a sustainable level benefits the whole ecosystem – promoting diverse vegetation composition and structure rather than limiting protection to the individual tree [148,149]. At least 40% of existing native woodlands in Britain are in unfavourable ecological condition due to excessive herbivore damage [150]. This indicates the importance of herbivore control in the initiation phase, and beyond, for nature-recovery objectives [66].

Landscape-scale strategies are widely advocated for the management of deer populations and are undoubtedly the most effective approach. Acceptable rates of seedling survival for wood pasture and other open structured woodland are likely to require deer populations of below 14 deer/km^2 in lowland areas [147] – a figure which may drop to as low as 4–5 deer/km^2 in upland environments, where less browse is available [151].

Deer control should be considered on sites above 10ha where it can be carried out safely. Below this size, deer fencing is likely to be more practical and effective.

In some landscapes, **livestock** may replace deer as the main constraint on tree establishment. Grazing densities at less than 1.2 sheep per hectare will enable most tree saplings to develop unbrowsed [152].

Voles present a very different constraint to tree establishment [153] and there are no effective measures for direct population control [145]. However, there are options other than the use of plastic spiral guards. It is also possible to encourage vole predators through provision of raptor perches [154] and raptor nest boxes [155].

Fencing

Preventing browsing and herbivore impacts within a fenced area allows trees and vegetation structure to develop. Fencing can also be designed to respond to the herbivore populations identified in the site assessment and can be moved or removed as animal populations change.

Fencing does not tackle the root of the problem of an overabundance of deer and may **increase pressure** on the surrounding land; therefore, fencing and deer control need to go hand-in-hand. Fences require **regular maintenance** to be effective and the need for some culling of deer and rabbits initially caught within a fenced area or gaining access to fenced enclosures should be anticipated. Even then, fences are not a fail-safe option and within many deer fences some further protection from voles and rabbits may be required [145].

Fencing may offer the best solution on small or medium-sized sites, or compartments of larger sites between 3ha and around 10ha [156]; but this should be in combination with herbivore management and sustained maintenance.

No-fence planting in the presence of grazing and browsing pressure is an attractive idea which is being trialled in some upland situations. The key methods are **sabre planting** – planting 1.2-metre saplings perpendicular to steep slopes, so the growing tips are out of reach of browsers (primarily sheep); **protective cover** – planting taller saplings in the middle of existing thorny scrub which keeps browsers at bay; and **willow** – either as **pegs** pushed into the ground so the entire peg is below ground level, allowing roots to establish before vulnerable shoots appear, or as **3-metre forks** which are buried to ensure the stem cannot be pulled out, and tall enough to be out of reach.

Individual tree protection

The use of **plastic tree tubes and shelters** has become standard forestry practice [130,145,149]. In response to the recent and growing awareness of the long-term accumulation and impact of microplastics in soils and ecosystems, as well as the litter eye-sore caused by un-removed tubes, the Woodland Trust is working to eliminate single-use plastic products from all of our woodland creation projects over the next 10 years. As part of this commitment, we stopped the use of new plastic tree shelters on our estate at the end of 2021.

A re-evaluation of individual tree protection may offer opportunities to change accepted approaches to establishing native woods and trees:

- Tubeless trees can be more resilient to weather extremes and drought, as although tree shelters protect saplings from the wind, they prevent root stimulation, thereby reducing good root development [157].

- Herbivore management will often be given a higher priority where tree tubes are not used. This will promote development of well-structured woodland habitats rather than just well-protected trees.
- Browsing pressure early in a tree's life may lead to a diversity of growth forms in later life – potentially contributing to the structural complexity [66,158].
- Some level of browsing will not necessarily prevent the successful establishment of trees, as broadleaved trees can produce new growth from dormant buds, giving them greater resilience to browsing damage [159].
- **Low-level grazing** can produce structural complexity, favouring shrubs, tall grasses and herbs, and provide a wider range of resources for wildlife [66,160]. An approach which reduces, rather than eliminates tree loss to herbivores, may provide better outcomes for wildlife.

Thresholds for acceptable damage should be set according to site objectives, and may well vary across a single site, such as between groves and wood pasture areas. For example, less damage will be appropriate for groves on sites with timber as a production objective, than for wood pasture components on sites where nature recovery, landscape or people-related objectives are a higher priority.

Alternatives to plastic

The idea of a simple, environmentally friendly and sustainable replacement material for the plastic used in tree tubes and shelters has great appeal. It would allow current practices to continue with limited implications other than likely greater costs. Several non-plastic products have been recently launched and more are in development. The possibility of a sufficiently durable and effective, genuinely biodegradable alternative seems to be on the horizon. All of these will have their own environmental footprint in the land due to the resources and energy used to produce and transport them. The Woodland Trust is continuing to assess the **full life-cycle impacts** of these products as they come to market to ensure that they offer a truly sustainable alternative to plastic. This sustainability assessment, combined with a thorough appraisal of operational effectiveness, will inform decision making across the sector. In the meantime, we continue to favour approaches that reduce overall demand for single-use guards, tubes and shelters [161].

Reducing the use of guards, tubes and shelters

In groves, where a more rapid establishment of dense tree cover is usually desirable, it may still be possible to avoid the use of tree shelters by planting **more trees than the target stocking density requires** or reducing the use of tree shelters to a proportion of all planted trees. This can ensure that a minimum density of establishment is achieved. The use of tree shelters can also be **targeted to the most palatable species**, leaving those less palatable, such as alder, beech, birch and hawthorn unprotected from deer and livestock. The need to protect trees may be lower in wood pasture and transitional habitats, where a higher level of browsing may be acceptable.

Recycling plastic tree shelters

Many millions of plastic tree guards and shelters are currently in use. Where possible, tubes and shelters should be **reused** a number of times. When they have reached the end of their useful life, the first imperative is to ensure that they are **collected and removed** from site to avoid the direct pollution of sites with microplastics as the shelters disintegrate. Plastic guards and tubes must be disposed of correctly and wherever possible, options to **recycle** should be pursued – ideally in a closed-loop system whereby they are remanufactured into more guards [161].

CASE STUDY

MIKE ERSKINE/STUMP UP FOR TREES

The Bryn Arw project is tackling woodland creation on a challenging, bracken-dominated hillside in mid-Wales.

Pioneering project to establish woodland on a Welsh common

The first ever large-scale woodland creation project on common land in Wales is taking place at Bryn Arw, part of the Brecon Beacons National Park. This pilot serves as a flagship site for Stump up for Trees, a community initiative which aims to plant a million trees in the Brecon Beacons by 2025. It will transform the eastern slope, which was bracken and bramble dominated, and unsuitable for sheep grazing due to lack of grass and difficult access.

Bryn Arw common occupies approximately 140ha of Bryn Arw hill in the Black Mountains of Monmouthshire. It has an altitude range of 200–384 metres and has long been grazed by sheep. The open hill is almost entirely dominated by dense, tall stands of bracken, with low botanical diversity over much of the site. Bramble has taken hold in places, particularly on the lower slopes, and in places bluebells are frequent beneath the bracken, with a few other plants associated with woodland, such as wood sorrel and three-nerved sandwort. Small areas of upland acid grassland occur on the higher ground where bracken is shorter and more sparse.

CASE STUDY

Natural colonisation of native trees and shrubs has occurred over the years, forming patches of woodland, particularly in the most sheltered areas and close to neighbouring woodland. There are also some ancient, veteran and notable trees around the site. Several small pockets of woodland adjoin the common, mostly of ancient origin, and some have been planted with conifers and/or grazed in the past.

In November 2019, the Bryn Arw Commoners' Association secured the consent of the landowners, the graziers and all the relevant consultees to establish native woodland over 71ha. Their aim is to replace the bracken-dominated eastern slope with native woodland that will absorb carbon and create habitat for wildlife. With advice from the Woodland Trust, the final design specified that 7ha would be established through natural colonisation and 64ha would be planted at 1,600 trees per hectare, supported by the Welsh Government's Glastir Woodland Creation biodiversity grant. The grant permits flexibility of tree spacing and unmapped open areas of up to 0.1ha to accommodate important natural features such as wet flushes, individual trees and other habitats. The most significant areas of acid grassland, gorse scrub and rocky outcrops had already been excluded from the planting proposals.

Preparation and tree establishment

Site preparation began in 2020 by clearing bracken using a specially designed machine called a Brielmaier mower. Two bracken cuts were undertaken, and the site was protected from grazing and browsing animals by stock fencing using locally grown sweet chestnut stakes.

A combination of bare-rooted and cell-grown local provenance trees were planted in 2021, sourced from a nursery in Shropshire which is part of the UK and Ireland Sourced and Grown (UKISG) scheme. A proportion of larger birch, rowan and oak transplants were planted as a trial, and relative growth rates will be monitored. No plastic has been used on site, though several prototypes of non-plastic tree guards are being trialled, and every other tree has been marked with a cane to guide subsequent maintenance. In anticipation of some losses, more trees were planted than required by the grant. Rabbits and occasional deer will be controlled by culling.

Continual bracken control is necessary to reduce competition with planted trees and the risk of fire damage. Bracken will be weeded mechanically between rows with the Brielmaier, and manually around individual trees by a combination of volunteers and contractors. Where necessary, brambles and grasses will be weeded chemically around individual trees, keeping herbicide use to a minimum.

