The UK Forestry Standard

The governments' approach to sustainable forestry

Forestry Commission
Scottish Forestry
Coilltearachd na h-Alba
Cyfoeth Naturiol Cymru
Natural Resources Wales
FOREST SERVICE

The UK Forestry Standard

The governments' approach to sustainable forest management

Forestry Commission

Scottish Forestry
Coilltearachd na h-Alba

Cyfoeth Naturiol Cymru
Natural Resources Wales

FOREST SERVICE

This publication is available from: www.forestresearch.gov.uk/publications

First published by the Forestry Commission in 1998. Second, Third and Fourth edition published in 2004, 2011 and 2017. This new Fifth edition published in 2023.

ISBN: 978-1-83915-021-0

FOREST RESEARCH (2023).
The UK Forestry Standard.
Forest Research, Farnham.

Keywords: biodiversity; climate change; ecosystem services; environment; forestry; historic environment; landscape; people; soil; sustainable forest management; water.

UKFS002/FR(PURE)/PDF/SEP23

Enquiries relating to this publication should be addressed to:

Forest Research
Alice Holt Lodge
Farnham
Surrey GU10 4LH

E: publications@forestresearch.gov.uk

Forest Research will consider all requests to make the content of its publications available in alternative formats.
Please send any such requests to: publications@forestresearch.gov.uk

Contents

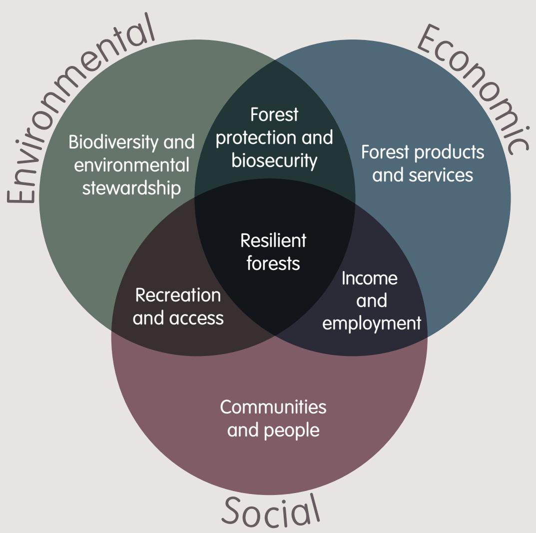
1. Introduction

The UK Forestry Standard (UKFS) is the technical standard for sustainable forest management in the UK. It sets out the approach of the four governments of the UK, and defines the requirements and provides guidance for foresters on how to practise sustainable forest management in the UK. In this way, it provides a basis for operating grant schemes and official controls and support for regulatory processes. It also provides the foundation for a number of voluntary certification and quality assurance schemes used in the UK, and for assessing compliance with environmental management standards.

Purpose of the UKFS

The UKFS is based on sustainable forest management criteria agreed internationally, implemented in a way that is appropriate to the UK. It is intended to be used by professional foresters such as forest owners, managers and practitioners, regulators and advisers. It will also be of interest to other land managers and stakeholders.

Sustainable forest management is the stewardship and use of forests and forest lands in a way and at a rate that maintains their biodiversity, productivity, regeneration capacity and vitality, and their potential to fulfil, now and in the future, relevant ecological, economic and social functions at local, national and global levels, and that does not cause damage to other ecosystems. Central to sustainable forest management in the UK is the concept of achieving a balanced set of objectives (see Box 1.1). It is vital that all parties involved in applying the UKFS understand the importance of achieving a balance of objectives. The landowner, forest manager and interested stakeholders all have a role in determining the most appropriate balance of objectives for the local circumstances.



Box 1.1 Balanced objectives

Sustainable forest management involves ensuring that the production of all forest and woodland benefits is maintained over the long term. This is achieved when the environmental, economic and social functions of forests interact in support of each other, as illustrated in the diagram on the left. The precise point of balance between environmental, economic and social functions will vary in individual forests in response to management objectives and local circumstances.
The concept of balanced objectives is central to the approach of the UKFS.

This edition of the UKFS builds on previous editions, reflecting changes in legislation across the four countries of the UK, new international agreements and advances in scientific understanding. It also takes account of the progress of devolution and a changed relationship with the European Union.

It has been endorsed by the governments of England, Scotland, Wales and Northern Ireland as their technical standard for sustainable forest management in the UK. The main bodies responsible for the regulation and monitoring of the UKFS (the 'forestry authorities') are the Forestry Commission, Scottish Forestry, Natural Resources Wales and the Northern Ireland Forest Service. However, while the UKFS underpins the implementation of devolved forestry policies, strategies, grant schemes and regulatory frameworks across the UK, it does not include detailed country-specific information on all these matters. This information should be sought from forestry authorities and other relevant bodies in each country (see section 1.3).

The UKFS is also the key reference document on forestry practice for the independent UK Woodland Assurance Standard (UKWAS), which is a certification standard adopted by the two global forest certification schemes – the Forest Stewardship Council and the Programme for the Endorsement of Forest Certification – for certifying responsible forest management in the UK. It can be used for assessing compliance as part of an environmental management system such as ISO 14001. The UKFS also underpins the Woodland Carbon Code, a government-backed quality assurance standard for woodland creation projects in the UK. Projects under the Code are required to comply with the UKFS, and this is checked by validation bodies.

Overview

Scope and application

The UKFS has been developed specifically as a technical standard for forestry in the UK and applies to all forests in England, Scotland, Wales and Northern Ireland. Forests are defined as land that is predominantly covered in trees, with a canopy cover of at least 20%, whether in large tracts or smaller areas. Although the minimum area of land classified as forest is defined internationally as 0.5 hectares, for the purposes of the UKFS it is defined in terms of national inventories and/or woodland creation scheme rules. In each country, legislation or grant conditions will determine the minimum area of land classed as a forest. These areas might be in rural or urban areas and be known by a variety of terms such as forests, woods, copses, spinneys or shelterbelts, and they include wooded areas on farms and in parks.

Within the UKFS, the term 'forest' is used to indicate all types and sizes of forest and woodland. References to 'forest and woodland' or to 'woodland' are made only where needed for clarity or to reflect commonly used terms (e.g. woodland creation, native woodland, riparian woodland).

The UKFS covers all UK forest types and management systems, including coppice with standards, short rotation coppice and short rotation forestry (whether managed as part of a forest or as an agricultural stand-alone regime). It does not extend to the management of individual trees (arboriculture), orchards, ornamental trees and garden trees, tree nurseries or Christmas trees.

The UKFS applies to the wide range of activities, scales of operation and situations that characterise forestry in the UK, and applies to the entire forest environment, including trees, open areas and water bodies such as rivers, lakes and ponds. It covers the process of woodland creation and the planning and management of existing forests, including in relation to the wider landscape.

Forest management requires long-term planning but management objectives need to be flexible enough to respond to changing scenarios, in particular those linked to biodiversity, tree pests and diseases and climate change. Changes and improvements may require timescales longer than the tenure of an individual manager or even a single forest rotation, which is why the UKFS emphasises the importance of forest planning. How the UKFS is used will therefore vary according to the circumstances of the site, particularly the size of the forest, the scale of operation, the objectives of the landowner and changing climatic conditions. Some aspects of forest management lend themselves to 'yes or no' compliance, but most do not, and so professional expertise and judgement are required to make the most effective use of this technical standard.

Structure of this edition

At the heart of the UKFS are two categories of Requirements:

- Legal Requirements (LR) are the statutory requirements relevant to legislation in England, Scotland, Wales and Northern Ireland that have the most direct bearing on the management of forests. Adhering to these Legal Requirements supports legal compliance, while contravening them could lead directly to prosecution. The term 'must' is used to describe the actions needed to implement a legal requirement.

- Good Practice Requirements (GPR) are important forestry practices that help deliver sustainable forest management. The term 'should' is used to describe the actions needed to implement a Good Practice Requirement, indicating that although they are not a legal requirement, appropriate action will usually be necessary in order to deliver sustainable forest management.

The UKFS Guidelines (GL) set out how the Requirements can be met. They provide information and guidance based on research and experience and are intended to help with developing proposals and planning management operations and activities to ensure that UK forests are sustainably managed. The term 'consider' is used to indicate that forest managers and regulatory authorities will need to consider whether Guidelines are applicable and should be implemented in any given scenario. For relevant Guidelines that stipulate 'consider', in order to comply with the UKFS, forest managers may need to show the workings behind their proposals when applying to their forestry authority for grants and permissions.

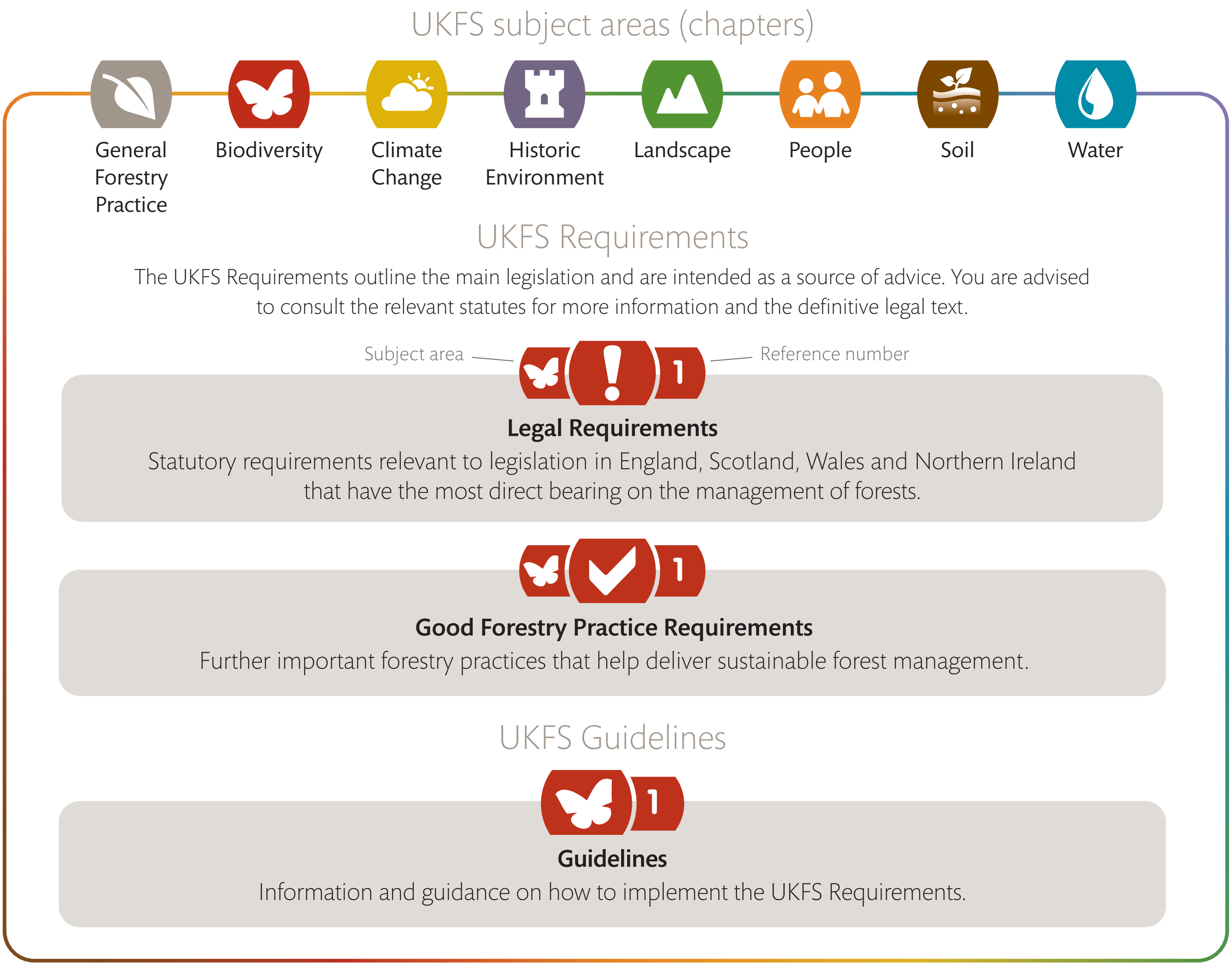
Some UKFS Requirements and Guidelines are expressed as maximum or minimum proportions of the forest. In these cases, the area in question is the forest management unit (FMU): the area subject to a forest management plan or proposal. The FMU is selected by the owner and/or manager and will be determined by the nature of the forest, the proposed operations and the management objectives.

In line with previous editions of the UKFS, the Requirements and Guidelines are grouped under eight interdependent subject areas. These illustrate the breadth of issues that are integral to sustainable forest management and that must be considered in combination (Figure 1.1).

Implementing the UKFS

Forest owners, managers and contractors are responsible for ensuring that forest operations and activities are delivered in accordance with the UKFS, and this is a prerequisite for the approval of forest plans, felling and replanting operations, woodland creation proposals and forestry grants.

Figure 1.1 The relationship between UKFS Requirements and Guidelines.



Country mechanisms are in place to address situations where the requirements of the UKFS have not been met.

Forestry authorities are responsible for determining how the UKFS is implemented and monitored in their respective countries. Monitoring activities include:

- Assessing and approving forest management plans and woodland creation proposals.
- Ensuring that forestry grant requirements have been met.
- Issuing felling approval and dealing with illegal felling.
- Preventing the entry and spread of non-endemic pests and diseases of trees.
- Controlling and regulating trade in forest reproductive material (seeds, plants or cuttings).

Country policies, strategies and regulations relevant to sustainable forest management

The UKFS sits alongside – but does not replace – the forestry policies, strategies and regulations of England, Scotland, Wales and Northern Ireland to deliver UK-wide and devolved country commitments to sustainable forest management. Country forestry policies and strategies give statements of intent for sustainable forest management in that country, and statutory regulations provide each country's framework for delivering these intentions. By contrast, the UKFS is the technical standard of sustainable forest management agreed by all four governments.

Forests in the UK are legally protected by a range of Acts and although these differ across the devolved nations, they share the same principles of:

- controlling tree felling;
- carefully considering the environmental impacts of woodland creation, deforestation and the construction of forest roads and quarries;
- balancing the production of timber with other benefits to society, the economy and the environment;
- respecting local, national or international conservation designations that may apply to a site;
- adhering to a general presumption that forest land should not be converted to other uses, to avoid deforestation;
- conducting forest operations in a way that minimises any significant negative impacts on the environment;
- managing and controlling plant health and biosecurity.

The following boxes summarise each country's key forestry policies and strategies. The information in these boxes is not a substitute for checking full country policies and strategies in detail: it is provided as summary information only. References to legislation are made when they directly apply to a Legal Requirement, otherwise, given the changing nature of legislation and devolved responsibilities, this edition of the UKFS does not contain a comprehensive list of all relevant legislation.