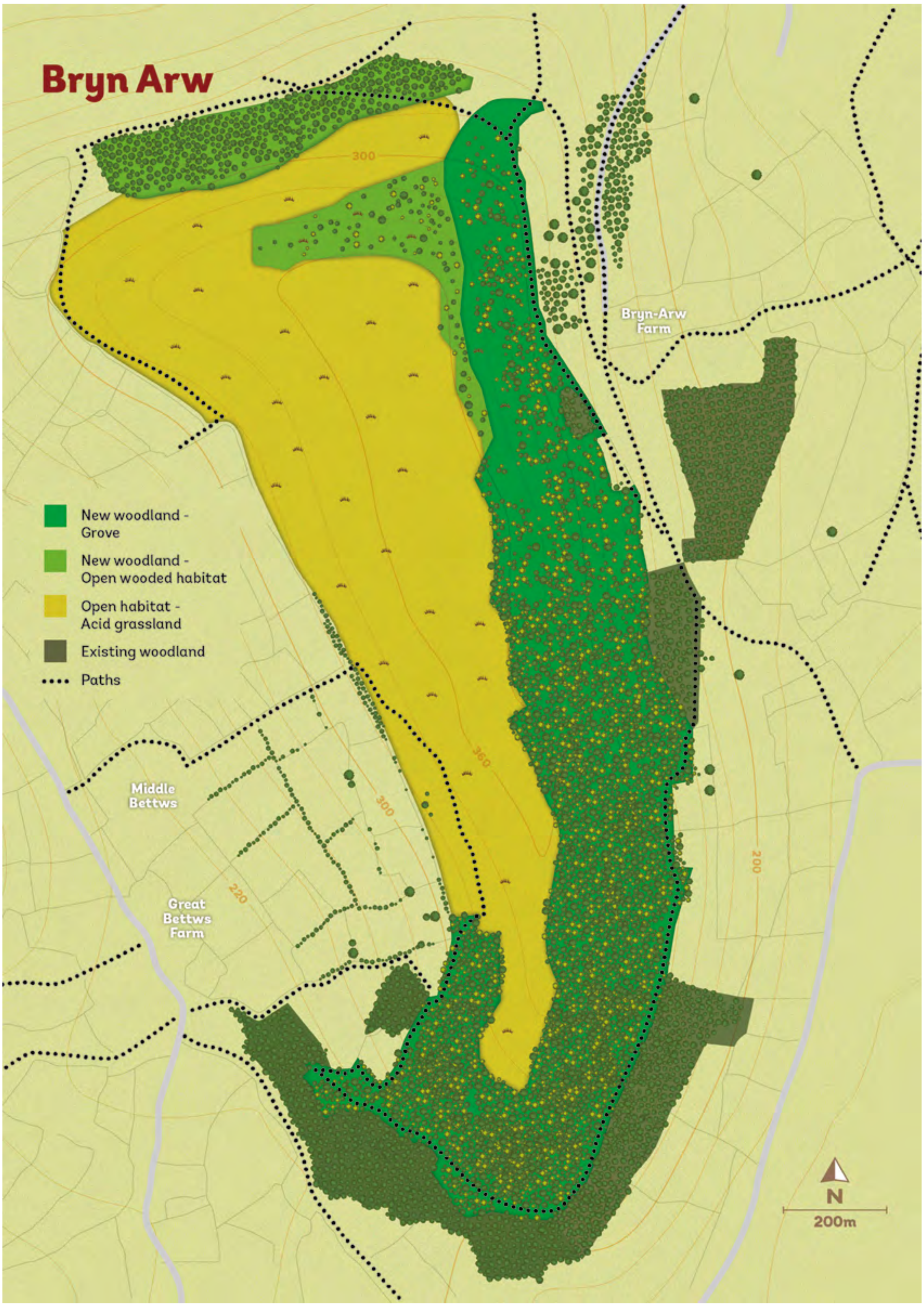
CASE STUDY

Over the next few years, maintenance work will be carried out supported by the grant, which specifies that livestock must be excluded for a minimum of 12 years. A botanical survey was carried out in May 2020 and further surveys of other taxa, including Lepidoptera and birds began in 2021. These surveys will provide a baseline against which progress towards restoring a biodiversity-rich wooded landscape can be determined.

ROB PENN2 / STUMP UP FOR TREES

Stump Up For Trees volunteers planting at Bryn Arw.

CASE STUDY



Bryn Arw
300
300
360
220
200
Bryn-Arw Farm
Middle Bettws
Great Bettws Farm
New woodland - Grove
New woodland - Open wooded habitat
Open habitat - Acid grassland
Existing woodland
Paths
N
200m

CASE STUDY

GEOFF EASTWOOD

The Woodmeadow Trust is creating species-rich meadow habitats alongside woods and trees at Three Hagges Woodmeadow. The site design creates complex shapes, with lots of transitions between woodland areas and hay meadows.

Three Hagges Woodmeadow

Collectively, our native trees, grasses and meadow perennials are host to a wealth of biodiversity. Rides, glades and the transitions where wood and meadow meet offer a range of niches and an amazing mosaic of habitats. Woodmeadows, where all of these are combined, are thriving ecosystems, and creating a network of woodmeadows across the UK would help to address the catastrophic decline in biodiversity. Woodmeadow Trust have shared their experience of successfully creating Three Hagges Woodmeadow on a 10ha former barley field in Yorkshire.

Three Hagges Woodmeadow was planted between 2012 and 2013. The project comprises an intimate mixture of wooded copses and wildflower meadows, with a network of glades, rides and 'messy edges', together with a small pond. Most of the wooded areas are to be managed as coppice-with-standards in order to maintain a range of age classes, with some areas of minimal intervention in order to produce varied transitional habitats and maximise structural diversity.

The project is still in its infancy, but as a result of promoting botanical diversity from the outset, Three Hagges Woodmeadow has already developed into an extraordinarily varied and valuable habitat. Botanical surveys during 2020 recorded 163 plant species within the woodmeadow, with an average of 16 species per square metre in open areas; and annual ecological surveys since 2015 have so far recorded 1,247 invertebrate species.

CASE STUDY

Laying the foundations for a woodmeadow

Woodland plant communities are typically very slow to naturally colonise newly established woodlands, particularly where these are planted on former arable land or improved pasture. If woodlands are created adjacent to existing semi-natural woodlands, then it is likely that more mobile species will gradually establish within newly planted areas over a period of decades. However, many 'woodland specialist' plants are extremely poor at dispersing and may take centuries to colonise, if at all.

Woodlands created on ex-agricultural land often exhibit high fertility and are particularly likely to develop persistent homogenous non-woodland communities dominated by coarse grasses and agricultural weeds. While this is unlikely to a be a significant concern where the main aim of planting is to produce timber, it severely limits the biodiversity and amenity value of new woodlands, particularly for the first few years between planting and canopy closure.

Three Hagges Woodmeadow was initially sown with a ground layer of fine meadow grasses and perennials based on the lowland meadows that were once characteristic of its location on the Ouse-Derwent floodplain. Mixes based on National Vegetation Classification (NVC) 'wet' (MG4) and 'dry' (MG5) neutral grassland were chosen along with a nurse crop of cornfield annuals to reduce ingress of undesirable weed species during the slower establishment period of the perennials. More vigorous grasses, such as cock's-foot, Yorkshire fog and perennial ryegrass were excluded in favour of less competitive grasses, including red fescue, sheep's fescue, sweet vernal grass and common bent.

From barley field to meadow

As the site had been in arable use for decades, soil fertility in terms of phosphate levels far exceeded the upper limit recommended for meadow establishment. In some situations, repeated cropping can be an effective means of reducing phosphate levels prior to the outset of meadow creation. However, waiting for phosphate levels to fall within 'acceptable' limits could have delayed the project by 20 years or more. Instead, after the last barley harvest in 2012, the site was ploughed and a seedbed prepared using the 'stale seedbed technique'. This involved allowing a flush of weed species to germinate before spraying them with herbicide (glyphosate). Seed was then very shallow-drilled directly with minimal soil disturbance. Any weed seed present is likely to be in the top 2–3cm of soil, but is usually unable to germinate unless exposed to light. The aim was to reduce the occurrence of common, vigorous and competitive weed species – the docks, creeping thistle, and nettle – that would otherwise compromise both meadow

CASE STUDY

and woodland and preclude the establishment of desirable and less robust wild flowers and grasses.

Continuous rain during the winter of 2012–13 prevented immediate sowing, but in early May 2013 the seed was eventually rolled in. The site was first opened to visitors that summer, to coincide with the colourful cornfield annual display. The area was then cut in late July 2013, with the resulting [35],600kg of material removed to reduce soil fertility. Regrowth was lush and a second hay crop was taken in October 2013 in preparation for tree planting.

Tree planting

By December 2013, and with the help of volunteers, 10,000 native broadleaf saplings were planted, including 24 species of native tree and seven shrub species. The canopy will mainly comprise pedunculate oak and small-leaved lime standards, while the varied understorey has a large hazel component. The trees were planted in twelve compartments, arranged to form open glades and broad rides to maximise the area of woodland edge (the preferred habitat of up to 60% of woodland flora) and allow easy access for hay cutting and baling with agricultural machinery. The Forestry Commission gave special dispensation to permit 40% of open space within the woodmeadow, as opposed to the usual 20% limit imposed on most Forestry Commission grant-aided projects.

A two-metre high perimeter fence was installed to exclude deer and rabbits, but plastic guards were still required to protect developing trees from voles. This approach was more cost effective than using tree tubes and the fence continues to act as effective protection for areas of coppice regrowth.

Management

The meadows are cut annually in mid-July, with all cuttings removed, then mob grazed with Hebridean sheep to maintain an open sward structure. Rows between trees were also cut annually for the first few years to minimise ingress of undesirable 'weed' species and prevent young trees from being swamped. Suckering shrubs are starting to form dense thickets in places, and some rows are now being left unmown to develop into tussocky grassland.

Formative pruning (no more than three cuts on selected oaks approximately 7–8 metres apart, generally every three years) is being undertaken to create a few 'winners' intended for eventual felling/income. The canopy has begun to close over in parts of the site and the first coppice cut was undertaken in November 2020.

CASE STUDY

Early signs of wildlife recovery

As well as supporting many plants and invertebrates, the woodmeadow has healthy populations of reptiles and amphibians. In April 2021, 111 great crested newts and 78 smooth newts were recorded in the small pond on site. Insect pollinators are attracted by the huge diversity of wild flowers that form a blaze of beautiful colour in the spring and summer. They include 34 bee species, 26 butterfly species, and 43 hoverfly species – none of which would have been found on the site when it was a barley field. Butterflies include the dingy skipper, marbled white, and purple hairstreak. Bees include the red mason bee and wool carder bee, and bumblebees such as the tree bumblebee and red-tailed bumblebee. There have also been unusual sightings, such as the yellow-legged clearwing – an insect rarely documented since records began in 1883 – and the third-ever recent British record of the ruby-tailed wasp.


LAURIE CAMPBELL

Widely spaced tree planting provides space for open grown trees to develop full canopies.

Establish

Vision → Assess → Design → Initiate → Establish

Establish

- Aftercare
- Structure, habitats and species
- Visitors
- Monitoring

6: Establish

Guiding woodland development

In the initiation phase you will have begun to introduce trees onto the site. You will have protected trees and woods from significant browsing, managed competitive vegetation and started enhancing other features of the site. This section focuses on the **establishment of woods and trees** and the early stages of developing a naturally **functioning woodland ecosystem**.

For most sites, the **establishment phase** lasts around **twenty years** and sets your wood up to achieve your objectives over the longer term. It is important that management during this phase is described in the design and planned as part of the project, and that the time and resources needed to support establishment are recognised and secured.

6.1 Aftercare

6.1.1 Replacing failed trees

Some loss of planted trees should be expected on most sites. The replacement of some or all of the failed trees, often referred to as 'beating up', may be necessary to achieve successful establishment and deliver the site objectives. The need for beating up will depend on the objectives and the conditions of any grants or other funding. **Different levels of failure may be acceptable** on sites with differing objectives, or between different structural components of the design on a single site. Within groves and dense clusters of trees, diversity in stem densities and resulting growth rates should be seen as an indicator of wildlife value and contribution to nature recovery [52,162].

Decisions on the replacement of failed trees can often be based on simple observation of the development of the site, but in some cases may require more structured monitoring. Care should be taken not to expend unnecessary resources on planting trees in ground which has been shown to be unsuitable; or planting tree species which have proved to be poorly suited to site conditions, and/or planting trees on ground where there is evidence of establishment through natural colonisation.

Generally, the replacement of failed trees in woodland, especially in groves, will need to occur within the first 2–3 years following initial establishment. For individual trees in open grown settings – such as in glades, hedgerows or street/urban settings – the loss of a single tree is more significant, and plans for the replacement of failed individuals may need to extend over several years.

6.1.2 Promoting successful establishment

The management of competitive vegetation and protection from grazing and browsing pressure will need to continue until acceptable levels of tree establishment are achieved. It is important that the measures put in place to initiate woodland creation are maintained. **Deer control** should be continued and may need to be intensified if deer numbers increase as trees establish and provide habitat and cover for deer. **Fences** to protect trees from deer or livestock will need to be checked and maintained.