Box 1.2 Forestry in England

The Forestry Commission is a non-ministerial department with a remit to increase the value of woodlands to society and the environment in England. It is responsible for the regulation of forestry in England and provides incentives and guidance to those creating and managing woodlands.

The England Trees Action Plan 2021–2024 sets out what actions will be taken to expand and improve woodland cover in England and the contribution woodlands make to the economy and society. The plan also sets out a long-term vision for trees, woodlands and forests in England.

The UKFS is monitored through compliance with existing grant and regulatory approvals. Where non-compliance is identified and corrective actions are not undertaken, then escalation is through regulatory mechanisms, including enforcement or where funding can be reclaimed.

Further advice and information on the application of the UKFS in England, forest regulations, news, guidance and support is available here.

Forestry Commission

Box 1.3 Forestry in Scotland

Scottish Forestry is Scotland's forestry authority and the Scottish Government agency responsible for forestry policy, support and regulation. Details of forestry policies in Scotland can be found here.

Scotland's Forestry Strategy 2019–2029 presents a 50-year vision and 10-year framework for action, articulating Scotland's ambition to have more forests and woodlands and for them to deliver more economic, social and environmental benefits to the people of Scotland. Scotland's Forestry Strategy Implementation Plan 2022 to 2025 sets out the actions that the Scottish Government and its partners will undertake over the next three years to deliver the Strategy.

The UKFS is monitored via compliance with existing grant and regulatory approvals. Where non-compliance is identified and breaches have occurred, corrective actions are identified via a Compliance Procedure. If corrective actions are not undertaken, then escalation is through regulatory mechanisms where funding can be reclaimed or permissions can be suspended or revoked.

For advice and information on implementing the UKFS in Scotland, forestry regulation and grant support mechanisms, contact Scottish Forestry.

Scottish Forestry
Coilltearachd na h-Alba

Box 1.4 Forestry in Wales

Welsh Government is responsible for forestry policy in Wales, encompassing the management of existing woodlands and new woodland creation, and for grant programmes that support delivery of its forestry policies and strategies. Natural Resources Wales (NRW) is the competent forest authority in Wales, with various duties delegated by Welsh Government.

Welsh Government's Woodlands for Wales strategy (2018) is a 50-year strategy for woodlands and trees in Wales. It outlines Welsh Government's vision for trees, woodlands and forests and is built around four strategic themes: responding to climate change, woodlands for people, a competitive and integrated forest sector, and environmental quality.

The UKFS is monitored via compliance with existing grant and regulatory approvals. Where non-compliance is identified and breaches have occurred, corrective actions are identified by the relevant authority. If corrective actions are not undertaken, then escalation is through regulatory mechanisms where funding can be reclaimed or permissions can be suspended or revoked.

For advice and information on implementing the UKFS in Wales, forestry regulation, and grant support mechanisms, see Natural Resources Wales or gov.wales.

Llywodraeth Cymru
Welsh Government

Cyfoeth Naturiol Cymru
Natural Resources Wales

Box 1.5 Forestry in Northern Ireland

In Northern Ireland, the Department of Agriculture, Environment and Rural Affairs (DAERA) is responsible for setting and implementing environmental and land management policy. Forest Service delivers the Department's policy and legislative responsibilities in relation to forestry and plant health, including the management of public forests, and regulates the sector in conjunction with its grant schemes and by issuing felling licences.

Forest Policy is outlined in Northern Ireland Forestry: A Strategy for Sustainability and Growth. Delivery against this strategy supports overarching and cross-cutting DAERA strategies including those for green growth, peatland and the environment.

The UKFS is monitored via compliance with existing grant and regulatory approvals. Where non-compliance is identified and breaches have occurred, corrective actions are identified by the relevant authority. If corrective actions are not undertaken, then escalation is through regulatory mechanisms where funding can be reclaimed or permissions can be suspended or revoked.

For advice and information on implementing the UKFS in Northern Ireland, forestry regulation, and grant support mechanisms contact DAERA.

Department of Agriculture, Environment and Rural Affairs

FOREST SERVICE

2. General Forestry Practice

This section sets out aspects of forestry practice that apply to most forest situations, and that are common to the elements of sustainable forest management within the UKFS.

The importance of forest planning

Compliance with the law is fundamental to the UKFS, and this is reflected throughout. Any environmental impact arising from forestry practice must be considered, and this can apply at any stage of forest planning, from woodland creation plans to felling and restocking (or regeneration) proposals, and the construction of forest roads and quarries. Regulations are in place to help ensure that forestry operations do not cause significant negative effects on the environment, and various mechanisms and practices seek to encourage complementary action between forestry and wider land-use objectives (see Box 2.1). Local, national or international conservation or heritage designations may also apply to a site.

A key reference document supporting the planning, delivery and monitoring of sustainable forestry practice is a forest management plan that is compliant with the UKFS. In some cases, a forest management plan is also used to support the delivery of incentives by government bodies and others, as it demonstrates an understanding of the principles of the UKFS.

Forests need to be healthy and resilient to environmental change if they are to maintain and enhance their capability to produce timber products and provide other benefits to society and a high-quality habitat for wildlife. A forest's resilience is a function of its extent, condition, diversity, connectivity and adaptability, and therefore its resilience affects its cover, productivity and resistance to disease. Controlling damage by mammals, especially deer and grey squirrel, is essential, as is managing plant health and biosecurity. Given the rising number and severity of tree pests and diseases in recent decades, forestry practitioners should actively monitor the health of existing forests and be alert to the importance of biosecurity in their planning and management activities. The source of planting material for afforestation is important, especially in terms of biosecurity, benefitting productivity and biodiversity by reducing the risk of pathogens.

Box 2.1 Complementary action between forestry and catchment management

The concept of integrated catchment management looks to apply the principles of sustainable forest management at a water catchment scale rather than in a piecemeal approach that artificially separates land management from water management. It provides a framework to safeguard the natural functioning of freshwater ecosystems by trying to reconcile the various demands on the catchment, such as water supply, power generation, flood storage, navigation and fisheries, without jeopardising the natural characteristics of the water environment and heritage features on water courses. Connectivity is understood to be increasingly important, with forested areas planned and managed to allow links within the catchment and across the landscape.

UKFS Requirements for General Forestry Practice

General compliance

All occupiers of land and parties engaged in forest management activities are subject to a range of laws and regulations. Some are relevant to land-based activities in general and others are more specific to forestry.

1 Forestry activities and businesses must comply with all relevant laws and regulations.

2 Operations must be authorised by the legal owner.

1 Reasonable measures should be taken to ensure no illegal or unauthorised activity takes place within the forest.

2 Forestry activities and businesses should comply with relevant codes of practice and industry guidelines.

Forest protection

Forestry legislation across the UK conveys wide powers to promote sustainable forestry, support woodland creation and timber supply, and control felling and deforestation. Country guidance on forest protection legislation in England, Scotland, Wales and Northern Ireland should be referred to.

In addition to softwood and hardwood timber, UK forests deliver a wide range of social and environmental (or 'non-market') benefits and services. These benefits and services, in particular recreation, biodiversity, carbon sequestration, landscape, water quality and flood risk management, need to be maintained and enhanced as part of forest protection measures.

Deer management measures will need to take account of factors such as the scale and structure of the woodland, differing management objectives of neighbours, fragmented land ownership patterns and the contrasting ecological characteristics of different deer species, including the distinction between territorial and herding behaviour, which can have significant implications for deer management.

3 When required by country legislation, proposals for felling or thinning must be submitted to the appropriate forestry authority for approval. Following felling, restocking or regeneration will normally be required.

4 Before felling and pruning trees, a check must be made to ensure there are no Tree Preservation Orders or Conservation Area designations. Permission must be obtained from the relevant authority to fell or prune trees subject to Tree Preservation Orders or notification made where Conservation Areas have been applied.

5 Proposals for access onto a public highway by a forest road must be notified to the planning authority and appropriate permission obtained.

3 There is a presumption that forest land should not be converted into other land uses; guidance on the exceptional situations where woodland removal may be possible is available from country forestry authorities.

4 The capability of forests to produce a range of wood and non-wood forest products and services on a sustainable basis should be maintained and enhanced where possible.

5 Forests should be protected from the time of planting or restocking (or regeneration) of trees to ensure their successful establishment and long-term viability.

6 In areas where deer are present, deer management measures should be developed and implemented as part of a management plan, with the aim that deer browsing does not prevent regeneration of trees or the development of resilient forests; ideally this will be in co-operation with neighbours or as part of a Deer Management Group.

Environmental impact

There is legislation in each country of the UK requiring that the positive and negative impacts of forestry on biodiversity and the wider environment are addressed at both the planning and the operation stage. Any negative environmental impact of forestry operations should be minimised.

The potential for environmental impact is regulated under the various Environmental Impact Assessment (EIA) Regulations that apply to forestry, including activities relating to short rotation coppice, Christmas trees, deforestation, and the construction of forest roads and quarries. The regulations require a forestry authority to determine whether a proposal may have a significant effect on the environment. Where this is the case, the proposer is required to present an EIA report or Environmental Statement that has been prepared by a competent expert.

Manufactured products such as fencing, plastic packaging and bags, and tree guards and shelters, should be managed appropriately when they stop having a functional value in the forest environment. They should be collected and disposed of, and the costs and likely timeframe for recovery from the site will need to be addressed in the forest management plan. Care will need to be taken that any items left on site are not at risk of being lost during flood and storm events and subsequently causing damage or posing a hazard to people or wildlife.

The environmental impact from using chemicals (including fuels, oils and lubricants) in forests would mostly arise from spillages or incorrect storage. Chemicals can move quickly through soil, with soil and water contamination leading to water pollution. Small quantities are enough to pollute drinking water supplies and have a toxic effect on land-based and freshwater life by preventing the transfer of oxygen through the water surface and causing aquatic animals to suffocate. Bio-fuels and oils are less persistent in the environment, but still pose a risk of pollution and can emulsify more easily, making it difficult to recover them.

The synthetic detergents and foams in fire-fighting chemicals have a high oxygen demand, which can kill fish in receiving watercourses. There is an increasing risk of their spillage or careless disposal – and a subsequent greater threat to the water environment – as climate change increases the incidence of forest fires.

6 The impacts of forestry on the environment must be taken into account in the submission of forestry proposals.

7 Environmental Impact Assessment (EIA) Regulations must be complied with; where an EIA is required, all the relevant environmental impacts must be considered by the proposers and the requirements for public consultation must be met.

7 Manufactured products associated with forestry should be appropriately managed when they stop having functional value to minimise their impact on the environment.

8 Only the minimum of oil and fuel should be stored on site.

Plant health and biosecurity

Legislation is in place in each UK country to protect trees and timber from notifiable forestry pests and diseases, and guidance is available from each country's forestry authority. Trees and timber products subject to a Plant Health Order cannot be landed into, or moved within, the UK unless accompanied by a phytosanitary certificate/plant passport.

As well as being vigilant towards pest and disease outbreaks on their trees, forest owners and managers should take a systematic approach to biosecurity to reduce the risk of pests and diseases entering, spreading and leaving their land. Measures could be, for example, to install hard-standing parking places for vehicles, and provide cleaning equipment for walkers, cyclists and pets. Removing stressed and dead host tree species can help limit the spread of insect pests by reducing the amount of suitable habitat in the environment.

8 Statutory orders made under the Plant Health Acts to prevent the introduction and spread of forest pests and diseases must be complied with; suspected pests and diseases must be reported to the forestry authority if they are notifiable, access must be given to Plant Health Inspectors and their instructions must be followed.

9 Managers should take a systematic approach to planning and implementing biosecurity measures on all their land to reduce the risk of pests and diseases being introduced or spread.

10 Managers should be aware of the risks posed by pests and diseases, be vigilant in checking the condition of their forests and take appropriate measures to combat threats to tree health.

11 Information should be reported to the forestry authority that might assist in preventing the introduction or spread of forest pests and diseases.

12 Suspected pests and diseases should be investigated and reported to the forestry authority, and biosecurity control measures recommended by the forestry authority carried out.

Forest reproductive material

A legislative framework of Forest Reproductive Material Regulations is in place in each UK country for controlling plant materials used in forest establishment, with specific country policies applicable to species not included in the Regulations.

9 For species covered by Forest Reproductive Material Regulations, only certified material must be used for forestry purposes.

Forest planning

Forest planning takes place at several levels. The highest level is the strategic plan, which defines the broad objectives of the owner and how these can be met across the forest estate or holding (which may comprise several forest areas). Beneath this are the three levels at which UKFS Requirements should be met:

1. Forest planning applies to a convenient management unit, called the forest management unit (FMU). The resulting **forest management plan** will vary with the scale of the forest and the size and nature of the holding.
2. An **operational (or site) plan** is concerned with the operational detail of how proposals will be implemented at site level.
3. A **contingency plan** ensures that procedures are in place and can be enacted should unforeseen events occur, for example, forest fires, catastrophic wind damage and accidental spillages.

Forest management plans may sometimes include the site operational plan and a contingency plan.

Forest management plan

The forest management plan is the reference document for the monitoring and assessment of forest holdings and forest practice. It allows for the positive impacts of forestry on the environment, economy and society to be proactively planned for, and for detrimental impacts to be minimised through direct measures and greater complementarity between forestry and wider land-use objectives. The importance of having forests managed in a way that helps them to be resilient to the impacts of climate change is becoming increasingly clear, with adaptation now understood as a fundamental part of long-term climate change mitigation.

The forest planning process starts with the owner's objectives and by identifying the opportunities and constraints offered by a site. This usually involves gathering and analysing a wide range of information about the site and its potential. Even for relatively small sites, planning will involve a range of professionals dealing with different aspects of the forest environment. The social dimension of forest planning is an important consideration from the outset. For forests that will be regularly used for recreation or are prominent in the landscape, community involvement in the planning process is a vital part of developing proposals.

A forest management plan is also used for communicating proposals and engaging with interested parties. Effective communication requires an awareness of the expectations of the intended audience, and when done well it can lead to positive outcomes for everyone with an interest in the forest management plan. The plan itself should be proportionate to the scale, sensitivity and complexity of the FMU.

13 Forest management plans should state the objectives of management, and set out how the appropriate balance between social, environmental and economic objectives will be achieved.

14 Early consultation with relevant authorities should be carried out to determine site sensitivity and inform forest management plans and operations.

15 Forest management plans should address the forest's context and potential and demonstrate how relevant interests and issues have been considered and addressed.

16 In designated areas, particular account should be taken of landscape and other sensitivities in the design of forests and forest infrastructure.

17 Consultation on proposals should be carried out with interested parties as forest management plans are developed.

18 Forests should be designed to provide a range of habitats, using a variety of site-adapted species and species mixtures to produce a diversity of stand structures appropriate to the scale, context and ecological potential of the site.

19 Forests characterised by a lack of age diversity due to extensive areas of even-aged trees should be managed to increase the range of tree ages and sizes.

20 Forests should be planned and managed to enhance their resilience and mitigate the risks posed to their sustainability by the effects of climate change or attack by pests or diseases.

21 Maintain or establish a diverse composition across the forest management unit so that no more than 65% of the area is allocated to a single species. Enhance resilience and seek to mitigate the risks from climate change and pests and diseases by selecting species appropriate to the site using Ecological Site Classification or a similar tool.

In all cases, incorporate a minimum of:

- 5% native broadleaved trees or shrubs;
- 10% of other tree species;
- 10% open ground, or ground managed for biodiversity as the primary objective.

Notes:

- The percentages using minimums do not add up to 100%. When deciding which of the above minor components to increase, consider the opportunities for further species diversification within the landscape context and scale of the forest, as well as the site conditions.

- In forests of less than 10 hectares and in native woods, the above proportions may be relaxed, as long as the adjacent land provides landscape and habitat diversity.

22 Management of the forest should conform to the plan, and the plan should be updated to ensure it is current and relevant.

23 New forests should be located and designed to maintain or enhance the visual, cultural and ecological value and character of the landscape.

24 Forest management should contribute towards achieving the objectives of River Basin Management Plans and ensure that forestry pressures on the water environment are addressed.

25 When planning woodland creation, the sensitivity of downstream water supplies, water bodies and wetlands (including Ground- and Surface Water Dependent Terrestrial Ecosystems) to a reduction in water quantity should be considered; where this is an issue, advice should be sought from the relevant authorities.

26 Forest management should not have a negative impact on flood risk to vulnerable downstream locations.

Operational and contingency plans

Operational plans aim to make forestry practice more efficient and to ensure that important site features are identified and protected in advance. Expansion of forest cover is generally encouraged across the UK, by planting or by promoting natural colonisation. Woodland creation should be undertaken according to an operational plan, and be appropriate to the site, support owner objectives and promote forest resilience.

Contingency plans address potential threats to the forest environment such as fire and pest and disease outbreaks or accidental events such as pesticide and fuel spillages into watercourses, and identify actions to help remedy any environmental damage that occurs. These plans may, in practice, be combined with the forest management plan.

27 Operational plans should be in place before major operations such as cultivation, harvesting and engineering works take place.

28 Where appropriate, contingency plans should be in place for dealing with actual and potential threats to the forest and environment.

UKFS Guidelines on General Forestry Practice

Forest planning process

Forest management plans

The process of producing a forest management plan falls into seven stages (Table 2.1).

1 Produce a clear forest management plan to demonstrate that all relevant aspects of sustainable forest management have been considered and to provide a basis for implementation and monitoring. The plan should:

- state the objectives of management, and how sustainable forest management is to be achieved;
- provide a means to communicate forest proposals and engage interested parties;
- serve as an agreed statement of intent against which implementation can be checked and monitored.

Table 2.1 The process of producing a forest management plan.

Stage	Objective	Activities and/or sources of information
Scoping	To develop management objectives	Draw on the owner's objectives, the potential of the site, UKFS Requirements and Guidelines, forestry strategies, policies and plans at country, regional and local level, and forestry frameworks.
	To analyse stakeholder interests	Consider of all potential interests, including those of specialist interest groups and the local community.
Survey	To collect information	Collect and map information about the site and its location, including any statutory constraints. Hold early-stage meetings with stakeholders and those with specialist knowledge including the forestry authority, to help identify all the factors to take into account and alert interested parties to the proposal.
Analysis	To assess information from the survey stage	Assess the survey information in light of the project's objectives, allowing the potential of the site to be determined.
Synthesis	To develop a design concept	Use the information that has been collected and analysed, including the visual aspects, to formulate a broad concept for the forest's design.
	To develop a draft management plan	Refine and develop the forest design concept into a draft management plan. This will be the basis of consultation with interested parties. Several drafts may be required in an iterative process.
	To finalise the plan and submit it for approval	Amend, refine and firm up the draft into a final forest management plan.
Implementation	To develop and implement work programmes	Use the forest management plan to develop operational plans and implement work programmes.
Monitoring	To evaluate progress	Check indicators of progress at regular intervals. Collect and record data to evaluate management.
Review	To make periodic updates of the forest management plan	Record work done on the plan and update it at regular intervals to keep it current. The plan is thoroughly reviewed and updated periodically (usually at five-year intervals).

Operational plans

Operational or site planning helps to ensure safe and efficient working practice on site and the protection of the forest environment. The starting point is a thorough assessment that identifies important features to be protected and options as to how the work could be undertaken. From this, a detailed operational plan can be developed that sets out the working arrangements for the site, protected areas and other site constraints. It is particularly important that the operational plan is communicated and understood by all those involved.

2 Produce a clear operational plan that is understood by all those working on the site. For major operations, the plan should include:

- A description of the site, including any relevant designations, consents, licences or agreements.
- A statement of the purpose of the operations and an outline description of activities, which explains how:
  - operations will be modified in case of bad weather;
  - potential hazards to workers will be mitigated;
  - potential hazards to forest users will be mitigated;
  - machine access, refuelling and timber stacking will be handled;
  - sensitive or easily damaged parts of the site will be safeguarded;
  - to ensure only the intended trees and shrubs are felled;
  - biosecurity will be addressed;
  - the site will be left on completion of operations.
- A site map showing constraints, hazards and other key information.

Contingency plans

Contingency plans cover what happens in the event of an unexpected or unplanned event. For site operations this may include dealing with accidents and mitigation measures in response to spillages, major soil disturbance, or other problems that could pose a serious risk to public health and the environment. Contingency plans can also address other threats to the forest, for example, fire, extreme weather events, or outbreaks of pests and diseases.

3 Have appropriate contingency plans in place to deal with risks to the forest, including spillages, major soil disturbance, fire, extreme weather events, and pest and disease outbreaks.

Forest planning considerations

This section sets out the key forest management issues that should be considered when producing a forest management plan.

Woodland creation

Expansion of forest cover in appropriate locations is encouraged across the UK. Woodland creation, whether expanding existing forests or creating new ones, should take account of impacts on the site and surrounding area. Planning and design should address all aspects of sustainable forest management in order to deliver a range of benefits for the future.

Well-planned, appropriately sited and well-designed woodland creation can help protect the quality of drinking water supplies, reduce flood risk, guard against erosion, landslides and the loss of soils, improve connectivity within and between habitats, support mitigation and adaptation to climate change, support the sustainable supply of timber and other economic activities and provide opportunities for access to support physical and mental health and well-being. On the other hand, poor planning can lead to significant negative environmental impacts.

4 When considering opportunities for woodland creation, ensure that planning, design and implementation support sustainable forest management to deliver a range of ecosystem services and benefits.

Forest productivity

The maintenance of the productive potential of forests includes both timber production, which supports the development of forest industries and economic well-being, and ecosystem services and wider non-market benefits. The essential consideration for the landowner or manager is to ensure that the forest thrives and is not degraded. This includes protecting young trees to help them become successfully established, and protecting the health of the forest, for example, by ensuring it has the necessary resilience to cope with emerging threats and changing conditions, especially in light of climate change. It also involves maintaining levels of fertility and site potential for future rotations.

5 Retain or expand the forest area and, where required, undertake compensatory planting where forest area is lost through land-use change.

6 Ensure new woodland and restocking (or regeneration) becomes established by ensuring adequate protection from pests and competing vegetation.

Forest composition and silviculture

Ensuring a forest has a varied composition in terms of age, species, origin or provenance and open space will help forests develop the resilience necessary to cope with emerging threats and changing climatic conditions, and will therefore allow for flexibility in management options. Being able to modify forest practice by, for example, moving to a low impact silvicultural system (LISS), will help improve the resilience of the forest and may limit the damage caused by extreme events such as gales or pest invasions.

Diversity can be increased by incorporating open areas and through phased felling and restocking (or regeneration) to ensure that, over time, a diverse forest develops. As part of this, some trees can be left as long-term forest cover to produce standing and fallen deadwood. Open space is a key element of diversity within a forest and can be used to develop permanent internal edges, structural diversity and flexibility for operational management. Wildlife habitat can be enhanced by developing non-wooded elements, such as streams, ponds, roads, utility wayleaves and rides. Open space is also important for the provision and development of access and recreation.

7 Plan to maximise forest resilience using a variety of silvicultural systems to foster a diversity of ages with a range of species, species mixtures and provenances, and create variation in stand structures; consider the risks to the forest from wind, fire, increased temperature, drought, waterlogging, and pest and disease outbreaks.

8 When selecting trees and shrubs for new woodland and restocking, ensure the risks and opportunities of climate change, biodiversity loss, and the vulnerability of particular species to pests and diseases are taken into account. Choose alternative species, or an increased diversity of species and genetic material, to improve resilience.

9 Develop a long-term forest structure of linked permanent habitats, such as riparian woodland, open space and mature broadleaves.

10 On suitable sites, consider continuous cover forestry as an alternative to clearfelling where this less intensive approach would be compatible with management objectives.

11 On suitable sites, consider the use of thinning to improve stem quality and enhance structural and species diversity.

12 Maintain or work towards creating a range of stand structures and silvicultural approaches across the forest as a whole, including veteran trees, open-crowned trees, occasional windthrow, understorey layers, open space and areas of natural regeneration.

Felling and restocking

When felling and restocking (or regenerating), take the earliest opportunity to review and realign plans to reflect the UKFS because it presents the opportunity to restructure age classes and improve diversity, thus improving forest resilience. In even-aged forests, particularly those established in the 20th century, this may involve delaying or bringing forward felling or, where windthrow is very likely to occur, delaying restocking. Following initial restructuring, further age class diversity can be introduced in subsequent rotations, especially where the nature of the forest site limited the initial scope.

Rotational felling also presents a major opportunity to reassess the forest through the forest planning process. Future felling coupes can be identified within a long-term forest structure, defined by open ground, watercourses, semi-natural habitats and areas managed by a LISS such as continuous cover forestry.

13 In forests characterised by a lack of diversity due to extensive areas of even-aged trees, retain stands adjoining felled areas until the restocking or regeneration of the first coupe has reached a minimum height of 2 m; for planning purposes this is likely to be between 5 and 15 years depending on establishment success and growth rates.

14 In upland forests, identify future felling boundaries as part of the long-term forest structure, manage compartment edges to increase stability and make use of permanent features such as watercourses and open space.

15 In semi-natural woodland, limit felling to 10% of the area in any five-year period and no more than 20% in any 20-year period unless there are overriding biodiversity or social advantages.

Mammal damage

Forests may be subject to damage or degradation from grazing or browsing mammals, particularly when trees are at the establishment stage. Mammals likely to cause damage are deer, grey squirrel, hare, rabbit, vole, goats, bison and wild boar. The forest manager's role is to monitor damage and decide whether intervention is necessary.

In areas where deer are present in the forest and wider environment, deer control is essential. A deer management plan – incorporating culling and habitat (or herbivore) impact assessments – allows a strategic approach to be taken. Keeping records of deer culled and levels of damage will help inform plans so that they can be refined to give more effective levels of control. Participation and consultation with local deer management groups (where they exist) will help to achieve effective deer management on the appropriate landscape scale. In Scotland, NatureScot advises on the sustainable management of wild deer. In England, Forestry Commission Deer Officers provide advice on the management of deer. In Wales, Natural Resources Wales supports provision of advice through partnership working. Responsibility for wild deer in Northern Ireland lies with the Northern Ireland Environment Agency of the Department of Agriculture, Environment and Rural Affairs.

16 Monitor forests for damage and intervene to protect vulnerable trees and habitats from domestic livestock and wild mammals.

17 In areas where mammals pose a threat, develop management plans to reduce environmental and economic damage, including by completing habitat (or herbivore) impact assessments. Collaboration at the landscape scale is most effective.

Pests and diseases

There has been a significant increase in the incidence of pest and disease outbreaks in forests in recent years, and climate change is likely to exacerbate these threats in the future. It is vital that all those involved in forest management take a proactive role in minimising risks, monitoring tree health, keeping abreast of emerging threats and deciding when intervention is needed.

18 Identify appropriate biosecurity measures by assessing the risks as part of a Risk Assessment; as a minimum there should be simple measures taken, such as cleaning equipment and clothing and avoiding moving materials from contaminated sites to clean sites.

19 Consider the susceptibility of new and existing forests to pests and diseases, taking specialist advice where appropriate, and use the assessment to inform planning and practices that promote resilience.

20 Be vigilant for pests and diseases in forests, including those in urban areas where the risk of new introductions can be high.

Use of chemicals and fuels

The use of artificial pesticides and fertilisers is generally a last resort in sustainable forest management, although they can have more of a role in energy crops such as short rotation coppice. Pesticides and fertilisers are expensive and should only be deployed in a reactive way to protect trees when a problem has been identified or is highly likely – and only then used at the minimum amount to satisfy crop need. Their use on special sites such as ancient woodland is particularly discouraged.

21 Minimise the use of pesticides and fertilisers.

22 If it is unavoidable to use static plant or equipment in a buffer area, position it on a suitably sized and maintained impervious drip tray with a capacity equal to 110% of the capacity of the fuel tank which is supplying the equipment.

Tree protection

In the UKFS, tree protection is taken to mean fences, tree shelters and tree guards.

The alignment and design of forest fences can have major impacts on access, wildlife, landscape and archaeology. Fencing needs to be considered in relation to public access because it is illegal to obstruct rights of way and, in other areas, public access can be an important consideration in fence alignment and the design of appropriate access points.

Fence lines themselves are not usually prominent but they can generate striking textural changes in the landscape through differences in grazing or land use. Fences can be invisible to birds such as black grouse, so using techniques to mark fences to improve their visibility, and to align them so that they avoid obvious flight paths, will help minimise collisions. Removing old fences from site when they become redundant or are replaced is a better option than leaving them there, as they can be a nuisance to livestock, wildlife and people.

Tree shelters and tree guards may provide an effective alternative to fencing, although the use of plastics, whether made from oil-based or bio-based polymers, should be avoided or reduced as much as possible. When redundant, tree shelters and tree guards should be removed and recycled to avoid the impacts of bio-accumulation in the forest soil.

23 Ensure the impacts of tree protection on biodiversity, landscape, archaeology and access are minimised.

24 Identify old and redundant tree protection and remove it as soon as possible for recycling or disposal.

Forest roads and quarries

Forest roads, quarries and associated infrastructure works can have a significant impact on the environment and landscape. They may therefore come within the scope of the EIA Regulations and be subject to planning controls rather than prior notification arrangements.

Considering important viewpoints and allowing road alignments to respond to the landform rather than taking the most direct route can ameliorate visual impacts and potentially reduce the amount of cut-and-fill needed for construction. The construction of forest roads and the extraction of material accounts for a high proportion of the total energy expended in a forest's life cycle, and so has a bearing on the sustainability of the timber grown.