Individual **tree protection** (guards, tubes and shelters) should be regularly checked during the early years of establishment to ensure that they are correctly staked (upright) and functioning effectively (firmly in contact with the soil and weed-free). Poor maintenance of tree protection limits the successful establishment of trees, is unsightly, and can contribute to pollution of the environment (e.g. from microplastics as plastic-based guards break down). **Tubes, guards and shelters should be removed** at the earliest opportunity when they have completed their function. The timescales for this will vary from site to site, but the removal of all tree protection should normally be completed within ten years. All the material collected from the site must be disposed of responsibly and wherever possible, reused or kept within a closed-loop recycling scheme. It is important that the time and resources to achieve this are incorporated into the woodland creation design and plan.

6.2 Establishing richer communities

To establish naturally functioning woodland ecosystems it is necessary to look beyond the native trees and shrubs that provide the essential and visible architecture, and consider the wider communities of **flora, fungi** and **fauna**. Woodlands are much more than just places with trees.

Colonisation of establishing sites will occur naturally. The rate and species richness of colonisation will depend on **proximity** to sources of seed, spores and breeding populations. Equally important is the creation of **suitable habitats and conditions** on the site. By using the range of structural components in your design (groves, open wooded habitats and glades), a great diversity of micro-sites for colonisation will have been created.

Your site assessment has included an assessment of the landscape context which can help you understand the likelihood of natural colonisation occurring. Proximity to ancient woodland or other high-value habitats that are in good ecological condition will create the best conditions for natural colonisation. In contrast, **ecologically isolated sites** may need help to establish key elements of the woodland ecosystem. Reflect on the landscape context and existing features on the site, then consider the need and opportunity to enhance the woodland ecosystem through **assisted colonisation**.

Any additional **species introductions** require careful planning, delivery and monitoring. Some general principles apply to all assisted colonisation:

- A thorough **assessment of impacts**, both direct and indirect, positive and negative, should be carried out. The precautionary principle should be applied, and where there is high risk, or uncertainty of risk, introductions should not proceed.
- There should be a clear understanding of the **role of species in the ecosystem**. Relatively common and widespread native species can play key ecological roles and be lower risk for introductions.
- The introduction of **conservation priority species** may be important and relevant to woodland creation. The potential impact on populations at donor sites, and the likelihood of successful establishment of a sustainable population, are key considerations. Introductions of this type are best considered as stand-alone projects.
- **Specialist ecological knowledge** of the species involved, and the local area, is essential. The International Union for Conservation of Nature (IUCN) guidelines on species introductions [163] should be followed in all cases.
- Any introduction needs to take full consideration of the concerns of **stakeholders** and **local communities** who might be affected.
- Translocation of species is not an acceptable mitigation for the **loss of irreplaceable habitats**, such as ancient woodland or ancient and veteran trees. Translocations to remedy habitat loss resulting from human actions are always an absolute last resort.

RICK WORRELL

Bugle growing from cuttings planted 10 years after planting of a birch and alder canopy at Ledcroisk Wood in Perthshire.

6.2.1 Plants

Field-layer plant introductions are typically the most relevant group to consider as part of woodland creation. They can speed up nature recovery by rapidly providing additional resources and supporting wider natural colonisation by insects, other animals and fungi.

Woodland creation sites can provide conditions for natural colonisation by a wide range of plants through changes of land use, cessation of fertiliser and herbicide application, and/or the reduction of grazing pressure. **Observation** of how the ground layer develops should inform decisions on any introductions. Plants can spread from adjacent or nearby woodland and from features recorded on the site, such as stream sides and hedgerows.

Maintaining patches of **bare and disturbed open ground** will enable woodland herbs and annual plants to seed, flower and colonise. This process can be supported by controlling competitive plants, such as sow thistle, barren brome and creeping thistle, and periodic disturbance of patches of surface soils.

Woodlands that are **ecologically isolated**, or are established on **former agricultural land**, can often fail to develop characteristic woodland plant communities [164]. Young woods can become dominated by grass and agricultural weeds [106]. On many fertile soils, nettles, cow parsley or some grasses can dominate groves and open wooded habitats. Ivy readily colonises young shady groves, and will dominate the field layer, which might prevent or delay other species from establishing.

During the initiation and early establishment phases (e.g. from years 0–10), attention will be on opportunities to enhance the ground layer of more **open wooded habitats and glades** in, for example, ex-arable sites or agriculturally modified/amenity grassland. Herbaceous flowering plants in these situations can provide important nectar and pollen for insects.

Introductions of **woodland specialist plants** associated with lower light levels are best considered later in the establishment stage. Focus on smaller **patches of plants** to act as sources for wider colonisation over time. Consider this in **groves** from years 10–20+.

Understand the **local vegetation ecology** when planning and delivering any plant introductions, which should reflect the flora of the local area as well as the soils and conditions on the site. This will add to a strong sense of place, and it is more likely that these plants will then support wider associated biodiversity. The table overleaf provides some examples of plants which might be appropriate (depending very much on geographical location) in the different structural components – groves, open wooded habitats and glades – on different soil types.

Primrose and violets growing from plugs planted 10 years after the planting of silver birch at Ledcroisk Wood.

Lists were produced for this guide, and are based on broad vegetation types and associations in the UK, as well as the ecology of individual species, and were informed by field experience and sources including the National Vegetation Classification, local and UK plant floras and atlases, and PLANTATT (Ellenberg scores).

Table 6.1: Field-layer plants for potential introductions, by wooded habitat structures and site characteristics

Soil type	Groves (>70% canopy)	Open wooded habitats (20–70% canopy)	Glades (<20% canopy) (likely to require regular cutting or grazing to maintain conditions)
On dry, neutral to calcareous soils (e.g. BU and BL habitats in section 5.1)	Dog's mercury, broad buckler fern, male fern, wood avens, lady fern, enchanter's nightshade, wood avens, wood melick grass, bluebell, sanicle, herb-robert, woodruff, wood anemone, lords-and-ladies, ramsons/wild garlic, yellow archangel (local, mainly south of UK), black bryony (local, England and Wales).	If fertility is high, then examples might include: hogweed, garlic mustard, red campion, cow parsley, hedge woundwort, cock's-foot, false oat-grass, greater stitchwort, bush vetch, lesser burdock, nettle-leaved bellflower (local, south UK), white bryony (local, mainly southeast), greater burnet saxifrage (local, mainly central and southeast England), ground ivy. With intermediate/ lower fertility: wild marjoram (local), perforate St John's-wort, nipplewort, agrimony, wood spurge (local, mainly southern England), wood sage, wild strawberry, wood false-brome, wild roses, wild basil, giant fescue, hairy brome.	If fertility is intermediate to high, examples might include: oxeye daisy, yarrow, red fescue, ribwort plantain, meadow vetchling, red clover, common sorrel, common knapweed, tufted vetch, Yorkshire fog, hogweed, crested dog's-tail, cowslip. With low fertility: bird's-foot trefoil, lady's bedstraw, rough hawkbit (local), quaking grass, wild thyme, sheep's fescue, common bent, burnet saxifrage, wild thyme, wild carrot (local, mainly southeast of UK), salad burnet (local, mainly south UK), field scabious (local).

Soil type	Groves (>70% canopy)	Open wooded habitats (20–70% canopy)	Glades (<20% canopy) (likely to require regular cutting or grazing to maintain conditions)
On wet or frequently waterlogged soils, floodplains, marshy or heavier clay soils. (e.g. WU and WL habitats in section 5.1)	Tufted hair grass, creeping soft-grass, yellow pimpernel, remote sedge, broad buckler fern, narrow buckler fern, wood avens, moschatel, bugle, enchanter's nightshade, opposite-leaved golden saxifrage, bearded couch, honeysuckle, dog's mercury, ramson/ wild garlic, wood anemone.	Wild angelica, hogweed, meadowsweet, red campion, water avens, hemp agrimony, common valerian, hemlock water-dropwort, garlic mustard, marsh thistle, narrow buckler fern, bittersweet, yellow flag, red currant, purple loosestrife, creeping Jenny, common hemp nettle, reed canary grass, yellow loosestrife, butterbur, wood cranesbill (local, in northern England and Scotland only), melancholy thistle (local, in northern UK only), marsh hawksbeard (local, in northern UK only).	Meadowsweet, common fleabane (local, mainly in south UK), marsh thistle, greater bird's-foot trefoil, Yorkshire fog, meadow foxtail, marsh bedstraw, ragged robin, cuckooflower, tufted vetch. On less fertile damper soils: Devil's-bit scabious, great burnet (local, mainly central and northern England and southwest Wales), purple moor-grass, tufted hair grass.
On more acidic and less fertile soils (e.g. AU and AL habitats in section 5.1)	Bluebell, wood sorrel, creeping soft grass, wood anemone, honeysuckle, bugle, yellow pimpernel, scaly male fern, male fern, broad-buckler fern, hard fern.	Greater stitchwort, red campion, pignut, betony, bitter vetch, raspberry, slender St. John's-wort, heather, bilberry, foxglove, heath speedwell, wavy hair grass, climbing corydalis (local), broom, wild roses, tufted hair grass, rosebay willowherb, gorses.	Sheep's fescue, common bent grass, heath bedstraw, tormentil, heather, bilberry, sweet vernal grass, wavy hair grass, heath speedwell, sheep's sorrel, betony, bitter vetch, common dog violet, harebell, mouse-ear hawkweed, cat's-ear.

Avoid generic prescriptions for plant introductions. Some of the plants in the table are only locally native and others have complex taxonomy; for example, the wild roses which are a complex aggregate of species and hybrids, and bramble which occurs in as many as 500 different microspecies. It is important to consider each species individually and look at maps of native distribution ranges in current botanical atlases and local county floras (e.g. Online Atlas of the British and Irish Flora [brc.ac.uk]).

Commercially available pre-chosen mixtures (e.g. hedgerow mixes, meadow mixes, wood-edge mixes, wild flowers for woodland) should be treated with caution and may not be appropriate to the locality of the site.

The supply of native wild plants is not currently subject to the same **local provenance** zones or **biosecurity** systems (e.g. UKISG) as tree and shrub supply. However, many suppliers will have experience of supporting conservation projects and will be able to provide evidence of the source of seed and other material. Ideally, donor sites should be as close as possible to the receptor site.

6.2.2 Fungi

Fungi and lichens are extremely important yet overlooked elements of woodland ecosystems. However, they are also very complex, and some can be mobile through spore dispersal. While there are increasing techniques for establishing fungi as part of conservation introductions [165], their complexity generally makes fungi unsuitable candidates for widespread translocations as part of woodland creation. Any fungal translocations are likely to require the involvement of expert conservation mycologists with good local knowledge. It is important to **avoid commercial mycorrhizae treatments**, as these can include species that are not native to an area. As with ground flora establishment, there are significant risks with soil translocation.

6.2.3 Animals

Mammals and other fauna can be the subject of introductions. Consider these as **standalone conservation projects** as they are likely to need the involvement of experienced specialists. It is important to recognise how these can support, and be supported by, the development of new woodland. For example, the **keystone**

The pine marten is a keystone species, helping to drive natural processes in a woodland. They may also be a flagship species for a woodland creation project, engaging people in the story of nature recovery.

species beaver can have a positive effect on the wider ecosystem through the creation of wetland habitats that support greater numbers of invertebrates, amphibians, fish and birds [166]. **Pine marten** has also been the subject of population reinforcement. **Creating well-connected wooded landscapes** to ensure a thriving pine marten population benefits many other species, including other mammals, invertebrates and plants. There may be opportunities for conservation **target species** to be considered for introductions into developing woodland landscapes – including birds such as marsh tit or willow tit, or some of the butterfly species. The extent and condition of sufficient suitable habitat must exist to **ensure viable populations**.