Forest roads and access onto them can disrupt forest drainage systems and cause water and soil problems. It is important that road drainage is designed to function independently from the main forest drainage network. Where minor public roads and bridges are weak, consideration should be given to how the forest road network can be designed or upgraded to avoid using public roads for timber transport. In many areas there are timber transport groups that involve local authorities and advise the forestry industry on preferred routes and the options for using alternatives to road transport such as rail or sea. Sensitivities with timber transport should be addressed as part of the forest management planning process.

25 Minimise the adverse visual impacts of forest roads and quarries; blend road alignments with landform, and locate quarries, roads and bridges to respect landscape character, especially in designated landscapes.

26 Design road surfaces, drainage and access points for harvesting machines to avoid erosion and other adverse impacts on soils, watercourses and water quality.

27 Wherever possible, use forest road networks to minimise damage to public roads, and take advice from timber transport groups.

28 Liaise with the highway authority when felling near public highways or when lorries emerging onto the highway might pose a threat to road users.

Mechanised operations

Mechanised operations, such as cultivation and harvesting, are resource intensive and can be the cause of significant negative environmental impacts. Careful operational planning is required to combine good silviculture and cost-efficiency with care for people and the environment.

29 Plan operations by selecting the most appropriate method and machine for the site.

30 Ensure that risk assessments and pre-commencement planning and communication have been completed and everyone working on site understands their roles and responsibilities; ensure operations are monitored as needed.

31 Mark out buffer areas in advance of any operations taking place.

32 Plan felling and timber extraction to minimise the number of stream and drain crossings, except where alternatives create more difficult, dangerous or potentially damaging extraction routes; protect crossing points and riparian zones from damage by machinery.

33 Install culverts or log bridges to avoid crossing and blocking drains; restore the site and drains as extraction progresses.

34 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.

3. Forests and Biodiversity

The conservation of biodiversity is an essential part of sustainable forest management. Forests cover nearly one-third of the world's total land area and are vital in ensuring that environmental functions such as climate regulation and soil conservation are maintained, as well as biodiversity. They provide habitats for a large array of plants and animals, many of which are rare or threatened. By providing these important ecosystem services, biologically diverse forests contribute to the sustainability of the wider landscape.

Forest biodiversity in the UK

The UK's biodiversity is declining and this mirrors the picture globally. Forests are one of the most biologically rich terrestrial systems with many hundreds of species associated with them. However, a number of biodiversity indicators in the UK show a marked and ongoing decrease of certain species over the last 30–40 years.

All forests support some level of biodiversity and provide habitat for a wide range of flora and fauna. Ancient and semi-natural woodlands in good ecological condition are more biodiverse than other types of forest and are particularly important for rarer and specialist woodland-associated species. Forests managed for primarily commercial reasons, including those comprised of mainly non-native species, have the potential to provide habitat opportunities for a breadth of biodiversity, particularly through the networks of rides and other types of open areas they contain, retention of mature stands and deadwood, and through early growth stages.

Evidence suggests that losing biodiversity will result in ecosystems that are less resilient to challenges such as climate change, invasive species and pests and diseases. Based on available evidence, it is now widely accepted that urgent action is needed to reverse the decline in biodiversity. Increasing the diversity of forest structure and tree species will provide more opportunity for greater biodiversity and improved resilience.

The progressive loss and fragmentation of natural forest has left the UK with a much smaller proportion of forest than many European countries. This has had a dramatic effect on native biodiversity. Some species of large mammals have completely disappeared, while other groups such as fungi, lichens and invertebrates associated with old growth, wood pasture and parkland have become less diverse as the quality and extent of their habitat has declined.

To counter the intensification of forestry and agriculture and the consequent fragmentation of semi-natural habitats since the 1980s, forest policies have given more emphasis to environmental benefits. Forest landscapes have become more diverse in structure and more native tree species have been planted or allowed to regenerate. There has also been a focus on managing and restoring ancient woodland, creating new areas of native woodland and improving habitat conditions for priority woodland species. However, species and habitats are still at risk from inappropriate management and the long-term effects of habitat fragmentation and degradation, now intensified by the impacts of climate change, the introduction of invasive non-native species and the increased prevalence of pests and diseases.

Using an ecosystems approach

The conservation, enhancement and restoration of semi-natural habitats and priority species is a clear aim of the UKFS and in the forestry policies and strategies of England, Scotland, Wales and Northern Ireland. The UN Convention on Biological Diversity – the first treaty to provide a legal framework for biodiversity conservation – advocates the ecosystems approach, which means managing natural resources to supply environmental, economic and social benefits within sustainable limits.

As part of the UK's implementation of the Convention, the UKFS helps to further this aim by integrating the conservation and management of biodiversity into sustainable forest management practices. It does this by, for example, reducing the threats posed by climate change, non-native invasive species and pollution, and protecting and restoring forest biodiversity by conserving natural habitats and priority species, creating habitat networks and restoring and enhancing biodiversity in managed forests.

There is no standard biodiversity prescription that can be applied to all forests because they are highly variable in size, situation, structure and composition. They are dynamic habitats that require flexible management strategies. Careful assessment and prioritisation, linked to the monitoring of outcomes, is needed to ensure that management will be effective in securing biodiversity and ecosystem objectives.

UKFS Requirements for Forests and Biodiversity

Protected and priority habitats and species

The forest environment hosts a number of habitats and species that are protected by law. Habitats and species are protected under UK or devolved country legislation, along with UK or country-level important sites and species.

The legal requirement below refers to the 'appropriate protection and conservation' of listed habitats and species, including those designated for their geodiversity. The UKFS follows the Common Statement made by the UK statutory nature conservation bodies by defining this as actions that bring individual protected woodland sites into 'Favourable Condition': a recognised level of the national measure of Favourable Conservation Status. Each country's statutory nature conservation body will advise on how forest owners can meet the Favourable Condition standard, and protected woodland that does not meet it (i.e. is in an unfavourable condition) should see action taken towards achieving it.

Each country within the UK has its own system of determining status and this is why, in order to comply with this legal requirement, it is crucial that advice is sought from the relevant authority about whether a site has any listed species, habitats or geodiversity features, how to minimise any potentially adverse effects of forestry activities on them, and how to help a site in unfavourable condition to recover.

Conservation legislation, first introduced as the Conservation (Natural Habitats, &c.) Regulations 1994 and since amended in devolved law, requires that an assessment is undertaken to assess the potential impact of an activity on the 'qualifying interest' of a European designated site. This is known as a Habitats Regulations Appraisal or Assessment (HRA), and is undertaken by the competent authority (e.g. forestry authority). The key determining factor of whether a HRA is required or not is the potential impact of a forestry plan or project on the conservation objectives of the qualifying features for which the site was classified.

The biodiversity lists of England, Scotland, Wales and Northern Ireland name priority habitats and species associated with forests, including woodland habitat, wood pasture, parkland and open habitats. Priority habitats have the potential to provide for the richest and most varied components of biological diversity. Priority species are those that are rare, at risk of extinction, threatened, or have special requirements. A high proportion of priority species are associated with forests.

! 1 Information must be sought to confirm the conservation status of a site, and appropriate protection and conservation must be afforded where sites, habitats and species are subject to the legal provisions of legislation. Information must be provided to allow an appropriate assessment to be made as part of a Habitats Regulations Appraisal or Assessment, where required.

1 Measures should be identified in forest plans to conserve, enhance or restore species identified in the statutory lists of priority species and habitats for England, Scotland, Wales and Northern Ireland.

Invasive non-native species

Some invasive non-native (or 'alien') species pose a significant risk of adverse impact and so they are regulated by law. Under devolved statutory instruments there are general duties to protect the environment, society and economic interests from the risks posed by certain, listed, non-native species. There is also devolved legislation, under which it is an offence to release or cause the spread of invasive non-native species, unless authorised.

2 For invasive non-native species subject to the legal provisions of the European Union Invasive Alien Species Regulations or others listed under devolved legislation, the requirements regarding the prevention, early detection and rapid eradication of new invasions and the management of invasions that are already widespread must be followed.

Forest management and biodiversity

While ancient semi-natural woodland (ASNW) has the highest value for biodiversity, all forests, including planted forests, can be valuable for biodiversity with appropriate management. Adjacent habitats such as hedgerows and open ground can further support forest biodiversity, as well as offering a range of other benefits such as carbon capture and reduced flooding.

Forest owners and managers also need to consider the impacts of their decisions beyond the forest boundary and engage with others if the conservation and enhancement of biodiversity is to be achieved. This has implications for the location, composition and size of woodland creation schemes.

Forests that link with each other and with other habitats, particularly semi-natural habitats, facilitate the movement of species through the landscape. This is particularly important in the context of climate change, as it can increase the ability of species and ecosystems to adapt to new conditions. However, these links can also increase the risks associated with the spread of problem species.

The loss of ecological connectivity through the fragmentation of woodland habitat poses a significant threat to woodland biodiversity. This is particularly the case where smaller woods are isolated by development or intensively managed agricultural landscapes. Smaller habitat areas and greater isolation between them increases the likelihood that priority species will become locally extinct. Climate change poses further threats to isolated populations as the limited genetic base of small populations in isolated fragments gives them less capacity to adapt to new conditions.

2 Existing biodiversity in forests should be protected; opportunities to restore and enhance biodiversity should be considered and implemented in forest management plans.

3 The implications of woodland creation and management for biodiversity and ecological resilience in the wider environment should be considered, including the roles of forest habitats, trees outside woodland, hedgerows and open habitats, in encouraging habitat diversity and availability through ecological connectivity.

UKFS Guidelines on Forests and Biodiversity

Priority habitats and species

Many habitats that are important for biodiversity in the UK have been reduced and fragmented and so need protection, restoration and expansion. Detailed advice is available from the forestry authorities and nature conservation agencies on forestry management systems and operations that will help protect a species or maintain or enhance a habitat. Certain forest operations can be damaging to priority species and habitats – including non-woodland priority habitats – and may need to be planned for another time of year or otherwise amended.

When land-use change is proposed, the relative merits of existing habitats and the potential impacts of change on priority habitats and species must be taken into account. Where impacts due to afforestation or deforestation are likely to be significant, an EIA will be required. Existing semi-natural habitats are likely to have a high value for biodiversity and this needs to be considered when proposing woodland creation. Moreover, there is a specific presumption against the conversion of priority habitats such as deep peat or active raised bogs for reasons of climate change and biodiversity.

1. Seek advice from the relevant forestry authority and nature conservation authority on the requirements of priority habitats and species and on suitable management options.

2. Consider options to extend and improve priority habitats and to increase and extend populations and ranges of priority species; plan forest operations to minimise any adverse impacts on biodiversity.

3. Identify sites of protected aquatic and wetland habitats and species, including spawning, and ensure protective buffer areas are established.

4. Consider the impacts of the silvicultural system(s) employed so that it is compatible with the habitat requirements of priority species.

5. Where priority species are ecologically dependent on a woodland habitat, plan felling programmes so that disturbance at sensitive times of the year is minimised.

6. For woodland creation proposals, include an assessment of the potential impacts on priority habitats and species as part of the forest design process.

Native woodland

Native woodland is broadly defined as being composed mainly of native species, and can be derived from natural seedfall, coppice and planted trees. It is among the richest habitat for biodiversity and supports a high concentration of UK priority species. All types of native woodland are priority habitat types in the country biodiversity lists, and some are of international importance.

Ancient woodland, and ancient and/or veteran trees, are irreplaceable and have a very high biodiversity and cultural value. The term 'ancient woodland' is used to describe ancient wood pasture and parkland, infilled wood pasture and parkland, plantations on ancient woodland sites (PAWS) and ancient semi-natural woodland (ASNW) that are characterised by predominantly natural features. These features include a range of native, naturally regenerated tree and shrub species, old trees and deadwood, woodland flora, and rich and undisturbed woodland soils. Sites with a long continuous history of woodland use are listed as ancient woodland.

Woods that are both ancient and semi-natural have the greatest value for biodiversity, and although they are still widespread, they are fragmented. They serve as valuable refuges for woodland biodiversity, particularly for sedentary species that, once lost, do not readily recolonise. They often retain characteristics of previous management such as coppicing and other traces of cultural history.

PAWS are sites that were once ancient woodland but have been converted to planted forests. Many PAWS retain some characteristics or remnants of native woodland, which give them the potential to be restored to native woods. Doing so will contribute to policy objectives for native woodland restoration.

New native woodland can be created by extending existing woods through natural colonisation, new planting or by improving the diversity of planted forests of non-native species. Published guidance on improving the ecological condition of new native woodland, including its role in habitat connectivity and in protecting and augmenting ancient woodland fragments, is available from forestry authorities and conservation agencies. Improving the condition of existing native woodland is best done by addressing threats to it, primarily illegal felling, fragmentation, neglect, unmanaged grazing or browsing, invasive non-native species, pests and diseases and pollution.

7 Manage native woodland to improve ecological condition; base management proposals on protecting or extending semi-natural features characteristic of that woodland type, controlling invasive non-native species and managing deer; place special emphasis on ancient semi-natural woodland.

8 In ancient semi-natural woodland, avoid introducing non-native trees and understorey species.

Ecological connectivity

The effect of fragmentation on different species depends on their modes of dispersal, habitat requirements and ability to migrate through the surrounding landscape. Many woodland species, especially those associated with ancient woodland, disperse slowly and so their ability to move between areas of suitable habitat may be low.

Options to restore or promote connectivity include expanding existing wooded areas and creating new woodland adjacent to them. Wood pastures, parkland, orchards and open semi-natural habitats can be created or managed to act as a link between woodland habitats. Because of their linear nature, riparian zones offer good opportunities to increase connectivity. Hedgerows and diverse uncultivated field margins can also serve in creating cover and developing connections.

However, consideration also needs to be given to wider aspects of biodiversity as other important habitats such as semi-natural open ground can be fragmented when new woodland is established, and pests and diseases can find increased mobility. The location and composition of forests and appropriate design of edge margins can facilitate the migration of species. Those comprising a diverse range of habitats and sites will help enhance the ability of individual species to endure as climate change progresses because they will contain more varied gene pools, facilitating adaptation.

9 Improve the ecological connectivity of the landscape for woodland and other species by extending and linking habitat features; consider the juxtaposition of wooded and non-wooded habitats and aim for the best overall result for biodiversity.

Ecological processes

The ecological processes that shape natural forest ecosystems include vegetation succession, natural regeneration, windthrow, flooding, drought, the activities of herbivores, predation and change caused by reintroduced species such as Eurasian beaver, insect attack, disease and fire. These processes can make a positive impact by introducing a degree of unpredictability, encouraging structural diversity to develop and assemblages of new species to establish. Allowing ecological processes to operate, and mimicking them within silvicultural systems, can therefore benefit biodiversity – provided this is done within the framework of a forest management plan with clear management objectives.

Within a managed forest, the areas with the most potential for this approach will have had limited recent intervention (for example by using a LISS such as continuous cover forestry), and will be linked to areas of high biodiversity value such as semi-natural habitat. Designated sites such as Sites of Special Scientific Interest (SSSIs) and other areas can also be set aside as 'minimum intervention' reserve areas, where silvicultural management is designed to maintain ecological processes and enhance the site. Intervention may still be necessary in these areas to manage deer, remove invasive species such as rhododendron, or to ensure that particular characteristics are favoured, for example. Risk assessments may reveal that some management of access may be needed as retained dead trees and branches can become safety hazards.

10 Identify areas for minimum silvicultural intervention and, where it is appropriate, encourage or replicate ecological processes as a way of delivering biodiversity objectives within a forest management plan.

11 If the reintroduction of a native species is being considered, guidelines from the International Union for the Conservation of Nature (IUCN), country guidance, long-term management plans and appropriate funding need to be in place to ensure that the positive impacts of reintroductions are maximised, while permitting early intervention when problems arise.

Tree and shrub species selection

A diverse range of tree and shrub species is generally beneficial for biodiversity. Conserving or enhancing species diversity in forests is a requirement of the UKFS, and forest management plans will need to address the tree species composition and resilience of the whole FMU. Native trees and shrubs support higher species diversity, and especially more rare species, than non-native species. However, non-native forests can also provide significant biodiversity benefits, particularly as they mature, develop herb and shrub layers and are colonised by invertebrates, fungi and lichens. Non-native conifers can also provide vital seed crops for birds and small mammals such as red squirrels.

For native woodland, augmenting the existing range of tree and shrub species with others that are characteristic of the woodland habitat type will often help meet biodiversity objectives and could increase the resilience of woods to the threats posed by climate change. There is also new evidence that the ecological implications of localised tree species loss could be mitigated by encouraging the establishment of alternative tree and shrub species that are ecologically similar. The choice of tree and shrub species should also be informed by the needs of priority species, the potential to develop and extend priority habitats, and the potential to develop riparian zones, roads and rides and edge habitats. It should not, however, increase the potential for pests and diseases to spread.

In addition to species diversity, genetic diversity – both within and between populations – is an important component of biodiversity. Genetic diversity varies at local and regional scales and may include distinctive genetic patterns or subspecies. The genetic diversity present in a population reflects its evolutionary history and determines its ability to respond to a changing environment by developing resistance to pests and diseases and adapting to climate change. The comparatively long generation time for trees makes it particularly important that populations contain sufficient genetic diversity to be able to adapt to change.

The evidence suggests that most populations of trees in semi-natural woodland contain high levels of genetic diversity, even in smaller and more isolated woods. However, linking and expanding native woods, using natural regeneration or by planting with well-adapted stock, will increase gene flow and increase the capacity of tree populations to adapt.

For all woodland creation schemes it is vital that material is drawn from a broad genetic base. When planting native species and native woodland, it is generally best to use well-adapted local or regional origins from similar elevations. Consideration can also be given to planting a proportion of native species from non-local provenances with conditions that are well matched to the predicted future climate at the planting site. Advice on suitable species and origins for both native and non-native planting is available from the forestry authorities.

The Forest Reproductive Material (Great Britain) Regulations 2002, and equivalent legislation in Northern Ireland, provide a system of mandatory identification and control of the seeds, cuttings and planting stock of 12 major species used for forestry. They ensure that planting stock is of traceable origin (and provenance). A voluntary scheme for the certification of native trees and shrubs is also available to help users identify and source suitable stock for all native species, including 41 native trees and shrubs that are not controlled by the regulations. The voluntary scheme uses 24 native seed zones and two altitude bands.

12 When managing or creating native woodland, encourage a representative range of the native species associated with the woodland type.

13 Use the information provided under Forest Reproductive Material Regulations to establish the origin or provenance of available planting material.

Forest and stand structure

Forest structure and stand structure are fundamental to woodland biodiversity. Forest structure is determined by the ages and species of trees and shrubs, the patterns of open space and internal and external edges, and other woodland features. Together, they shape the character of the canopy, vegetation layers and the intensity of light reaching the forest floor.

Different types of forest structure benefit different species. In managed forests, the silvicultural system employed will affect the overall structure and supporting floral and faunal communities. Continuity of the management regime is vital to maintain the conditions to which wildlife communities have become adapted. Permanently wooded areas can form part of a long-term forest structure, managed using a low-impact silvicultural system such as continuous cover forestry to maintain optimal conditions. This is beneficial to species such as woodland bryophytes. By contrast, open areas are used by species that benefit from a mixture of cover and open space, for example, nightjar and fritillary butterflies.

Many broadleaved woodlands have been simplified in their composition and structure through past management and, in some cases, neglect. Using management regimes that increase the diversity of age classes and allow old or veteran trees and deadwood to develop will enhance the structure for biodiversity, as will regular coppicing of those species for which continuity of the conditions created is vital to their habitat. Leaving some windblown trees will provide nesting sites, decaying wood and structural micro-sites.

14 Manage a minimum of 15% of the forest management unit with conservation and the enhancement of biodiversity as a major objective.

15 Identify sites for long-term forest cover and thin them appropriately.

Deadwood

Up to one-fifth of woodland species depend on dead or dying wood for all or part of their life cycle and it is an important indicator of the level of biodiversity in forest ecosystems. Generally, the greater the volume of deadwood, the higher the biodiversity value. Deadwood occurs as whole standing trees, fallen branches and stumps, while veteran or ancient trees – although alive – have rot holes, dying limbs and heart rot. All of these different deadwood types have their own characteristic fungi, flora and fauna.

The most valuable areas for deadwood are where linkages can be made with existing deadwood habitats to develop ecological connectivity, which is why it is important to leave deadwood concentrated in high value areas and not dispersed evenly across a felling coupe. High value areas might be found in long-term forest cover areas and wood pasture, parklands and ASNW with veteran trees. Deadwood retained close to sunny glades and edges will provide a useful habitat for insects in particular, while in riparian or wet woodland it provides special humid habitats.

There are numerous opportunities to develop decaying wood habitats and increase the quantity of deadwood in all forests, particularly in very old stands (more than 120 years old). The long-term provision of deadwood can be assured by protecting current and future veteran trees from loss or harm.

Native species provide the most valuable deadwood for biodiversity, especially in sections of 200 mm diameter or more, although deadwood from all species has value and sections above 100 mm make a useful contribution to the habitat. As a guide, an FMU should have around 20 m^3 per hectare (equivalent to a lorry load per hectare) deadwood (excluding tree stumps), but because it may take some time to build up to this level, especially in first rotation even-aged forests, it is not necessary to measure site deadwood volumes to comply with the UKFS.

However, forest managers will need to be aware of the potential risk posed by deadwood (and stressed trees) of aiding the spread of pests and diseases. Where exotic pests such as *Ips typographus* may be present, dead and stressed trees of host and potential host species (Norway spruce and Sitka spruce in the case of *Ips typographus*) should be removed at the earliest opportunity and stands of host tree species inspected for damage after storms or drought.

In all forests there is a need to minimise hazards to visitors by routing paths and siting recreational facilities away from sources of falling deadwood. In some cases it may be necessary to make deadwood and veteran trees safe if they are close to existing recreational facilities or areas well used by the public.

16 Leave a proportion of standing and fallen deadwood in each forest management unit, concentrated in areas of high ecological value, where there is existing deadwood and where linkages can be provided between deadwood habitats; avoid uniform distribution across the forest management unit.

17 To reduce the amount of suitable habitat for specific pests and diseases, inspect the deadwood of host tree species for damage after storms or drought and remove it from site if necessary.

Open, scrub and edge habitats

The open, scrub and edge habitats within or adjacent to forests are especially important for biodiversity. These unplanted areas may contain valuable habitats, such as shrubs, open and stunted forest at the natural treeline, grasslands, crags, heaths, limestone pavements, bogs and a range of aquatic habitats. Open areas such as utility wayleaves, roads and rides add to and interconnect these open habitats.

Their value as habitats is greatly increased if they can be linked together and if the forest edges next to them are managed as part of this network. In some situations, management will be required to maintain open areas and prevent them reverting to woodland; shrubby woodland can be flailed, grassland mown or lightly grazed, and heathland periodically burned. Tree seedlings encroaching on areas of important open habitat may need control. Where woods have been recently planted, open areas within them may be of botanical interest that can be maintained with periodic mowing or, where practicable, livestock grazing.

Forest edges that move along a gradient into open ground and, where possible, contain mixtures of native trees and shrubs are far more beneficial to biodiversity than abrupt edges. They provide, for example, bird nesting and feeding areas and sources of nectar for pollinators and other insects. Many birds nest in edge habitats, and some, such as black grouse, depend on the maintenance of a diverse edge structure. Forest edge habitats often have better coning/fruiting and so are good for species such as red squirrel and dormice, and butterflies require nectar sources and food plants associated with edges and open areas.

Distinctive open habitats and species associations have developed in wood pastures, parklands and woodland with a long history of grazing, and these have specific management requirements.

18 Plan open space in new and existing forests to create and enhance networks of open-ground habitats.

19 Consider practical opportunities to restore open habitats where their value could be maintained and enhanced.

20 Develop graded edge habitats; thin forest edges to create a diverse and convoluted structure and a transitional zone between habitats.

21 Ensure wetland features such as springs, flushes and bogs are protected, and take opportunities to restore degraded features.

22 Consider how open areas and areas with partial tree or shrub cover, including encroaching seedlings, can be managed to maintain or enhance their value for biodiversity.

Habitat creation and restoration

Significant gains for biodiversity can arise from creating new habitats and restoring degraded ones, to help reverse the effects of habitat fragmentation. Restoration of former habitats is most beneficial where the original features survive and the re-establishment and management of a functional ecosystem over the longer term is a practical possibility. It normally involves enhancing remnant native ecological features by natural regeneration and colonisation, and in some cases removing non-native and invasive species.

The creation of new native woodland and the extension and restoration of existing ASNW are particularly valuable and can help reverse the effects of habitat fragmentation. The clearance of ASNW for agriculture and development usually removes all evidence of a wooded past. However, there are sites such as permanent pastures in the uplands where scattered remnant trees live on and are sometimes accompanied by traces of woodland ground cover. There are also likely to be areas within managed woodland with indicators of a long history of woodland cover.

If native species are still present, natural regeneration and colonisation are the most appropriate ways of creating and restoring woodland habitats. Although this approach has the advantage of conserving local genetic material that is suited to the site, the diversity of the species and origins may need to be considered in light of climate change and threats from pests or diseases. Restoration will normally involve the progressive enhancement of the remnant native ecological features and the removal of non-native and invasive species. However, in some instances, non-native species may be of high ecological or cultural value, for example, veteran trees, and can be retained.

Ancient woodland sites and PAWS might have retained some features of ecological and cultural interest and so provide valuable opportunities for restoration. The minimum required by the UKFS is to ensure these remnant features are protected; the highest priority for restoration is on sites where irreplaceable features and vulnerable species survive.

Habitat restoration and creation within a forest is not confined to the woody elements, as a range of other habitats and micro-sites contribute to the wider forest environment. Much can be made of sites that are inaccessible or wet and therefore unsuitable for timber production, and they can greatly extend the potential for biodiversity. The management of drainage offers many opportunities through the creation of ponds and wetlands in buffer areas for the seepage of water.

Some forests have been established on what are now recognised as priority open-ground habitats, such as bogs and heaths. Although there is a general presumption against deforestation, some of these sites may have potential for restoration where this offers significant and demonstrable benefits for biodiversity and climate change mitigation. Any change from woodland to non-woodland habitat needs to be compliant with the country's policy on woodland removal and, where deforestation is proposed, an EIA is likely to be required. All the various implications, including the practicality of habitat restoration, will need to be considered in the context of policies at country level on woodland removal.

23 Consider expanding native woodland by creating new woods, restoring native woodland sites, and converting non-native woodland; concentrate on areas that will enhance existing ancient semi-natural woodland and, where possible, include sites large enough to overcome edge effects.

24 On plantations on ancient woodland sites (PAWS), ensure that ancient woodland remnant features are protected and consider progressive restoration to native woodland; refer to country guidance, where available, on PAWS restoration.

25 On ancient woodland sites, ensure features are protected and appropriately managed.

26 Consider creating or restoring semi-natural habitats: prioritise special and designated sites, extensions to them, and areas beneficial for priority species or habitats.

Invasive species

An invasive species is any animal or plant that has the ability to spread and be detrimental to the environment, the economy, or our health and well-being. In the UKFS they are categorised separately from tree pests and diseases (defined as organisms which specifically harm trees and which are dealt with in the General Forestry Practice section).

Some invasive species are native (e.g. bracken) but most are non-native (e.g. grey squirrel and rhododendron). The effects of invasive species on the biodiversity of forests and their associated habitats are wide ranging. Those that pose the most significant risk are subject to control provisions under legislation. Because invasive species can quickly colonise and dominate areas, and are expensive to eradicate, early action to prevent populations establishing will be more cost-effective than later attempts at control. A collaborative eradication strategy across a defined geographic area is likely to be more effective for more mobile species. Advice on practical control measures is available from the forestry authorities or nature conservation agencies.

27 Where species are invasive and pose problems, manage, control or remove them where this is feasible; take action early while populations are still small.

28 Participate in collaborative actions to control invasive species at appropriate spatial scales.

29 Plan for the control of invasive species where feasible by developing barriers to their dispersal; ensure newly created elements in habitat networks do not facilitate dispersal.

30 Consider how forest operations such as felling and thinning might promote the spread of invasive species and take action to control them beforehand.

31 Where there is a risk of spreading invasive species, take action to clean footwear and vehicles before moving between sites and avoid moving gravel between rivers and catchments.

Grazing and browsing

Natural woodland ecosystems have evolved together with a range of grazing animals. The effective management of grazing and browsing is important in achieving objectives for woodland and open-ground habitats. While low grazing pressure can be advantageous, in the absence of control, herbivore populations (in particular deer, but also other wild or feral species such as goats, and livestock including cattle and bison) can increase to a level where biodiversity is impoverished and the growth of alternative species planted or regenerated to increase species diversity is limited. This is particularly significant for biodiversity in semi-natural woodland where the target community is composed of species that are especially palatable, such as hornbeam, field maple, oak, ash, hazel, honeysuckle and certain ground flora species, and where management is reliant on natural regeneration.

The key stages to managing grazing are to assess the impacts, determine if control measures are needed, work with others at the landscape scale to find solutions, and monitor the effect of interventions, adjusting the control measures as needed.