6.3 Promoting structural complexity

Thinning at Easters Wood in Herefordshire has been at a variable intensity, creating more complexity across the site.

6.3.1 Structural complexity of woods and trees

Newly established woods and trees inevitably have a **uniform age structure**, whether planted, seeded, or naturally colonised. This gives sites a uniform appearance, enhanced only where existing trees provide a different structural element.

Structural complexity is a key design principle for nature recovery. Although it may take many decades to develop the **structural complexity** provided by a range of age classes, **early interventions** can enhance the structure of woods and trees on the site and set it on a trajectory towards good ecological condition.

UKFS (climate change): *Consider the risks from* ***wind, fire, pests and disease*** *outbreaks. Promote a variety of* ***ages, species and stand structures.*** *Review management as further evidence on pests and diseases becomes available.*

UKFS (water): *Management should contribute to* ***water quality*** *objectives of River Basin Management Plans and reduce environmental pressures on the aquatic environment. Prevent* ***sediment*** *entering watercourses by minimising compaction, rutting and erosion during management operations. On vulnerable sites, consider the weather and aim to carry out operations during dry periods. Modify, postpone or stop activities if degradation starts to occur.*

UKFS (soils): Avoid burning *brash and harvesting residues unless it can be demonstrated that it is a management necessity, all the impacts have been considered, and the necessary approvals obtained.*

UKFS (landscape): *Manage establishing woods and trees to* ***develop appropriate shapes*** *(of structural components and transitional zones), including the effects of fences, felling operations and access routes. Ensure all those working on site are aware of important historic environment features.*

Small-scale **re-spacing** interventions may be appropriate early in the establishment phase (approx. years 3–10). For example, cutting to give space for selected trees such as oak or rowan among a thicket of birch. This early intervention can help to promote tree species diversity.

Most **thinning** and **coppicing** should be considered once trees are more established (approx. years 10–15) and may coincide with the removal of any remaining tree guards or shelters and the maintenance or removal of fencing.

Thinning and coppicing interventions in the establishment phase should aim to promote a diversity in **stem density, stem diameter, tree forms** and **growth rates**. This will set the site on a trajectory towards the structural complexity that is characteristic of old-growth woodland [50,54,55]. Variation in stem density and diameter is an indicator of wildlife value and an important contribution to nature recovery [52,162].

Woodland management and silvicultural treatments are complex and numerous, and a full account is beyond the scope of this guide. Various factors will inform aspects, such as the timing and intensity of an operation.

A set of **guiding principles for enhancing structural diversity** should be considered throughout:

Avoid uniformity. To maximise complexity for nature recovery, follow a **variable density-thinning** approach. This highly selective and irregular approach aims to accentuate variation across a site – maximising differences in growth rates and ensuring the widest array of conditions. It involves leaving some areas as denser groves and being highly selective and irregular about thinning elsewhere, so that some patches are considerably more open (like small, temporary glades or coppice coupes up to 0.25–0.5ha), but not clearly delineated. In groves with **high stem density,** competition suppresses growth; whereas in more open areas, trees will usually grow more rapidly in the absence of significant crown competition. The latter become **open grown** trees with larger diameter stems and greater structural complexity in their crowns.

Some areas might be managed as **coppice,** where larger groups of trees (coupes) are cut at the same time. Generally, consider small coppice areas as the more open parts of variable density thinning interventions – which mesh into treatments across much wider areas – as opposed to clearly delineated traditional coupe rotation. But some coppice areas may be more fixed for practical reasons; for example, alongside main access routes, permanent rides, public highways or neighbouring properties. Trees should be well established (approx. 8–10cm diameter) before making a first cut.

Use interventions to **accentuate transitions**. The design of grove, open wooded habitat and glade components are a key reference for this, and as establishment progresses, wide **transition zones** between these components can contribute to overall structural complexity. If the boundary between open components and groves are abrupt, use felling interventions to blur them into more graded and extended transitions. It is often these transitions that are the focus of interventions, as the densest groves and most open glades are maintained at either end of the spectrum.

Be guided by the **target species composition** as described in the design. Selectively thin to promote the desired species mix, consider which species might be lost or at a competitive disadvantage and intervene to give them more crown space. Any colonising **non-native trees** or **invasive plants** can also be removed at this stage.

Favour naturally regenerated trees over planted trees within the parameters of your target species composition. It is human nature to want the trees that we have planted to thrive; however, trees that have regenerated naturally on the site will be better adapted to site conditions and of greater value to genetic conservation.

Create conditions and structures to promote regeneration of a diverse range of native trees. Tree regeneration is required to develop age structure, and although this goes beyond the early stages of woodland establishment, it is never too early to create the conditions in which trees will naturally regenerate and establish from seed, or vegetatively. Many native trees produce seed from 10–30 years and most require relatively sunlit conditions to establish. In **groves**, managing trees and shrubs to allow light to reach the ground layer is important to promote regeneration of a range of tree species as well as a rich ground flora [167]. The resulting **high structural complexity** provides better foraging conditions for many bat species [168], and more microhabitats and resources for many birds and butterflies [169,170].

If future **timber** production is a primary objective, then a more **systematic approach** involving the creation of permanent extraction racks may be needed as a first intervention. Graduated density-thinning patterns involve the creation of racks and more systematic removal of trees from lines in between. This is most easily applied on stands that have been planted in quite uniform rows, but it can help to develop structural complexity early, and begin the development of irregular high forest stands. The formation of permanent systems of racks and track infrastructure will be essential to future harvesting, and should be part of the design from the outset.

In the establishment phase, early **crown thinning** for timber quality (giving space for well-formed future timber trees) can also support nature recovery objectives and is similar in approach to developing future veteran trees, although these are permanently retained. Maintaining crown thinning beyond the establishment phase promotes structural diversity and natural regeneration in groves and accelerates the development of quality timber (e.g. 60cm DBH* oak within 60 years on some good sites), while generating intermediate income (e.g. from firewood) [102,171,172].

Formative **pruning** during the establishment phase can also enhance future timber value, by reducing branching on the main stem. However, do not prune too early as it reduces the live crown of the young tree. For timber objectives, avoid 'releasing' some trees too early and retaining a deep crown with heavy branches. This is different to developing future veteran trees for nature recovery, where deeper crowns, complex branching and wide crown space are the objectives.

*DBH is the diameter of a tree measured at 'breast height', defined as 1.35 metres up from the highest point of ground at the tree's base.

Time sequence (top to bottom) showing variable density thinning to increase structural complexity in a uniform plantation site. Thinning intensity is higher in some areas, particularly to give considerable crown space to legacy trees as permanent retentions which may become the future veterans. Some areas remain un-thinned, where competitive

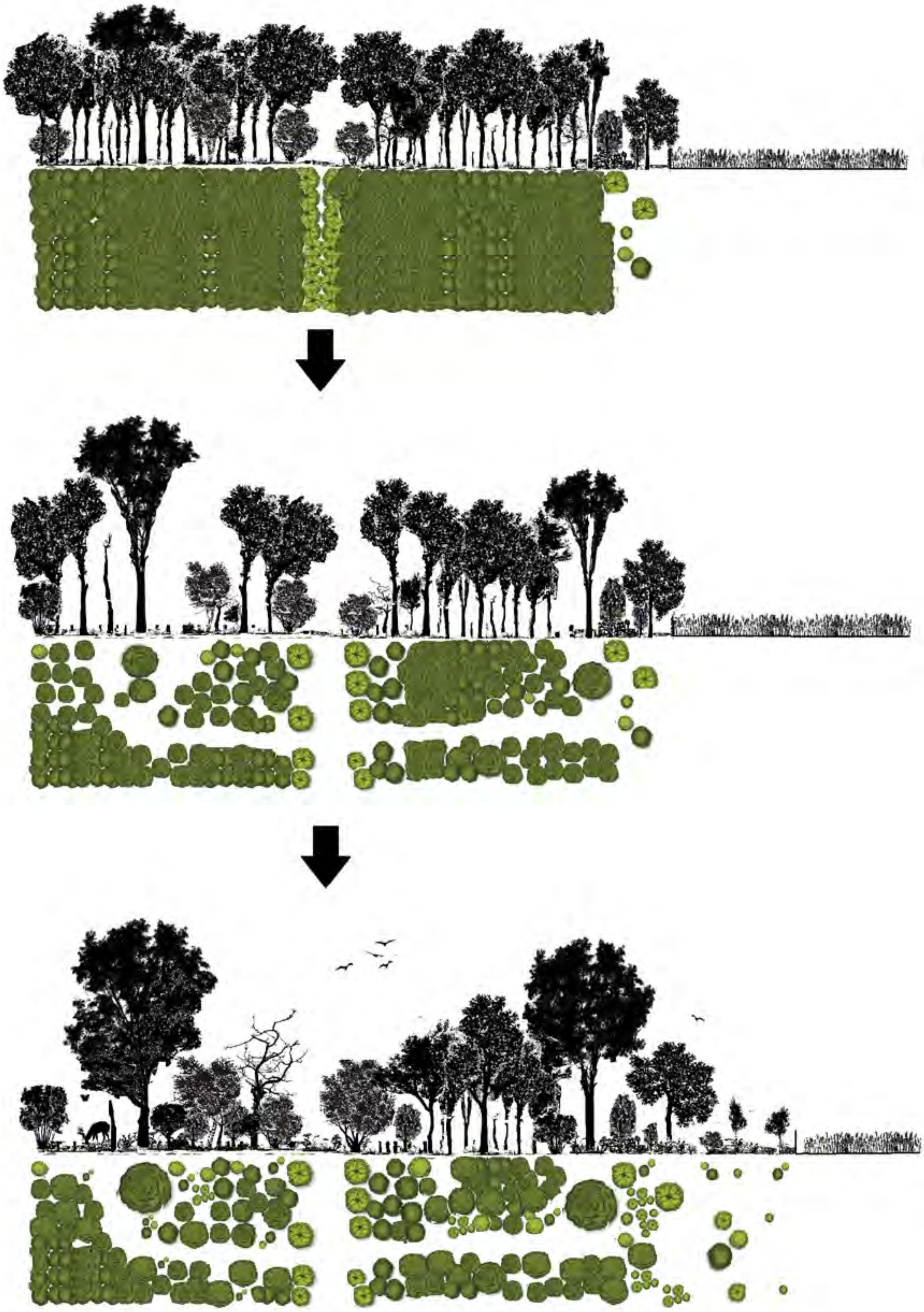


Figure 6

DAVID VENABLES

Thinning of dense silver birch regeneration at a variable density.

6.3.2 Future veteran trees

Large old trees are the keystone 'megaflora' of wooded ecosystems. They are essential to nature recovery, providing **unique structures and microhabitats not offered by younger, smaller trees**. Yet, most UK native woods are lacking in old trees [3]. Woods with veteran trees and decaying wood also provide significant and efficient carbon storage [173–176] and are more resilient in the face of climate change.

For **existing veteran or mature trees,** it is vital to think about their **continuity and enhancement**. The design should ensure that there is sufficient space around existing trees, and management planning in the establishment phase must ensure this space is maintained. Developing a flower-rich field layer close to existing veteran trees can support associated wood-decay insects that require nectar or pollen as adults [177]. Providing a range of nectar sources in grassland, taller vegetation and scrub is important. Umbellifers such as hogweed are especially valuable, as are flowering brambles and shrubs like hawthorn and blackthorn in sunny spots.