Livestock can sometimes play a role in maintaining the structural diversity of open habitats: they can scarify the ground, which encourages seedling establishment, but this needs to be tightly controlled. Uncontrolled grazing by livestock or horses is invariably detrimental and will eventually lead to loss of woodland habitat. In wood pastures and parkland, light grazing is an essential element of maintaining the characteristics of the habitat. Where there is no grazing or browsing at all, the development of coarse vegetation and scrub eliminates less competitive plants. By contrast, heavy grazing can prevent woodland regeneration and dramatically reduce the quantity or diversity of woodland ground flora and dependent fauna.

Trees can be temporarily protected from grazing by fencing; tree guards or tubes offer protection to individual trees, but not the entire habitat. Other management techniques, such as piling brushwood on a small scale or establishing thorny species, can allow tree species to establish. Wider habitat protection may require herbivore populations to be reduced, possibly in conjunction with fencing. Landowners and managers should be aware of the need to maintain fencing in good condition. Deer fences are rarely completely deer-proof, but they do reduce negative impacts for a period of time. Consider the potential adverse effects of using fences, such as the long-term decline in vegetation diversity, increased shading and the problem of birds striking fences during flight.

32 Assess grazing and browsing impact levels on woodland habitat by making a regular survey of impact indicators.

33 Take action to control grazing and browsing levels that will have negative impacts on the forest or its biodiversity.

34 Consider using controlled grazing by livestock as part of the planned management for biodiversity, including for open habitats within the forest.

35 Consider the potential impacts of fencing on wildlife and minimise adverse effects.

4. Forests and Climate Change

Climate change is one of the greatest challenges facing the world today and there is mounting evidence that it could create substantial, abrupt and irreversible impacts on our environment. The UKFS response to climate change is through both mitigation (establishing new forests and managing existing forests and wood products in a way that enhances their potential as a sink of greenhouse gases) and adaptation (reducing the vulnerability of forests and using forests to increase society's resilience to climate change). In other words, long-term climate change mitigation is not possible without short-term adaptation. Forest managers must plan and implement changes as a matter of urgency to adapt their forests in the context of rapid climate change.

Carbon in forests

Forests play an important role in the global carbon cycle, accounting for almost three-quarters of the annual exchange of carbon between the land and the atmosphere. Sustainably managed forests perform a vital role as carbon stocks and sinks, and are an important means of removing carbon dioxide from the atmosphere (Figure 4.1).

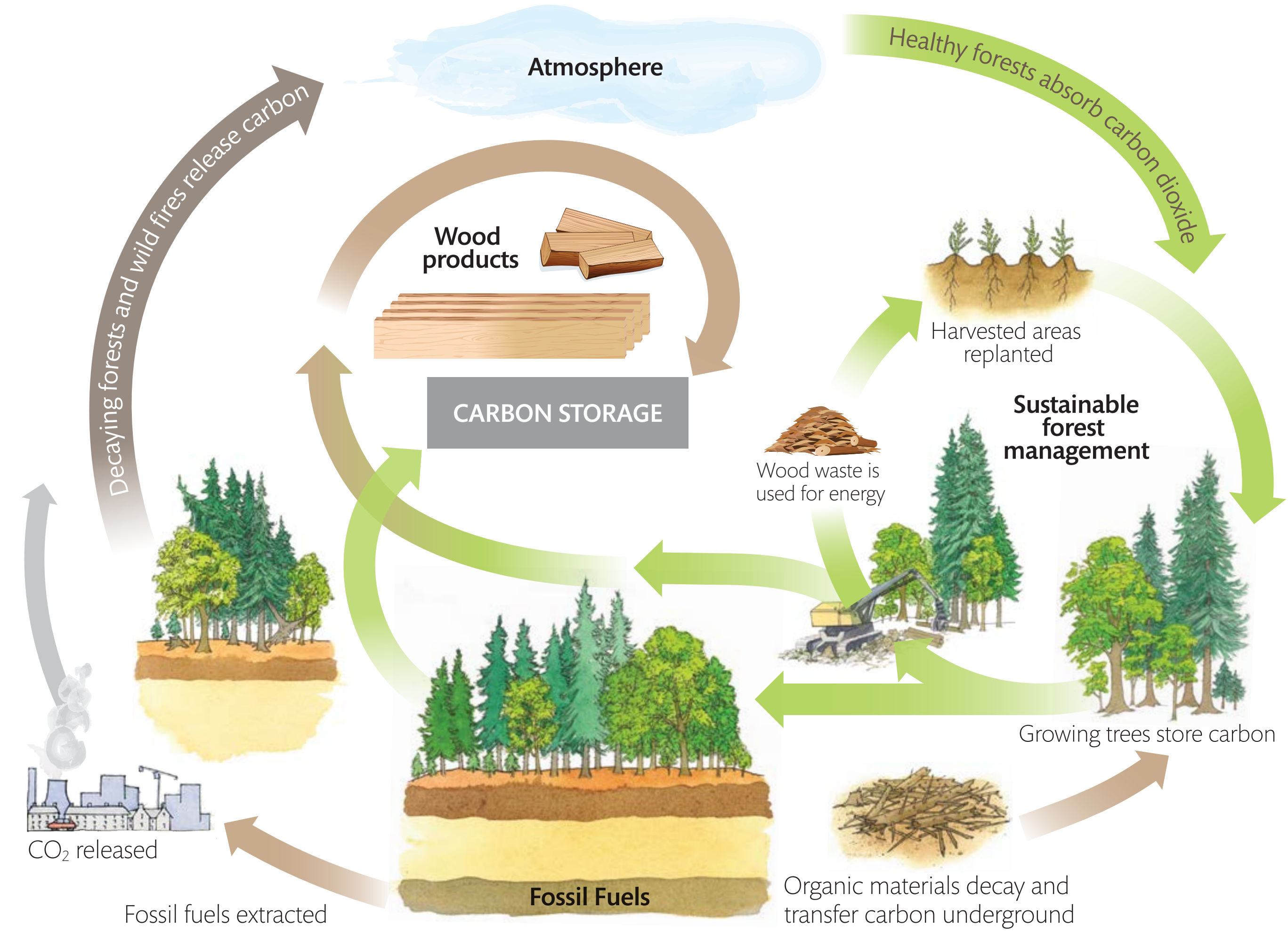
A particular carbon balance may be described as a 'sink' if there is a net transfer of carbon from the atmosphere. Combined, forest biomass and forest soils and litter contain more carbon than the atmosphere. Carbon in forest soils is particularly important as a greater proportion can be stored here than in the tree biomass, especially on peat-based soils. However, the accumulation of carbon by a forest can be lost through natural disturbances such as storms, floods or fire, and through the removal of material during management such as thinning or harvesting. If these natural and managed carbon sinks were lost as a result of forest degradation or climate change, the rate of accumulation of carbon dioxide in the atmosphere would rise dramatically.

Climate change mitigation

Forests capture carbon and store it as a component of wood itself (in stems, roots, branches and twigs), and this is a key mitigation measure of the UKFS. Over time, forests can also slowly enrich the soil carbon content through the addition of organic matter from leaf, seed and fruit litter, branch fall, root exudates and root death. It follows that the rate of carbon capture is closely related to the growth rate of the trees, and UK forests are among the most productive in northern Europe. However, the amount that is captured and stored depends on planting rates and management as well as the impacts of climate change, and on the number of trees being thinned or harvested. Sustainable forest management, which includes harvesting to transfer carbon from the forest to wood products and the regrowth of the forest, will maintain net carbon uptake.

In general, forest soils that experience low and infrequent levels of disturbance, particularly when managed under a LISS such as continuous cover forestry and for a given soil type, will have a higher total carbon content per unit area than agricultural soils. Some forest operations, such as ground preparation to establish trees, may result in a short-term loss of

Figure 4.1 The role of forestry in the carbon cycle.



Carbon released
Decaying vegetation and trees and forest fires release stored carbon into the atmosphere. In addition, human activities that use energy in the form of fossil fuels – for example transport and manufacturing – generate carbon dioxide which is released into the atmosphere.

Carbon absorbed
Sustainable forest management is an effective way to store carbon. Young, healthy forests absorb carbon more rapidly than older, dense forests.

Carbon stored
Carbon is stored in the trunks, branches and roots of trees as they grow. Sustainably managed forests continuously store carbon over long time periods. Carbon continues to be stored in wood products after trees are harvested. Harvested forests are replanted and the cycle begins again.

carbon from the soil until this is replaced as forests grow. The aim of the UKFS is to minimise short-term losses while recognising that some level of disturbance is necessary for successful establishment and management, which will go on to deliver the benefits of carbon capture over the longer term.

In addition to carbon sequestration, forests contribute to climate change mitigation by providing a source of renewable energy and sustainable wood products that continue to store carbon. Carbon comprises about 50% of the dry weight of wood. Timber and wood products can be used for a variety of purposes, and the longer they remain in use, the longer the carbon is stored.

Carbon substitution benefits also arise when wood is used as fuel instead of fossil fuels such as coal, gas or oil. Although burning wood generates carbon dioxide, an equivalent amount of carbon dioxide was relatively recently sequestered from the atmosphere as the trees grew. Trees planted specifically for use as woodfuel and managed on short rotations can provide a substitute for fossil fuel over a shorter timescale than conventional forests, but may not provide as wide a range of other benefits such as biodiversity and recreation.

Standards for carbon sequestration

The Woodland Carbon Code is a standard in the voluntary carbon market for UK woodland creation projects that make claims about the carbon they sequester. It sets robust standards for carbon accounting and management in addition to the sustainable forest management practices set out in the UKFS, and it facilitates payments for provision of the ecosystem service of carbon sequestration. Projects that comply with the Woodland Carbon Code directly help the UK to meet its targets for both woodland creation and reducing greenhouse gas emissions.

There is also the UK Peatland Code, a voluntary standard for UK peatland projects that provides a mechanism for private investment to reduce emissions from peatlands through restoration projects.

Climate change adaptation

Improving the resilience of forests is key to climate change adaptation. However, in developing resilience, a balance is required to ensure that, as far as possible, the integrity of existing ecosystems is maintained.

As the natural distribution of tree, plant and animal species changes, it is likely that regional differences in adaptation measures will be required. Thought should also be given to the prevailing risks at specific sites. This could include an increased frequency of drought at some sites or an increased risk of flooding at others. As well as using an appropriate choice of tree species and origin, improving the connectivity of existing forests through woodland creation and developing and maintaining a range of tree ages, classes, and diversity in canopy structure can increase resilience to climate change. These measures will also develop the management flexibility required for forests to thrive in a changing environment.

Further information is given in the UKFS Practice Guide *Adapting forest and woodland management to the changing climate*.

Climate change projections

The climate is changing already and projections suggest that we should prepare forests for an increase in mean temperature in the long term. Temperatures of 40°C were experienced for the first time in the UK in 2022 and it is likely that this temperature will be reached more frequently in the future. Summer rainfall is projected to decrease, potentially making summer droughts more frequent and severe, and winter rainfall is projected to increase, extending the duration of winter waterlogging. Flooding is projected to become more severe, alongside increasing windthrow, soil erosion and the frequency of landslips.

Impacts on tree growth and forest productivity

Carbon dioxide has a direct impact on tree function and forest productivity, as well as being the most significant greenhouse gas. An increased concentration of carbon dioxide in the atmosphere stimulates photosynthesis and is likely to result in an increase in growth rates and leaf area. Other changes in the atmospheric environment may also have impacts, including changes in nitrogen and sulphur deposition and increased levels of ozone pollution. There will be a number of new and indirect effects on forests through changes to the frequency and severity of pest and disease outbreaks, increasing populations of mammals that may do damage, and the impact of existing and new invasive species. Planning for uncertainty is therefore the key consideration when developing approaches to adaptation, especially in the case of the long timescales associated with forest management.

An increased frequency and severity of summer drought is likely to represent the greatest threat to forests from climate change. Drought is already a problem on shallow, freely draining soils, particularly in the southern and eastern areas of Great Britain, and there is a very high likelihood that this will cause serious impacts on drought-sensitive tree species. These impacts will be widespread in established stands, so that the suitability of species for use in commercial forestry in all regions will need to be reassessed.

UKFS Requirements for Forests and Climate Change

Climate change mitigation

The climate change programmes operating within the UK seek to encourage activities that will reduce greenhouse gas emissions while allowing sustainable economic development to proceed. This approach is reflected in these UKFS Requirements, which aim to protect and extend the carbon resource in the forest environment over the long term, as well as the carbon stored in wood products.

A long-term view of the forest carbon stock (e.g. beyond the first rotation, when trees are being grown for timber) is important and recognises that short-term losses of carbon stocks associated with forestry operations, such as thinning, felling, site preparation and civil engineering, may be countered by gains over the rotation.

1 Woodland creation and forest management should contribute to climate change mitigation through the net capture and storage of carbon in the forest ecosystem and in wood products, through appropriate management objectives.

Climate change adaptation and protection

Based on the science and evidence of climate change impacts, there now needs to be a sense of urgency about implementing adaptation measures. It is essential that the risks and opportunities presented by climate change for forestry and achieving management objectives are accounted for in forest management plans. Risks include tree mortality, fire, drought, extreme weather events, and pest and disease outbreaks. Opportunities include potential increases in productivity and the range of species that can be grown. Forests can help people, society and the economy adapt to climate change by providing a range of benefits such as natural flood management, slope stability and the control of soil erosion, shade and reduced temperatures in urban areas, shade and shelter for livestock, and shade over watercourses to reduce the occurrence of lethal high water temperatures for fish.

Knowledge about the impacts of climate change on forests is likely to change over time, and so forest owners and managers will need to base decisions on the available evidence and advice on good practice. Guidance and a framework for forest adaptation is provided in the UKFS Practice Guide *Adapting forest and woodland management for the changing climate*.

2 Forests should be planned, created and managed to enhance their resilience and mitigate the risks posed to their sustainability by the effects of climate change or by pests and diseases.

3 Woodland creation and forest management should enhance the potential of forests to help society and the environment adapt to the various effects of climate change at the forest management plan review stage or earliest opportunity.

UKFS Guidelines on Forests and Climate Change

Mitigation

Forest expansion enhances the capacity for mitigation and is a principal consideration in addressing climate change through forestry. Furthermore, forest management can contribute to climate change mitigation by:

- managing for products used in place of fossil fuel-intensive construction materials;
- managing for woodfuel to substitute for fossil fuels;
- maintaining and enhancing carbon stocks in forests and their soils;
- managing risks such as wind, drought, fire and damage from pests and diseases.

Carbon in forest products

In general, the faster a forest grows, the more carbon dioxide it sequesters from the atmosphere. Management intervention (such as thinning and felling) maintains high rates of growth and carbon capture. Although wood will be removed from the forest, the accumulated carbon is retained in the timber products, particularly in those that last a long time. Using timber as a substitute for fossil fuel-intensive materials such as concrete and steel also contributes to climate change mitigation.

Woodfuel is a valuable substitute for fossil fuels, such as coal, oil or gas, as a source of heat or electricity. It may be grown specifically as coppice crops and short rotation forestry, or it can be an additional product from forest management or arboricultural work. Markets for woodfuel are continuing to expand and can provide a source of revenue to help support forest management that would not otherwise be undertaken.