Although you shouldn't rush to create features of older woodland habitats in young developing woodland, it is still important to **think ahead**. Supporting the development of future veteran trees and associated microhabitats is important for nature recovery. It does require time for veteran characteristics to develop (for long-lived trees like oak or beech it could take 200 years or more), but active interventions in the establishment phase can **accelerate growth rates** and encourage the development of complex branch architectures.

Ensuring **crown space** around a significant number of individual trees can accelerate the development of **larger and elite trees** and contribute to structural complexity. This applies to open grown trees in glades as well as individual trees within open wooded habitats and groves. **Positively selecting trees for retention** and **selective thinning** around them removes crown competition and helps retained trees develop habitat features such as holes and cavities which provide roost sites for bats and other animals [178]. Thinned trees can be left in situ as decaying wood. **Identify and map** these as **permanent legacy trees** in management plans and use work programme interventions to maintain wide space around them over the long term. **Grazing animals** can develop space and old-growth trees, and many landscapes rich in old trees have a history of grazing animals in open wooded habitats.

A variable density thinning approach has created considerable space for an identified legacy tree with deeper crown and more complex branching structure.

Pollarding trees towards the end of the establishment phase (approx. 15–20 years) can begin to speed up the formation of tree hollows and other veteran characteristics [179]. This provides important continuity in sites with existing hollow trees. Re-pollarding on rotations of 7–25 years, and maintaining space and light, must be included in management plans. These trees are likely to be retained as a permanent legacy. Pollards are best situated as individuals in glades or open wooded habitats.

Veteranisation on living trees involves using tools to mimic damage from natural processes like storms or branch failure. Trees survive the treatment, but it is significant enough to instigate decaying wood habitat. There is no substitute for natural development of these features, particularly of heartwood decay and large hollows. Many veteranisation techniques work better for trees beyond the establishment phase (over 20 years old), but should not be used on trees already developing veteran characteristics. An example veteranisation technique is chainsaw-carved cavities, which can create hollows that more accurately replicate the environmental conditions (stable temperature and humidity) of tree hollows than artificial nest boxes. They are used by bats, birds and mammals and contribute to wider wood-decay habitat provision [180–182].

6.3.3 Creating decaying wood

The habitat resource and structures provided by decaying wood contributes considerably to the richness of wooded habitats [59]. Young wooded habitats will naturally not contain much of the decaying wood resources that characterise old-growth woodlands. But it is possible to start to accumulate this crucial component of woodland ecosystems. Some things to consider are:

- Always take opportunities to **retain cut woody material** (e.g. whole crowns and branches) on site in pieces as large as is practicable. This increases the biodiversity benefits of any interventions. Ensure that some decaying wood occurs in the full spectrum from full sun to very dense shade to benefit the most species. Once the decay processes begin, **avoid moving material** or drastically changing the environment it occurs in (e.g. from deep shade to complete exposure).
- **Log piles** provide habitat for species such as voles, mice, hedgehogs, newts, frogs and molluscs. Leave stacks or piles in direct contact with the ground, in dappled shade and compacted to maintain humidity (but leave some gaps and tunnels). Larger-diameter pieces are of most value, but even small twigs and the cut hollow stems of herbaceous plants (like hogweed stems) contribute and are used by insects.
- **Competitive exclusion** in dense young groves of trees results in standing decaying wood features on remaining living, relatively small trees (e.g. decaying lower branches or cavities). This 'self-thinning' can result in a decrease from over 4,000 stems per hectare in a 30-year-old stand, to below 650/ha after 140 years [38]. So, ensure some densely treed areas are left to these natural processes (see variable density thinning in 6.3.1, page 276). These areas can be as small as 0.25ha. Always leave existing dead trees and shrubs standing to decay (if they are not in a dangerous place).
- In some areas, **ringbarking** could be used to increase structural complexity and decaying wood volumes [183] by complete removal of bark from around the circumference of the tree or limb. Resulting decaying wood can be exploited by invertebrates and other species such as woodpeckers. This can be used as part of variable density thinning in groves, or to accentuate transitional areas

in open wooded habitats, for example, but is generally more appropriate after the establishment phase (e.g. 20+ years).

- Focus on ways to **develop larger-diameter trees and deadwood (logs and trunks) on your site**, rather than moving decaying wood into your new site. The latter can risk transferring pests and diseases, and could disturb the ecology of both the donor and receptor sites.

ALASTAIR HOTCHKISS

Competiton in unthinned groves can create decayng wood. Even small diameter standing dead trees can provide important resources, such as this willow tit nest site.

Sowing flower seed in glades alongside planted trees can greatly increase the value of the woodland for wildlife

6.4 Managing open wooded habitats and glades

Open wooded habitats, glade components and transitional zones are dynamic systems which can incorporate elements of scrub, more open grassland, heath or wetland vegetation. Their maintenance can be achieved through prescribed and planned **mechanical cutting** or **animal grazing**. Each of these provides something that the other cannot and may be more relevant for different parts of a site. They need not be seen as alternatives, as both can be applied concurrently or sequentially on sites.

Some features that were part of the project design, such as paths and amenity spaces, may need to be kept more permanently open and require more control.

UKFS (biodiversity): *Develop a long-term (complex)* ***stand structure,*** *linking habitat features. Maintain structural elements, such as veteran trees, open-crowned trees, windthrow, open space (glades), understorey layers and natural colonisation. Maintain open habitats with partial tree or shrub cover and manage to enhance their biodiversity value.*

ALASTAIR HOTCHKISS

Small-scale tree felling promotes dynamism in woodland habitats

6.4.1 Cutting

Maintaining the ground layer by cutting vegetation (mowing, flailing, brush cutting or felling trees) can be preferable in some situations, particularly where there is a need for more control or predictability of outcome. Prescribing regular cutting within management-plan work programmes can ensure that permanent **rides, paths, glades and other access routes** are maintained. It is important that ride **management is well planned** so that not all areas are cut at the same time, thereby maintaining continuity of varying sward heights and structures across a site.

Periodic cutting on a 5–10-year cycle (rotational cutting) can help to maintain the structures and composition associated with early successional scrub, and may be used for scrub along rides and tracks, for example. Cutting can be used to blur the boundaries between more open habitat components and densely treed areas if too abrupt, into more graded and wide transitions.

Cutting can produce small-diameter **fuelwood** or generate **decaying-wood** habitat if cut material is left on site. Cutting allows positive **selection to retain trees** that have specific habitat features and ensures that even the most palatable trees can persist.

Routine and regular removal of cut material **can help to reduce fertility** of the site (e.g. on agriculturally improved sites). This may be important in creating other species-rich vegetation.

RICHARD BROWN

Well-planned thinning operations can increase structural complexity and emphasise transitional zones between structural components of the woodland.

However, maintaining the ground layer by cutting has **limitations**:

Mechanical cutting **cannot replicate what animals can do** in terms of the complexity in sward and patchiness of other small-scale processes (e.g. small tracks and disturbed ground). Cutting alone can rarely maintain the most species-rich open habitats, as without large grazing animals, coarse grasses can begin to dominate in glades and open wooded habitats, and consequently species richness and diversity decline. Nor does mechanical cutting replicate the soil disturbance from animals which results in patchy bare ground that can be important for many plants and invertebrates, often where these are in small-scale mosaic with taller herbs in sunlit pockets among woody vegetation.

Heavy tractor-mounted machinery used to maintain space around existing mature or veteran trees risks impacts to roots and soil compaction.

Mechanical cutting is more **challenging on steep or rocky ground** and heavy machinery risks **damage to historic features**.

It may also prove impractical or **too costly to sustain** for open and transitional spaces within larger, more extensive woodland creation sites.

Grazing animals can help develop and maintain patchy woodland mosaics of denser groves, open wooded habitats and glades.

6.4.2 Grazing animals

The natural processes driven by large grazing animals are impossible to replicate using other methods [63]. Extensive and low-level grazing provides a greater diversity of vegetation structure and species composition than either overgrazing or complete absence of grazing [66]. Naturalistic grazing of domestic animals, such as hardy native cattle breeds, produces a patchier vegetation which can be beneficial in all the structural components of the design, but especially important in maintaining ground layer and scrub in glades and open wooded habitats [64,65].

***UKFS (biodiversity):** Encourage **ecological processes** as a way of delivering biodiversity objectives. Control grazing and browsing that will have a negative impact on the woodland or its biodiversity. Develop and monitor **deer management** plans in areas where they are a threat. Consider using controlled **grazing by livestock** to enhance the biodiversity value of the site, but minimise the adverse effects of fencing on wildlife, archaeology, landscape and public access.*

Grazing animals offer the best opportunity to develop and maintain **patchy mosaics** of denser groves, open wooded habitats, scrub and more open vegetation and the unique environments these create. This provides structural complexity and enhances floral and wider diversity.

They offer a more **sustainable approach** to developing complex and irregular stands, reducing the need for cutting interventions. Over the long term, this can help develop old trees by maintaining open conditions for individual trees to grow without significant crown competition.

Grazing animals can reduce dominant species, such as bramble and rank grasses, and promote floristic diversity [184] . They can be essential for maintaining and enhancing existing habitat and vegetation features – such as tall herb communities and some bog communities that benefit from very light or infrequent grazing.

Grazing animals can be a component of productive agroforestry systems. In many situations, the introduction of grazing with cattle or other livestock should be done once trees have reached a suitable stage of development, probably between five and 10 years after initial establishment. This is especially the case where intensive control of deer populations is required to secure the establishment of trees. Earlier introduction of large grazing animals may be appropriate on parts of a site; for example, in glade or wood pasture areas. It will also be appropriate, perhaps essential, on sites where **natural colonisation** is key. In this scenario, large grazing animals will be required to disturb the ground and create opportunities for trees and shrubs to colonise.

Cattle can provide the kind of natural disturbance that drives dynamism in woodland habitats

Practical considerations

The inclusion of grazing animals will require additional **planning**, adequate access for vehicles, and grazing infrastructure (fencing, handling facilities, drinking water supply). A well-considered **grazing regime** is essential before introducing grazing animals [185] and the resources and skills allocated to sustain grazing over the long term – see the **Woodland Grazing Toolbox**. Stocking levels, breed choice and timing of the grazing season are site-specific decisions.

If stock is not owned or kept on site all year, it will require **working with others** who keep livestock through licences or agreements. **Off-site land or housing** may be required for wintering or at other times of year. Regular checking ('lookering') of stock is also a welfare requirement.

Forage quantity and quality must be assessed [186] and the **impact of any wild herbivores** [185].

Monitoring of grazing impacts against your objectives is necessary to avoid overgrazing. This may be indicated by a lack of tree recruitment or ubiquitous browsing damage. Certain trees and shrubs are more palatable and may be preferentially browsed. Some open and transitional habitats can be dominated by taller palatable herbs (like meadowsweet or angelica) which are more sensitive to prolonged grazing. Stocking levels and management need to avoid impacts on existing veteran tree features; for example, from congregating animals leading to compaction or significant bark damage.

If livestock grazing is proposed in areas with **public access**, consider the suitability of the livestock, site layout and access infrastructure, and provide information for visitors.

Grazing can be used to maintain the visibility of historic environment features. Fencing and the presence of animals should also be planned to avoid or minimise disturbance to archaeology and will require consent on Scheduled Monuments.

Brown hairstreak butterfly is a conservation priority species, and relies on blackthorn as its larval foodplant and aphid honeydew and flowers for nectar as adults

6.5 Conservation of target species

It is a key design principle to ensure that projects protect and enhance target species. Where these influenced your design, it is important you **continue to recognise their needs** within management during the establishment phase. **Monitoring** of these species will provide an important measure of success for the project.

6.5.1 Artificial cavities – boxes

The provision of artificial structures can support a range of cavity-dependent species that would naturally occur in wood-decay tree cavities, holes and cracks. Longer term, your priority should be to develop trees with these old-growth and veteran characteristics. In newly established woods, and trees lacking these features, provision of boxes is a simple and familiar way to provide these microhabitats in the interim, until natural cavities form for your target species. Nest boxes do not provide exactly the same environments as natural cavities, but are a useful stop-gap measure [187].

For **birds**, nest boxes can provide for a whole suite of taxa, from songbirds to owls, raptors and even ducks. They can benefit population density, growth rates and productivity, and their design is critical [188]. Good design improves nestling development, and reduces mortality caused by pests, diseases and predation [187]. **Regular cleaning** is required to prevent the build up of nest material from year to year, which can harbour fleas and parasites.

All UK **bats** have been found in or around trees and woods. Some may only use woods to forage, but many are known to roost in tree cavities, including brown long-eared, noctule, barbastelle, Bechstein's and Natterer's. Tree-roosting species require cavities, crevices and splits, loose bark and dense ivy in different parts of the tree at different times of the year to provide the conditions they need (Jackson, 2015). Bat boxes can be fitted to younger trees to provide artificial roosts where these features are lacking.

Boxes can also be used successfully for **other animals**, including small mammals, such as dormouse and wood mouse; and invertebrates, including moths and butterflies, and those that are associated with wood decay (various beetles, true flies and other groups), by packing them with wood mould, sawdust and other decaying material [189,190]. The contribution this might make to a new woodland creation depends on the context; for example, if you are in an area with known dormouse populations in well-connected established woodland or where lots of decaying and hollowing veteran trees occur.

ALASTAIR HOTCHKISS

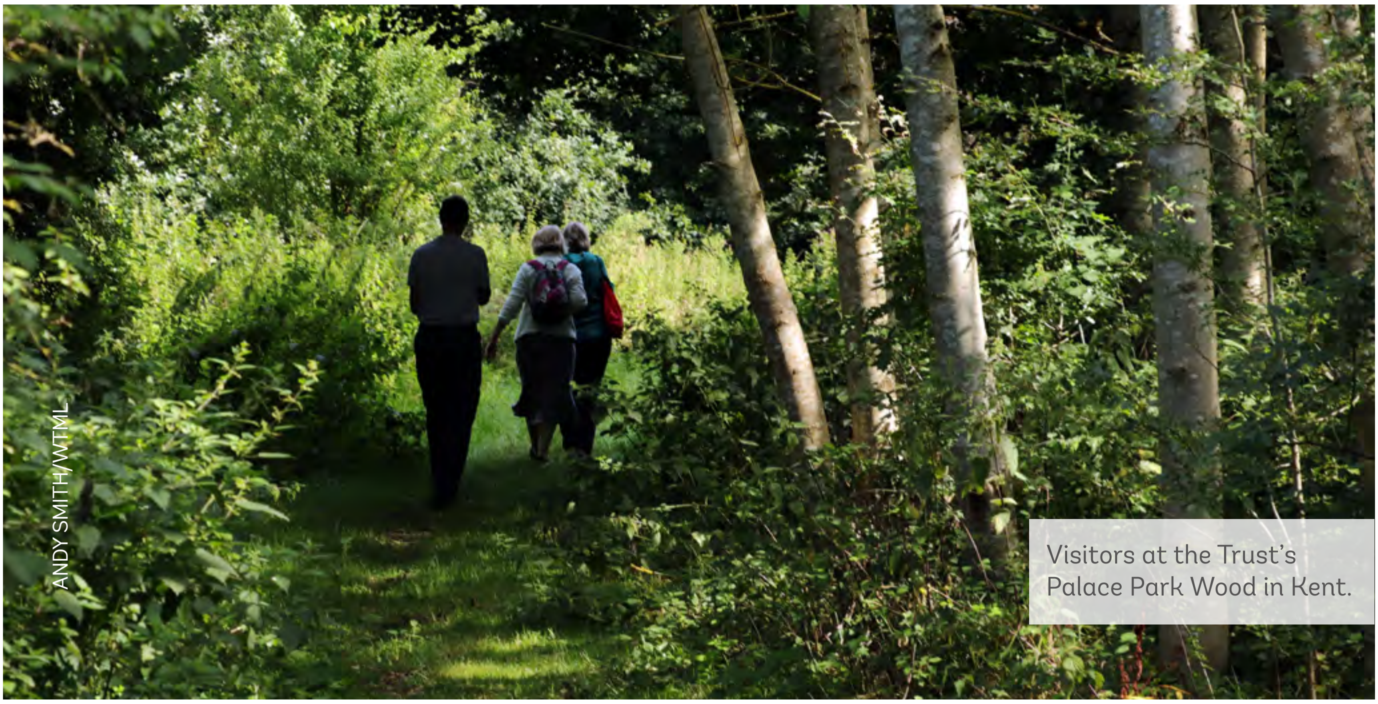
Artificial cavities can support species long before natural cavities begin to form on young trees. Natterer's bats using a box.

6.5.2 Additional habitat features

Take opportunities to **create additional habitat features** to support nature recovery. Although many of these features ought to have been considered in the design phase, if machinery is available, then it may be straightforward to create a **pond** or **scrape** for wetland species to move into. Pond creation must be well planned, designed, and managed. Other habitats that might be easily created in the establishment phase could include **bee banks.** These can be large soil banks in sunny glades that provide opportunities for ground-nesting bees as well as other species like reptiles and plants that prefer drier conditions.

Useful resources

- **Woodland grazing toolbox** (Scottish Forestry, 2005). Templates, advice and calculators for woodland grazing systems.
- **Conservation grazing – Rare Breeds Survival Trust** (Online support and resources for conservation graziers).
- **Wildlife ponds in woodlands** (Fresh Water Habitats Trust). Advice on creating wildlife-rich ponds in woodland.
- **Woodland wildlife toolkit** (partnership website with factsheets and advice for rare and declining woodland wildlife).



ANDY SMITH/WTML

Visitors at the Trust's Palace Park Wood in Kent.

6.6 Visitor access and engagement

UKFS (people): Maintain visitor safety, including discharging the statutory duty of care to all visitors on the land, whether or not they have permission. Manage hazards to minimise significant risks. Ensure the safety of visitors using permissive ways and on land dedicated under the CRoW Act 2000 (England and Wales).

UKFS (people): *Consider opportunities to promote* **recreational access** *to support people's health and wellbeing. Consider permitting and promoting* **educational and learning activities** *and community use and* **volunteering**. *Weigh up the potential for supporting sustainable woodland-based* **businesses and livelihoods**. *Manage the impact of visitors on* **susceptible wildlife**, *especially at critical life stages such as breeding, nesting and flowering. Where public access is significant, consider producing an access management plan. This should include risk assessments and record the regular inspection of main routes and facilities and any work undertaken, as well as any accidents or incidents.*

The level and need for engagement and communication with visitors will vary with the location, size and use of your site, and any objectives you have to promote and facilitate particular use or access. Where you have provided or promoted opportunities for visitor access, engagement activities and events, volunteering or other group activities, these will then require appropriate management as your wood establishes.

Your stakeholder engagement and consultation will have given you a feel for people's interest in your site. Sometimes, it is not until activity happens on the ground and your young woodland begins to establish that you will know how your site is being accessed and used. It is helpful to **monitor access and engagement** with the site during this time and collect any **feedback** from visitors. This can be done using visitor counters, on-site surveys, observations and conversations, and monitoring any social media interaction. It is important to **respond** to visitor use and feedback where relevant, such as widening or surfacing new paths as 'desire lines' develop. You may wish to provide **virtual access** to users who would find it difficult to access the site physically. This could include video tours, on-site webcams, discussion webinars and so on.

You will want to provide **a welcoming environment** which engages people from the beginning. If appropriate, consider providing web-based information or on-site signage which explains how people can access and use the site; for example, transport links to get there, paths for different user groups (including walkers, cyclists, dog walkers, etc.), any zonation of the site (e.g. dog-free areas), and user facilities (e.g. tracks suitable for wheelchair users and children's buggies; toilets; car parking; and camping).

Providing **interpretation** of your site's vision and objectives, and how the activities people see happening are leading towards this, can be helpful during the establishment phase to take people on the **journey of change** with you. People may see fencing going up or coming down, areas being cut or mown, views appearing then disappearing as the trees grow, deer and grey squirrel management, trees being felled, temporary closures, research being carried out and so on. **Interpretation can be** achieved through simple temporary signage, designed on-site information boards, guided walks and events, volunteering opportunities, virtual tours and information. Explaining these changes will help broaden understanding and support for your vision as your site becomes embedded in the community.

Safety of your visitors is paramount, and it is also important to **protect** the conservation features on your site. A **site risk assessment** is vital to ensure obviously dangerous or sensitive areas are closed off or that paths do not enable easy access to them. This may include risks from falling branches or trees, on-site machinery, tick or other animal bites, steep or rocky terrain or open water, exposure to weather, how to behave around any livestock, interacting with other users (e.g. horse riders and mountain bikers), how to handle dogs during bird-breeding season and around ponds, deer management activity, how to reduce the spread of tree disease, and so on. **Explaining** how people can behave to protect themselves and wildlife can be useful. Risks may change seasonally and/or as your site establishes, so it is important to **regularly review** your risk assessment. We recommend following the guidance available on the Visitor Safety Group and other websites detailed below.

Keeping on top of the **practicalities** of access management is key to visitor satisfaction and ensuring visitors act in the interests of your site. This includes maintaining open tracks and paths, coppicing scrub/trees to maintain views, maintaining any on-site shelters or play areas, tree safety works, car parking access, and managing any litter, dog waste or vandalism problems. Setting a regular programme of works and, if appropriate, volunteer activities, can aid you in the maintenance of safe and welcoming access to your site.

Useful resources

- **Visitor Safety Group** (website). Guidance on managing visitor safety in the countryside, including legal requirements and best practice advice.
- **National Tree Safety Group** (website). Advice on tree safety legal requirements and practicalities.
- **Paths for All** (website). Useful resources on path design and grading, etc.
- **gov.scot/policies/landscape-and-outdoor-access/public-access-to-land** (web pages with links and maps). Scottish Government information on landowner responsibilities and best practice

CASE STUDY

JUDITH PARRY/WTML

The wide open rides at Heartwood Forest contribute to the woodland structure across the site and are appealing to the large numbers of visitors.

Heartwood Forest – Hertfordshire's new native woodland on a grand scale

'A range of excellent woodland wildlife habitats, from native woodland groves of varying age structure, to patches of scrub and thicket, as well as mature trees, woody shrubs, tall-herb communities, and open habitats'. This is the long-term vision for Heartwood Forest – a 347ha site owned and managed by the Woodland Trust – with work well underway.

Between 2009 and 2018, around 260ha of native woodland was created at Heartwood Forest on ex-arable land, buffering and linking pockets of ancient bluebell woods while preserving views and maintaining rides and open spaces. Many kilometers of old hedgerows crisscross the site, and patches of species-rich wildflower meadows and open grassland form an important part of the habitat mosaic. This mix of early successional woodland and existing habitats provides huge biodiversity benefits as well as an important amenity for the public to explore.