Both forest residues (brash) and tree stumps can be considered as a source of woodfuel. However, their harvesting and removal can have negative and unsustainable effects. The removal of such material can deplete the site of its fertility, particularly in the case of brash, where many of the recyclable nutrients are found. Moreover, when stumps are removed the overall carbon benefit of the operation is unlikely to be positive due to the energy expended in their extraction and transport and from the release of carbon from soil disturbance. These practices can therefore only be considered sustainable on a limited number of sites, where it can be demonstrated that the nutrient status will be maintained, there will be a net carbon gain from the activity over the forest cycle, and the soil is not classified as at high risk of acidification.

1 Where forests are managed for timber production, maximise carbon sequestration through effective management, consistent with the storage and substitution benefits of wood products.

2 Consider the potential for woodfuel and energy crops within the sustainable limits of the site.

Carbon in forest ecosystems

Deforestation is a major source of carbon dioxide emissions and the protection and expansion of forest cover is a global priority in mitigating climate change. The whole ecosystem is a store of carbon, and it is important to consider management implications for all forest carbon, including the underlying soils, which often contain more carbon than the trees.

The highest sustained levels of forest ecosystem carbon are found in ancient woodland, mature woods managed for conservation and forests managed for continuous cover. Standing and fallen deadwood provides a vital element of ecosystem carbon, and actions to remove forest residues for woodfuel have to be carefully balanced against the benefits of retaining them for ecosystem carbon storage. It follows that any controlled burning of forest residues for forest management reasons diminishes forest ecosystem carbon and returns carbon dioxide to the atmosphere without the compensatory gains from their use as substitutes for fossil fuel. Formal woodland carbon projects, such as those set up under the Woodland Carbon Code, are managed in line with an approved forest management plan. Adherence to this plan ensures that the agreed level of carbon benefit is delivered.

There is a general presumption against the removal of forests across the UK. Net deforestation would reduce the capacity to sequester carbon and is counter to several international commitments on retaining forest cover. Where deforestation is proposed, an EIA is likely to be required.

3 Woody biomass should not be removed from an approved woodland carbon project unless this is part of the agreed forest management plan.

4 Conserve and enhance forest carbon stocks in the medium and long term.

5 Retain or expand the forest area and, when required, undertake compensatory planting where forest area is lost through land use change.

6 Ensure woodland creation proposals are appropriate for the site and designed to be resilient to the effects of climate change.

Operational carbon footprint

Forest operations are mostly mechanised and (through fossil fuel use) emit greenhouse gases. However, the overall emissions associated with forestry operations are small (equivalent to 2% of the carbon sequestered by UK forests). Emissions of greenhouse gases in forestry operations are also far lower than for other productive land uses. Although they are small, reducing these emissions will reduce the operational carbon footprint and help mitigate climate change. For example, sustainable biofuels could be used instead of fossil fuels for machines and vehicles. Another source of greenhouse gas emissions is timber haulage, so shorter haulage distances to local markets and the use of rail and sea transport as an alternative to road will reduce emissions.

Energy-efficient forest buildings constructed from wood instead of less sustainable materials, and the use of renewable energy sources instead of fossil fuels, will all contribute towards reducing the operational carbon footprint of the forestry sector. Within the forest itself, minimising high energy inputs, including fertilisers and pesticides, will also minimise the operational carbon footprint. Forests can also provide sites for other sources of renewable energy generation such as wind and hydro power.

7 Plan forest operations, civil engineering and timber transport to minimise energy use.

8 Consider the use of timber for the construction of forest buildings and recreation infrastructure.

9 Consider the energy efficiency of forest buildings and the efficient management of waste, and how renewable energy might be used or generated by the forestry business.

Adaptation

Forest planning and adaptive management

Forests can help society and the environment adapt to the impacts of climate change, particularly by alleviating flooding, controlling soil erosion and moderating temperatures in towns and cities, rivers and streams. These aspects of adaptation should be considered in the design and location of new forests and individual trees, as well as the management of existing forests.

Adapting to climate change is an element of sustainable forest management that is best addressed within the broad scope and long time frame of a forest management plan and the management that follows. However, based on the science and evidence of climate change impacts, there now needs to be a sense of urgency about implementing adaptation measures, and a flexible, reactive and anticipatory approach to management.

Ensuring a forest is diverse in terms of age, structure, species and origin, genetic diversity and choice of silvicultural system is likely to give forests greater resilience to the changing climate and should also keep a wide range of forest management options open. Regular monitoring will provide an early warning of potential problems in relation to climate change. For small wooded areas, published trends and associated guidance may suffice, but for larger forests some form of monitoring will help inform management decisions.

Some of the management decisions that may need to be reviewed in response to changing climatic conditions are the:

- Planting season – in response to changes in dormancy and water availability;
- Choice of species and mixtures – in relation to the changing climate and impacts of pest and disease outbreaks;
- Thinning regime – in relation to wind, drought and disease risks;
- Rotation length – to reflect changing wind risk and growth rates;

- **Timing of operations** – to avoid interfering with vulnerable life-cycle stages of protected species and to protect forest soils;
- **Mammal control** – of deer, grey squirrels and other invasive species that threaten regeneration and growth.

LISS such as continuous cover forestry encourage structural and species diversity and evolutionary adaptation by promoting natural regeneration. Such management systems can also make forests more resilient to wind damage as there are always areas of established young trees should windthrow affect the canopy. Not all forests can be managed under a LISS, but there are still opportunities for adaptation within clearfell systems.

The future climate may include more extreme weather events, and contingency plans will be valuable in the event of fire, wind or the outbreak of pests and diseases. A range of decision support tools are available to assist with forest planning. Changing rainfall patterns, indicated by the UK Climate Projections of the Met Office, will be relevant to operational planning, including the design and specifications of forest roads, culverts and bridges to ensure appropriate forest drainage and that infrastructure releases water slowly after heavy rainfall.

The potential for fire is a particularly important consideration in the context of climate change as it can lead to uncontrolled release of carbon from the forest ecosystem and may result in forest loss. Fire risk is currently highest in areas with high recreational pressure, in young trees, in forests with accumulations of dead vegetation, and in areas adjacent to heathland or where moor (muir) burning takes place. The risk of fire needs to be assessed in the forest management plan; it can be reduced through forest design, for example, by introducing diversity in age classes. Contingency plans in the event of fire will help ensure that damage is contained should it occur.

10 Ensure management and contingency plans address the impacts of climate change.

11 Consider projections of changes to rainfall patterns when specifying designs for culverts, drainage systems and roads, to ensure they have sufficient capacity to manage increased volume.

12 Consider the impacts of climate change on current silvicultural practices, and modify them as necessary; for example, adjust rotation lengths and planting seasons.

13 Consider the susceptibility of forests to pests and diseases and develop appropriate strategies for protection; review practice as further evidence becomes available.

Tree and shrub species selection

Climate change will lead to shifting climatic regimes and more frequent extreme weather events, presenting risks and opportunities for trees and the pests and diseases that attack them. The resilience of forests to deal with these changes can be improved by increasing the species and genetic diversity of trees and shrubs. Achieving species diversity in forests is a UKFS Requirement, and forest management plans will need to address tree species composition of the whole FMU. In addition, there are specific policies in relation to species diversity which are detailed at a country level.

The impacts of climate change will vary across the UK and so a range of adaptation strategies will be required. Establishing a variety of species, either in mixtures or in pure stands, can enhance the resilience of forests to projected climate change. For productive forests, a broader range of timber species than have typically been planted in the past must now be considered. For native woodland, augmenting the current range of species with others associated with the woodland type will often help meet biodiversity objectives in addition to increasing the resilience of woods.

Climate change projections suggest that, on some sites, growing conditions will become more challenging in the future for some species, especially where summer drought coincides with freely draining soils. Where a new forest is established in these situations, careful thought needs to be given to the choice of species and to the origin or provenance of the planting material. This may mean planting a more drought-tolerant species that is better matched to a drier site, or planting material of a more southerly origin that may be better adapted to the future climate. The ESC decision support tool can help with appropriate species selection. The comparatively long generation time for trees makes it important that populations contain sufficient genetic diversity to be able to adapt to climate change and develop resistance to pests and diseases.

14 Where timber production is an important objective, consider a wider range of tree species and genetic diversity than has been typical of past planting, and consider planting these in mixtures; consider the limited use of planting material from more southerly origins.

15 Choose trees or shrubs which are drawn from a sufficiently wide genetic base of parent trees to promote future adaptation.

16 Encourage natural regeneration and 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 woodland.

Urban woodland

Urban woodland can help society adapt to a changing climate by:

- providing cooling through evaporation and reflecting solar radiation;
- providing shade for comfort and reducing the incidence of health problems related to ultraviolet light;
- reducing solar gain of buildings in summer;
- reducing wind speeds, and consequently heating requirements, in winter;
- absorbing pollutants and improving air quality;
- contributing towards urban 'wildlife corridors' to aid species movement;
- contributing to sustainable urban drainage systems;
- providing recreational opportunities close to where people live and work.

However, the risk of new pests or diseases becoming established in urban areas is high because of the range of exotic tree and shrub species found in parks and gardens, and because warmer urban climates may help some imported pathogens become established – a risk that is magnified by urban trees being frequently found in a more stressed environment, experiencing air pollution, soil compaction and water shortages.

17 In urban areas, consider the potential benefits of woodland in reducing the impacts of climate change and supporting a range of ecosystem services.

5. Forests and Historic Environment

Several thousand years of human activity have contributed to the variety of landscapes found across the UK today. Surviving elements of the historic environment take many forms, and include ancient woodland, veteran trees, earthworks, ruined structures and archaeological sites, soils and paleoenvironmental sequences. Together, these heritage features contribute to the essential character of our landscape and inform both our sense of place and our knowledge of the past.

Protecting heritage features

It is important that all significant heritage features and designated heritage assets are protected, and that consideration is given to the conservation and enhancement of historic landscapes. Forests can offer a relatively stable environment in which many heritage features survive. However, good management is needed to ensure that these features are preserved for the future and are not damaged by forest operations.

The nature and extent of many elements of the historic environment are not fully known, but information is continually being added to the record from archaeological surveys and research, and from incidental discoveries. Obtaining information and advice in regard to the historic environment to inform appropriate protection and conservation measures in forests is important. Heritage features should be identified and appropriate measures taken to protect them. Where relevant, it may be necessary to involve suitably qualified and experienced historic environment professionals to inform decisions and provide baseline evidence, particularly in advance of woodland creation. Issues raised during this process should be evidenced and considered for integration within the forest management plan.

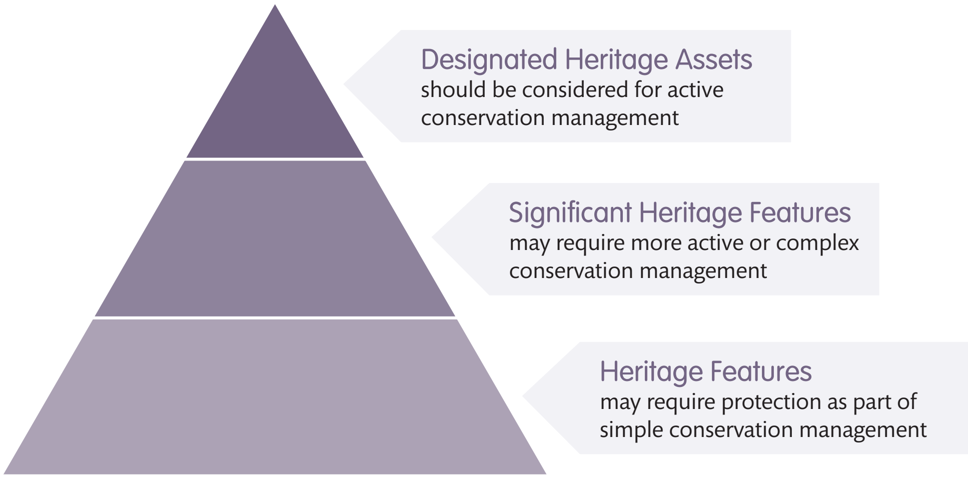
The relative importance of identified heritage features should be assessed (see Figure 5.1) and the majority retained as found, requiring simple conservation management through protection by avoiding damage or disturbance. The most significant heritage features and designated heritage assets should be considered priorities for active conservation management. Where appropriate, designated heritage assets should be managed in accordance with plans agreed with the appropriate statutory historic environment authority.

Forests containing or adjoining notable heritage features may attract many interested visitors, and opportunities to enhance or maintain public access, undertake active conservation management and consider options for interpretation should all be included within forest planning.

Obtaining information and advice

Effective and accurate information is required to properly manage the historic environment. Obtaining new information (e.g. by commissioning an archaeological survey) may be required to assess the impact of any proposal and determine whether any design or operational modifications are necessary.

Figure 5.1 The relative importance of identified heritage features.



The appropriate archaeological response depends on the detail of the proposal, the terrain in question and the quality of the existing information base. The information gathered should influence the design of forests and forestry activities to ensure that relevant heritage features are protected and that an appropriate record is made of any heritage features that could be lost because of operational activities.

To protect relevant heritage features a range of issues need to be considered, such as providing a protective buffer area to exclude new planting and avoid any inadvertent impact. On occasion, the retention of a group of sites in a larger open area may be appropriate and consideration may also need to be given to the setting of the heritage asset. Having accurate survey information is essential during the planning phase and marking-out surveys may also be needed to confirm the strategy on the ground.

Where significant heritage features are located within existing forests, specific management operations may be required. Having detailed site location and condition information is therefore essential to enable planning and subsequent management.

Evidence of the historic environment

In cultivated agricultural landscapes, many buried archaeological remains are first identified as crop marks from aerial photographs. These images, taken from flights over several decades, have allowed an extensive monument mapping programme to be undertaken with the results incorporated into the various Historic Environment Records. The results of archaeological walkover surveys and geophysical surveys have also added to our knowledge, and heritage features and historic landscapes may be evident on historic maps.

Aerial survey techniques cannot be used in areas where there is tree cover. As a result, many existing records do not extend to forests, which, in comparison with open areas, have received relatively scant field study. The lack of widespread detailed surveys means that many heritage features in forests are unknown or not recorded, and that they are therefore at greater risk of accidental damage. However, recent progress in using new remote sensing techniques such as Light Detection and Ranging (LiDAR; airborne laser scanning), is contributing new data to the records.

The need for detailed archaeological survey will depend on a number of factors. It will not be necessary to commission an archaeological walkover survey for every existing or potential forestry site. A visual survey, together with reference to existing records, will help reveal any obvious evidence and determine whether further investigation is warranted. A visual survey will also identify extant features of historical interest, including long established boundaries such as ancient rides, walls, banks and hedgerows, and veteran trees and features associated directly with forest management. Forestry practitioners are encouraged to make themselves aware of the common types of historical evidence and to record the location of features of interest that they may find.