The next few years are crucial to ensure the successful establishment of the new native woodland areas. The aim is to develop diverse new woodland that is healthy and well-integrated into the existing habitats and landscape. To achieve this, new areas of scrub, thicket and young woodland groves are being left, where possible, to develop and diversify through natural processes. Management interventions are only used where evidence suggests action is necessary. For example, a small amount of beat-up planting was undertaken in areas where the

CASE STUDY

sapling survival after two years was particularly poor. Also, more established groves that lack structural or age diversity may be periodically thinned to encourage regeneration and development of a mixed-age woodland.

Interventions are required at the edges of groves to promote well-lit edges and habitat variety, and in rides and glades to prevent them becoming shaded. The transitions at the edges of denser groves at Heartwood are being managed to encourage shrubs interspersed with occasional individual trees. Scalloping some edges through regular coppicing maintains a gradation from grass through coppice and shrubs to larger trees in the core of the groves.

Enrichment planting of wild honeysuckle (*Lonicera periclymenum*) is planned to improve wildlife value along transitions from groves to open wooded habitats, rides and glades. Other management techniques are being explored, such as ground disturbance along edges of groves that may allow natural colonisation, to create more transitional habitats. Future plans include accelerating the development of appropriate ground flora species by seeding or planting in some areas when conditions become more suitable.

To inform management, annual surveys of the new native woodland are being carried out, starting in 2020 with the areas planted in 2009, then followed in 2021 with the areas planted in 2020, and so on, to identify and map areas that could be managed to achieve a desired habitat. Management actions will be identified, such as thinning or coppicing, and reviewed every five years.

CASE STUDY

Heartwood Forest
Pismere Spring
Well Wood
Pudler's Wood
The Magical Wood
Langley Wood
Hillend Farm
110
100
120
115
110
100
90
95
100
N
200m
New woodland - Grove
New woodland - Open wooded habitat
New woodland - Glade (Grassland/wildflower meadow)
Existing woodland
Community orchard
Paths

Surveying on the BeeBlitz at the Trust's Victory Wood in Kent

6.7 Monitoring

The information gathered during the **site assessment** should provide a **baseline for monitoring** the successful delivery of your project. Regular monitoring is important throughout the establishment phase as the site develops. Change can occur rapidly as trees become established and monitoring may need to be done at more frequent intervals than would be necessary in mature woodland.

Monitoring provides the information required to inform **management decisions** and keep the development of the site on course to deliver against the agreed **objectives**. It also provides the **evidence** that may be required by regulators, funders and stakeholders to **demonstrate** that the project is being delivered successfully.

There are several components of a monitoring programme:

Project delivery

Firstly, you will need to monitor how successfully the project has been delivered. This could cover reaching **key milestones** in a project plan, or actions described in the woodland creation design. Examples would include finishing the installation of infrastructure such as tracks and entrances, completion of maintenance planting/beating up, and the removal of tree guards.

In addition to the project milestones, you can evaluate the level of **satisfaction of key stakeholders**. This could involve a landowner survey, stakeholder questionnaire or more in-depth meetings with stakeholders and key delivery partners.

Project impact

Understanding the impact of a woodland creation project can be complex. The basis for this should be the **objectives** agreed for the project. Measuring the extent to which these objectives have been delivered may involve the use of **metrics at a range of scales**.

Some objectives can be measured at the **site scale**. For example, if you have a water quality objective, it may be possible to carry out water quality monitoring at key points where watercourses leave the site. Equally, if public access is an objective, then visitor numbers and satisfaction surveys will provide a picture of public use as the site develops.

Other objectives may need reporting at **landscape or catchment scale**. Providing monitoring data from the site can contribute to reporting on catchment management plans, green infrastructure strategies and local nature recovery strategies. This is particularly important for projects in the Trust's **priority treescapes**, for which good monitoring data from woodland creation sites will inform key metrics for landscape-scale delivery. This should be a two-way process, with landscape metrics helping to demonstrate and set in context the contribution of a single site to the delivery of wider landscape-scale change.

Some monitoring data is also important at **country** and **UK scale**. For example, consistent use of the eight themes in setting objectives for people and wildlife will provide a clearer picture of the contribution of native woodland creation to regional and national strategies. This will enable us to talk with a stronger voice about what has been delivered for climate change mitigation, flood management, public health and wellbeing and other key policy and funding priorities.

Nature recovery

The final component of monitoring, and one which underpins the delivery of all other objectives, is monitoring the development of **quality habitats** on the site, and the response of **wildlife**.

Habitat condition assessment

The basis of this should be a **habitat condition assessment** based on the indicators and thresholds defined in the **National Forest Inventory (NFI)**. Using this standard will enable woods and trees created with this approach to be directly compared with national standards.

The NFI condition-assessment approach has some limitations. It is most suitable for mature or well-established woodland habitats, and while it can be used effectively to evaluate mosaics of groves, open wooded habitats and glades, it is less applicable to other open habitats as components of woodland, and is unlikely to provide an effective assessment of the condition of trees in the farmed environment or in many urban contexts.

The condition-assessment **indicators and thresholds (or ranges)** form criteria that define **good ecological condition**. These thresholds should be seen as **broad criteria**, and **should be regarded as guidance, not targets,** for any individual site. Plans and aspirations set out in your design may often exceed the thresholds for good condition for certain indicators.

The condition assessment method forms part of the Trust's monitoring approach. Large sites and landscape-scale projects may require more comprehensive monitoring than smaller projects and schemes, which can be monitored using a sampling approach. The **survey method** could range from a simple walkover survey to more specialist and detailed monitoring.

Grazing regimes (deliberate livestock grazing or wild herbivores) on your site may need additional monitoring at more regular intervals than habitat condition assessment, to assess impacts and make adjustments to stocking-levels timing and type, and/or culling regimes for wild herbivores, depending on the outcomes of your assessments.

Wildlife response

Condition assessment is a measure of habitat quality. Your nature-recovery objectives may include objectives for **flagship, keystone, indicator** or **target species**. In this case, you will need to monitor the presence or abundance of a species, community or assemblage to be able to assess progress against these objectives. This can be done by ad hoc recording of observations, tailored site surveys or by using the methodologies – and in many cases volunteers – of existing **national monitoring programmes**, such as those managed by Butterfly Conservation, British Trust for Ornithology or Botanical Society of Britain and Ireland. Some species (such as keystone species, like beaver) may have been part of a wider **reintroduction programme** and may have additional monitoring requirements.

An awareness of the response of wildlife is important for all woodland creation projects, as the species' response delivers the **direct evidence** that habitat quality and natural processes are providing the niches and resources to support nature recovery [191].

UKFS (biodiversity): *Assess grazing and browsing levels and the impact on the biodiversity value of the woodland.*

6.7.1 Condition assessment

The **condition assessment** records information on broad habitat attributes as a proxy for wider nature recovery. It is based on a survey of indicators and does not require expert identification skills or complex survey techniques. At its simplest, this can be a walkover survey, although the addition of 10-metre radius survey plots will increase accuracy and confidence in the assessment. Full details of the survey methods, indicators and thresholds are provided in the **Condition Assessment Handbook**.

The full suite of **NFI indicators** provides an assessment of ecological condition for an area of established woodland on a scale of **good, moderate** or **poor**. Some of the indicators cannot be applied in the earlier stages of woodland creation, but the method can be amended, with additional indicators added to the survey as the site becomes established.

A summary of the indicators for the **initiation** and **establishment phases** is provided in this section, along with a summary of the additional indicators which form the full **woodland condition assessment**.

Recording a site as good condition in the earlier stages of woodland creation will show that it is on a **trajectory** to become native woodland of high nature value. In addition to the condition thresholds, a **direction of change** can be applied to give further confidence about this trajectory. This is an opportunity to draw on evidence of management interventions or other changes that have taken place since the last condition assessment, to inform whether things are **improving**, **declining**, or whether there is **no change**.

Initiate – condition indicators

In the initiation phase **(years 1–5)** of woodland creation, a suite of seven indicators should be recorded to assess condition:

- **Wild, domestic and feral herbivore damage:** recording browsing pressures and impacts (browse lines, bark stripping, browsing of shoots, deer-tracks, etc.).
- **Invasive non-native plant species:** the presence and extent of invasive non-native plants. Some species such as rhododendron and cherry laurel can outweigh all other positive indicators, to place a site in poor condition.
- **Native tree species**: the composition of tree species during the initiate stage is recorded, with good condition generally associated with a higher diversity. This indicator should be interpreted based on an understanding of the target woodland community and the timescales for woodland development and natural colonisation.
- **Nearby semi-natural habitat:** recording the presence and extent of 'favourable land cover' within a 5.6km radius of the site (100km^2 circle).

Favourable land cover includes semi-natural habitats, such as existing native woodland, species-rich grassland, bog, dwarf shrub heath, fen, marsh and swamp, montane habitats and fresh water.

- **Regeneration:** recording the percentage cover of natural regeneration (seedlings and saplings) of native trees and shrubs and any non-native trees. This is important at the initiate stage for all sites as it recognises the importance of natural colonisation for habitat quality and resilience.
- **Vegetation and ground flora:** recording the extent of recognisable semi-natural vegetation communities (e.g. National Vegetation Classification communities) within the site, and any key species identified. In some areas, this might include ancient woodland indicator plants and/or some existing more open priority-habitat features.
- **Size of woodland:** there is an established relationship between species richness and habitat area, particularly for more specialist species. As the size of the site increases, there is proportionally more internal habitat and less edge effect. For new woods and trees, the size measure should include adjacent existing woodland and could also include other contiguous priority habitats that form part of a coherent habitat mosaic.

These indicators do not include some important structural components and features, such as **veteran trees** or **decaying wood**, although where present, these will have been recorded in the site assessment. The contribution of these features to habitat quality and a diversity of wildlife should be reflected in any reporting of habitat condition and inform management decisions.

Initiate – wildlife response

Many of the more complex habitat structures that are the focus of condition assessment will not be present in the initiation phase. In the absence of these habitat indicators, evidence of colonisation or use of the site by **indicator species** can provide invaluable evidence of progress and contributions to nature recovery.

In the initiation phase, species indicators may include an **increase in abundance** in habitat generalists such as common birds and butterflies. A relaxation of intensive land use may be indicated by the presence of species such as barn owls, and an increase in the mice and voles that are their prey.

Other indicator species may reflect the **change in land use**. The diversity of insects visiting flowering herbs in the ground layer may show a significant change from previous pasture or arable land use.

Some species may be useful indicators for **priority habitat** features identified in the site assessment. For example, plant indicators of species-rich grassland may be very important in determining that these habitats are being maintained in good condition.

Establish – condition indicators

In the establishment phase **(years 5–20)**, five additional indicators can be added to the seven recorded in the initiation phase:

Occupancy of native trees: the overall cover of native trees across a site is an important indicator at this stage.

1. **Open habitat:** the percentage cover of temporary open glades and transitional zones within the woodland. This indicator is measuring dynamism in the woodland ecosystem and is focused on recording space which is available for the natural regeneration of trees and shrubs, and the configuration may well change during the establishment phase.
2. **Tree health:** monitor any rapid loss (mortality) of trees or shrubs, along with any extensive crown/branch dieback and evidence of pests and diseases (identified and recorded via Observatree/TreeAlert).
3. **Woodland vertical structure:** record the number of canopy storeys present – upper, middle and lower canopy, young trees and shrub layer. The habitat mosaics and structural complexity built into the design will begin to develop during the establishment phase and can be recorded as a key indicator of habitat quality.
4. **Woodland damage:** record significant patches (>0.1ha) of nettle and/or goose grass, which can indicate significant nutrient enrichment. Also note soil that has been damaged (e.g. deep ruts) or compacted (e.g. by forestry machinery, animal poaching, etc.).

Establish – wildlife response

In the establishment phase, it may be possible to record early evidence of colonisation by **specialist species** associated with **woodland habitats**. This could include the presence of birds of the dense thickets of establishing groves, such as chiffchaff, willow warbler and garden warbler, or those of open wooded habitats, such as black grouse or tree pipit. Equally, records of insects may progress beyond the increases in abundance that might occur in the initiation phase to include colonisation by insects with strong associations to one or more native tree species.

Indicator species for **priority habitat** features continue to be important. These may directly inform management decisions; for example, by showing whether mowing or grazing regimes are maintaining species-rich grassland in good or improving condition.

Woodland condition assessment – indicators

A timescale of around **20 years** is suggested to reach the end of the establishment phase, but the growth rate and size of trees may vary between locations, species and initiation methods. Practically, this may be considered as the point at which felling licence permissions will be required, or when trees have reached around 10cm in diameter at 1.3-metre height.

Once woodland is established, the remaining three indicators can be added:

- **Age distribution of trees:** the presence of a range of age classes (young, intermediate and mature) is a key indicator of habitat condition in an established woodland. Age structure cannot be developed in the establishment phase, but can be promoted by protecting and managing all existing native trees on the site and by phasing woodland creation interventions – such as ground preparation, seeding and planting – over many years.
- **Veteran trees:** record the presence and location of veteran trees, identified by DBH for a given species, and/or a total of three or more veteran features. Features may include: trunk cavities or hollowing, water pools in tree crevices, large quantities of decaying wood in the canopy, loss of larger branches, sap runs, missing or loose bark, fungi on the trunk or large branches, and plants growing on the trunk or branches. Ensure that records of any veteran trees are shared with the Ancient Tree Inventory. The threshold for good condition is very low, but in many woods an aspiration of four or more veteran trees per hectare would be appropriate.
- **Amount of decaying wood:** this includes decaying wood in live trees and standing dead trees, as well as large, fallen decaying branches and stumps. Volumes of 40m3/ha of decaying wood are required across most of a site to achieve a good condition score for this indicator, although in some wooded landscapes you should aim for much higher volumes.

The addition of these long-term indicators to the assessment may reduce the overall condition score as the establishment phase is concluded. However, if the other indicators recorded during the establishment phase are in good condition, this should ensure a moderate or good overall assessment of condition. At this stage, the wood should be moving into long-term and sustainable woodland management, ideally guided by an appropriate management plan. The aim should be to maintain the trajectory towards native woodland of high nature value; for example, by managing open grown trees as potential future veterans, building volumes of decaying wood, and managing the field layer and scrub through grazing or mowing in open wooded habitats and glades.

6.8 Congratulations!

Having followed through the different stages of this guidance you should be well on your way to creating woods and trees you can be proud of!

You will have set out with some ideas and aspirations and developed these in collaboration with others. You will have got to know your site in detail and developed maps, plans and designs for establishing woods and trees. You will have committed time and resources to the complexities of initiating woodland creation and followed this with many years of considered and adaptive management as woods and trees have become established.

We hope that after all the years of effort, you will have seen your aspirations and vision realised and be able to observe and enjoy the benefits that your project brings to people and wildlife.


JUDITH PARRY/WTML

Dawn at Heartwood Forest

Glossary

Term	Definition
Agroforestry	The practice of deliberately integrating woody vegetation (trees or shrubs) with crop and/or animal systems to benefit from the resulting ecological and economic interactions.
Ancient tree (also see Veteran tree)	A tree which is exceptionally old (and often very large) in comparison with other trees of the same species. Often of great biodiversity and cultural importance.
Ancient woodland	Woodland believed to have been in continuous existence for centuries (officially since 1600 in England, Wales and Northern Ireland, and 1750 in Scotland). Often of great biodiversity and cultural importance.
Baseline	The time when records began. Used to establish trends over time.
Beating up	Replacing newly planted trees which have died.
Continuous cover forestry	A forest management practice which aims to achieve a forest with trees of irregular age and structure, often providing a wider variety of habitat 'niches' in comparison to a clearfell forestry system.
Condition/ ecological condition/ condition assessment	Refers to the state of ecological systems, which includes their physical, chemical, and biological characteristics and the processes and interactions that connect them. Condition assessment takes easily assessed indicators – such as habitat structure, species composition, level of invasive species, etc. – and scores them against established criteria to determine condition status. Repeating assessments over time can indicate how condition is changing in response to management or external threats.
Canopy cover	From above, the area of land beneath the tree canopy. Distinct from 'woodland cover' as it includes trees outside woodland and excludes the open space in woodland.
DBH (diameter at breast height)	1.3 metres – a standard height at which to measure the diameter of a tree. For example, 'the tree is 30cm DBH'.
Dynamism	Refers to the processes which drive change in ecosystems (positively or negatively, e.g. storms, disease, tree felling): creating tree canopy gaps which allow light to reach the forest floor for new tree generation; and providing decaying wood as habitat.

Term	Definition
Ecosystem services	The benefits provided by ecosystems that contribute to making human life both possible and worth living. Examples of ecosystem services include products such as food and water; regulation of floods, soil erosion and disease outbreaks; and non-material benefits such as recreational and spiritual benefits of natural areas.
Ecotone	The transition between two biological communities.
Elite tree	A **tree** which is considerably more advanced (growth rate/form, etc.) than an average **tree** of the same species in a locality.
Felling license	License required before trees (above a certain volume within a specified time period) can be felled. Obtained from the relevant regulatory body. May have 're-stocking' conditions attached.
Fragmentation	Occurs when large areas of habitat are divided into smaller areas by habitat loss, both decreasing habitat availability and increasing isolation between habitat patches. Can drive species dependent on large habitat areas to local extinction.
Functional connectivity	The connectivity between different habitat patches that allows species to successfully disperse between them, linking populations. Typically larger, better-quality habitat patches produce more disperses, and dispersal is more successful between spatially close patches separated by other permeable habitat types.
Glades	A structural component of woodland, with only sparse or scattered trees and scrub (<20% canopy cover). They may be temporary as the result of natural disturbances or interventions, or maintained as open for longer through grazing, cutting or physical factors (regular drought, waterlogging, etc.) with field-layer vegetation which may be characterised by plants associated more with more well-lit situations.
Grove	A structural component of woodland, with relatively closed canopy (>70% canopy cover) and typically dense trees and shrubs. They may be young (thickets or pole stage) or old (ancient and old growth), and ungrazed or grazed. But they are usually characterised by plants and animals associated with lower light, humidity, leaf litter, etc.
Indicator species	A species which can be used to infer suitability of conditions in a habitat, and may also indicate trends in other species requiring similar conditions
Legacy tree	A tree identified to maintain to live out its natural lifespan: providing old-growth characteristics and seed-production potential.
Native range	Area of the UK to which native species have colonised naturally (without human assistance).

Term	Definition
Native species	Species which have naturally colonised regions of the UK since the last ice age.
Natural colonisation	The natural process by which trees and woodlands establish on sites which were previously unwooded.
Natural regeneration	Natural establishment of trees and shrubs from seed, layering or suckering.
Naturalised	Trees that were introduced to the UK a long time ago (hundreds of years) and are able to reproduce naturally.
Non-native species	Species introduced to the UK (or regions of it) which would not naturally be present.
Open habitat	More extensive areas of vegetation characterised by very few or no trees (e.g. grassland, ponds, lakes, etc).
Open wooded habitat	A key structural component of woodland, including a wide range of habitats with much variation in degrees of canopy openness (20–70%) and vegetation patterns. These may include habitats that can be described in different ways, such as scrub, wood pasture, ffridd, wood meadow, wood edge, ecotone, low-density woodland. Crucially, open wooded habitats provide an essential spectrum of transitional wooded habitats in between groves and glades. They may be temporary, as a result of interventions (e.g. thinning), or maintained for a very long time (e.g. old-growth wood pastures).
Phenology	The study of the timing of seasonal events.
Precautionary principle	Proceeding with caution where there is incomplete information to make a decision about the effects of environmental management, so as to not have inadvertent consequences on habitats and species
Priority habitats	UK BAP priority habitats cover a wide range of semi-natural habitat types, and are those identified as being the most threatened and requiring conservation action under the UK Biodiversity Action Plan (UK BAP). Notwithstanding devolution, the UK list of priority habitats remains an important reference source and has been used to help draw up statutory lists of priority habitats under countryside and nature acts.
Provenance region	A broad area from where seed or plant material was sourced (see 'Seed zone').
Remnant features	Features of previous habitats or archaeology which may need protecting or enhancing.
Re-spacing	Cutting dense saplings to create a desired stem density.
Sapling	A young, slender tree.
Saproxylic	Any species dependent for part of its life cycle on decaying wood in living or dead trees.
Screefing	Scraping away vegetation to create a seed bed.

Term	Definition
Seed zone	Delineating an area with similar characteristics (altitude, soils, etc.) from which seed has been collected (within a provenance region).
Stand (of trees)	A forestry term for an identifiable group of trees within a bigger woodland, forest or site.
Transitional zone	The area in which the change from one habitat/ecological community to another occurs. (See also 'Ecotone').
Priority treescapes	The Woodland Trust's landscape-scale delivery areas.
Trees outside woods (TOWs)	TOWs include individual trees, small copses, hedgerows, street trees, trees on farms and along rivers, and in wood pastures and parklands. Any trees outside the definition of woodland.
UK Forestry Standard (UKFS)	The reference standard for sustainable forest management across the UK, applying to all woodland regardless of who owns or manages it. Set and updated by the UK Government.
Urban forest	An overarching term for urban tree and woodland cover, including individual trees – from newly established to ancient – as street trees, riverine trees, hedgerows, copses, and in parks and woods.
Veteran tree	The terms ancient and veteran are sometimes used interchangeably, but we also make a distinction between them. Veteran trees may be a great size or age, or display physical features, such as trunk hollowing. By contrast, ancient trees are old in comparison with other trees of the same species. Thus, all ancient trees are veteran, but not all veteran trees are ancient.
Veteranisation	Deliberately initiating development of veteran characteristics in a tree too young to have developed them naturally.
Woodland	An ecosystem characterised by a significant proportion of woody vegetation (trees/shrubs), comprising an intimate mix of groves (>80% canopy), open wooded habitats (20–80% canopy) and glades (<20% canopy, but can include individual scattered trees or scrub).
Woodland condition	See 'Condition'.
Woodland cover	The amount of land covered in woodland and wooded habitats. Usually includes open habitats within woodland. (See also 'Canopy cover').
Wooded habitats	Habitats with woodland, copses, individual trees and shrubs, interspersed with other habitats such as grassland, heath, bog and farmland.
Wood pasture	Mosaic systems which can comprise groves, open wooded habitats and glades, and typically including the following features: grazing animals, an open ground layer or grassland or heath, shrubs and scrub, veteran trees and decaying wood

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