Archaeological survey

When a specialist archaeological survey is required, it is most appropriate for this to be undertaken by a suitably qualified and experienced historic environment professional. Prior to any work commencing, a method statement should be agreed between the forest manager, the historic environment professional undertaking the works and forestry authority staff or the Local Historic Environment Service (which may be referred to as the local or regional curatorial service). This method statement should detail:

- the area of ground to be covered and the nature of the terrain;
- the techniques to be used, including the standards to be complied with;
- the timescales and resources needed for completing the study;
- the required format and scope of results and reports.

There are several established techniques that are used to determine and identify heritage features. Some of these allow the remote detection of sites (such as aerial photography and LiDAR), while others are used to make a more detailed record of upstanding surviving earthworks and structures (such as archaeological survey).

Assessing an area deemed to be archaeologically sensitive usually requires a combination of techniques appropriate to the previous land use and potential archaeology that may be encountered. Commonly used techniques are:

- Desk-based assessment: the identification of known or potential heritage features through the examination of relevant Historic Environment Records, and sources such as historic maps, aerial photography and the results of LiDAR surveys.

- Prospective survey: a survey undertaken to locate and define upstanding heritage features. Surveys can take a variety of forms: the targeted inspection and definition of known sites; the prospective survey of ground of high archaeological potential to locate previously unidentified sites; and the comprehensive inspection of all ground covered by a proposal.

- **Protective and detailed survey:** a survey undertaken to support agreed design solutions such as: a final walkover survey to mark out relevant heritage features within the proposal and fully check the area identified for planting; or a detailed archaeological measured survey to provide a baseline record of the heritage feature or historic landscape.

The results from a combination of desk-based assessment and prospective survey will significantly enhance the Historic Environment Record for a study area, providing an excellent evidence base for land management. This enables all future planting and management proposals to be integrated with the historic environment, with significant heritage features avoided (or retained in open areas). Advice on the design of any programme of historic environment works can usually be provided by the local historic environment service.

UKFS Requirements for Forests and Historic Environment

Scheduled Monuments

The Ancient Monuments and Archaeological Areas Act 1979 in Great Britain, Historic Environment Scotland Act 2014, Historic Environment (Wales) Act 2016, and Historic Monuments and Archaeological Objects (Northern Ireland) Order 1995 provide the legal basis for designating Scheduled Monuments in the UK. Consent is required from the relevant statutory historic environment authority for most works within a Scheduled Monument and for any that have the potential to damage or disturb the monument. Undertaking unauthorised works or causing damage to a Scheduled Monument is an offence and can lead to criminal prosecution.

1 Scheduled Monuments must not be damaged or disturbed, and consent must be obtained from the relevant statutory historic environment authority for any works that have the potential to damage or disturb the monument.

Archaeological finds

In England, Wales and Northern Ireland there is a legal requirement to report treasure finds, which are carefully defined under the Treasure Act 1996. In Scotland there is a legal requirement to report all archaeological finds under the Treasure Trove system and only disclaimed finds can be legally acquired. In each country there are regulations affecting the use of metal detectors. Throughout the UK, it is illegal to use a metal detector on, or to remove any archaeological finds from, a Scheduled Monument without the permission of the statutory historic environment authority. There is also the Portable Antiquities Scheme, to which chance discoveries of archaeological artefacts outside an archaeological context should be reported.

In Scotland, *Crimen Violati Sepulchre* (violation of sepulchre) means that sites with the confident potential to contain buried human skeletal material are protected, and any accidental discovery of human remains (however old) must be reported. Similarly, in England and Wales, accidental discoveries of human remains must be reported; human remains on un-consecrated ground are protected by the Burial Act 1857 and a licence to disturb or remove these is required from the Ministry of Justice.

2 The relevant authorities must be informed if discoveries are made that come within the scope of the laws covering archaeological finds and human remains. Metal detectors must not be used where legally restricted or on a Scheduled Monument. Human remains must not be disturbed without prior permission.

Listed buildings and structures

When a historic building or structure is listed, it is placed on a statutory list of buildings and structures of special architectural or historic interest. These lists are compiled by the statutory historic environment authority in each country. From an owner's or manager's perspective, the listed building or structure cannot be altered, damaged or demolished without obtaining the necessary consent from the relevant national or local authority.

Repairs that exactly match the existing structure may not need consent, but the local planning authority will advise, as the impact and effect of any repairs is not always straightforward.

3 Listed building consent must be sought and obtained from the local planning authority to demolish a listed building or structure or any part of it, or to alter it in any way which would affect its character, inside or out.

Protection of Military Remains

All military aircraft crash sites in the UK, its territorial waters, or British aircraft in international waters, are controlled sites under the Protection of Military Remains Act 1986.

4 It is an offence under the Protection of Military Remains Act 1986 to tamper with, damage, move or unearth any items at such sites, unless the Ministry of Defence has issued a licence authorising such activity. Anyone seeking to recover a military aircraft or excavate a military aircraft crash site is required to obtain a licence from the Joint Casualty and Compassionate Centre, part of the Defence Business Services, Ministry of Defence.

Historic landscape character

The historic environment shapes the character of our landscapes. It also reveals how communities adapted to ongoing climate, economic and technological change. There are many historical and cultural associations with particular places, different land uses and individual heritage features, and these associations can bring a cultural dimension to the value of historic landscape character. Policies have been developed to reflect the importance of historic character and protect important landscapes. Some areas have special designations, such as being registered parks and gardens, and some may have locally specific policies that apply in addition to those accompanying the designation.

In some situations, woodland creation can enhance or develop the historic character of the landscape, but in others this may be inappropriate. Where existing forests were planted with little attention to the historic landscape, felling and restocking (or regeneration) presents an opportunity to reassess their design; this is especially the case where previously unrecorded heritage features have since been identified. In many parts of the UK there are projects identifying the historic character of landscapes that can help inform decisions about a proposed change.

1 Forests should be designed and managed to take account of the historic character and cultural values of the landscape.

2 Forests should be designed and managed to take account of policies associated with World Heritage Sites (and their buffer areas), historic landscapes, battlefield sites, Conservation Areas, historic parks and gardens and designed landscapes.

3 Where forest creation or substantial forest management is proposed within registered parks and gardens, the relevant Gardens Trust should be consulted as well as the statutory historic environment authority.

Heritage features

The primary responsibility for land managers is to ensure that heritage features receive appropriate protection and are not accidentally damaged. This will involve the identification and assessment of sites, and the inclusion of designated heritage assets and significant heritage features as part of the forest management plan. A range of measures can then be set out in operational plans to ensure that features are protected and that suitable conservation management is considered. Designated heritage assets and significant heritage features with an appropriate conservation option and added value in terms of wider sustainable forest management should be considered priorities for action. Social opportunities and environmental constraints should also be considered.

Heritage features are not confined to archaeological sites and include a range of features of local significance, such as relict field systems and veteran trees. The relative importance of identified heritage features will need to be assessed on an individual site basis. Information and advice to support the development and design of the forest management plan can usually be provided by the local historic environment service and/or a suitably qualified and experienced historic environment professional.

4 Steps should be taken to ensure that heritage features, which may be adversely affected by forestry, are known and assessed on an individual site basis, checking Historic Environment Records and obtaining information and advice where appropriate.

5 Forest management plans and operational plans should set out how designated heritage assets, significant heritage features and woodland heritage such as veteran trees are to be protected and managed, and should clearly show their location and extent.

UKFS Guidelines on Historic Environment

Historic landscape context

The long history of human settlement and land use in the UK has left a legacy of varied landscapes rich in historical and cultural values. The vast majority of natural tree cover was cleared to provide land for other uses and, at a broad scale, the geomorphology of an area dictated where activities such as quarrying, mining, agriculture or forestry would have been the predominant land use. Features such as burial mounds, hillforts and farmsteads indicate a history of open land, whereas features such as saw-pits or charcoal platforms indicate a woodland history.

Ancient woodland, parkland and wood pasture will all have a long history of woodland culture associated with them – although the historical use of the term 'forest' was misleading as it was often used to describe a hunting area, irrespective of tree cover, in ancient hunting forests. Cultural values are often linked to historical uses and may include designed landscapes, cultural associations, or areas imbued with social history, such as the crofting landscapes of Scotland.

Projects to understand the historic development of landscapes, rather than individual special sites, have been undertaken across the UK. Examples include Historic Landscape Characterisation (HLC) in England and Wales, and Historic Land-use Assessment (HLA) in Scotland. These projects examine the origins of land-use patterns and map them in areas of similar character to provide a basis for guiding land-use policies. They can also contribute the historical element to a Landscape Character Assessment (LCA).

The most important historic and designed landscapes are entered onto registers of landscapes of historic and design interest and some of the most sensitive historical areas have been identified in indicative forestry strategies, regional forestry frameworks and local forest management plans.

There is popular interest in landscape history, and this can present opportunities: for example, in generating support for proposals to restore woodland cover on sites that were wooded in the recent past. First-series ordnance survey, other early maps and old aerial photographs (e.g. the RAF stereoscopic cover produced from the late 1940s) provide useful sources of information and can help show how the landscape has developed over time and how the woodland and tree elements have changed. In some cases, tree planting may have disguised or detracted from the historical value of landscapes and there may be a case to consider removing trees to restore special sites.

1 Contact the local historic environment service for information on the historic landscape context; check to see if a historic assessment or categorisation has been undertaken, or if the landscape is listed or registered as being of historic or design interest.

2 Use the historic assessment or categorisation or any description given in a historic register or list, together with a Landscape Character Assessment, to inform the development of proposals.

3 Consider the impacts of forestry on the historical context and landscape character in forest management plans; consider opportunities to complement, enhance or re-create landscapes of historic interest.

Forest planning

Obtaining information and advice in regard to the historic environment to inform protection and conservation measures in forests is important. Where heritage features are newly identified in a desk-based assessment, or where there is potential for unknown heritage features but information is lacking, a more detailed prospective survey may need to be commissioned. This is particularly relevant in upland areas and in areas of previously unimproved agriculture. However, for many sites, records may already exist, and a useful starting point in identifying this information is the various Historic Environment Records. Advice to support the development and design of the forest management plan can usually be provided by the local historic environment service or can be commissioned from a suitably qualified and experienced historic environment professional.

Consideration of the historic environment should precede any new planting on an area of ground previously unplanted with trees. However, there are different levels of response required, depending upon the conditions. A professional archaeological survey may be required in some situations while a desk-based assessment may suffice in others. Unimproved or upland areas such as upland moorland and pasture may be more likely to require field survey, and advice should be sought from the local historic environment service.

Consideration of the historic environment should also precede any harvesting and restocking operations. However, there are levels of response appropriate to different conditions. A professional archaeological survey may be considered appropriate in some cases, such as in previously unimproved areas, ancient and semi-natural woodland and areas with a high density of heritage features, as the likelihood of unknown sites being found is much higher.

It will not be necessary to conduct a full historic environment survey for every existing forest or potential woodland creation site, particularly in areas of previously improved agriculture. A visual survey, together with reference to existing records, will help reveal any obvious evidence and determine whether further investigation is warranted. A visual survey will also identify extant features of historic interest, for example, long established boundaries such as ancient rides, walls, banks and hedgerows, and woodland heritage features such as veteran trees associated directly with woodland management. Forestry practitioners are encouraged to make themselves aware of the common types of historical evidence and to record the location of features of interest they come across.

The process for integrating the historic environment into the forest management plan involves collecting and analysing all relevant information, including the historical context and evidence of the historic environment resource. In some situations, evidence of the historic environment will be compelling and forestry may be inappropriate. However, where features or areas of interest have been identified within a forest area, it will often be appropriate to safeguard them as an area of open space within a forest management plan.

As a guide, a margin of at least 20 m should be identified and maintained around designated heritage assets such as Scheduled Monuments and other significant heritage features, but this will depend on the site itself. There is a presumption against restocking (or allowing regeneration) on designated heritage assets and significant heritage assets. Linear features such as ancient rides, walls, banks and hedgerows, and woodland heritage features such as veteran trees, may not justify such a large buffer area, but they can be identified for protection in the forest management plan and operational plans.

Growing short rotation forestry or coppice crops on agricultural land to provide a source of woodfuel is of increasing interest, but the practice can pose threats to the historic environment. Species such as willow have a high water demand that can affect waterlogged archaeology. In addition, these crops may eventually be removed by a deep cultivation process, which can disrupt or destroy buried historic environment evidence.

The setting of designated heritage assets and significant heritage features may also be relevant and will need to be considered in woodland creation proposals and/or in the forest management plan. Where groups of features occur adjacent to each other, a larger area of open space is preferable to a series of smaller spaces. Where features are prominent in the landscape, or have sight lines associated with their function, then the area to be excluded from planting will need to be larger to accommodate these visual qualities. Sites where evidence suggests that significant historic environment potential may be present, but specific features have not yet been identified, also need to be identified in forest management plans.

4 Obtain information from all relevant Historic Environment Records and seek advice where appropriate to support the development and design of forest management plans from the local historic environment service and/or a suitably qualified and experienced historic environment professional.

5 Look for indications of the historic environment on the ground and conduct further investigation where evidence is found; commission archaeological surveys or seek specialist advice where there is considered to be high archaeological potential, submitting the results to the relevant Historic Environment Record.

6 Ensure those working in forests are aware of the importance of the historic environment and encourage them to recognise evidence and to assist in gathering information.

7 Integrate historic environment considerations into the forest planning process by identifying relevant heritage features and evidencing management decisions, and including long-established boundaries and woodland heritage as features to be protected.

8 Plan an appropriate area of open space around significant heritage features; for designated heritage assets such as Scheduled Monuments this will normally be a minimum of 20 m; consider the setting as well as the individual features.

9 Where archaeological evidence suggests that significant historic environment potential may be present but specific heritage features have not been defined, identify these areas in forest management plans and, if appropriate, restrict any planting to smaller trees or shrubs and minimise ground disturbance.

10 Record the nature and position of any newly discovered heritage features or objects such as pottery, flint or bone, and report them to the relevant local historic environment service.

11 Keep drains well away from known buried archaeological remains; where existing drains may be having a detrimental effect, consider blocking or re-routing them.

12 Take particular care to avoid heritage features where short rotation forestry or coppice crops are proposed.

Forest management and woodland heritage

Existing forests may also be part of the historic environment. Some may contain veteran trees or coppice, possibly reflecting centuries-old management traditions on the site, while others reflect more recent social and economic policies from the 20th century. Woodland heritage such as veteran trees, old coppice and pollards also need to be protected and it is important to select and manage suitable replacement trees that will eventually take their place. In particular, veteran pine and oak trees can be very important to dendrochronologists seeking to build regional reference chronologies.

Existing forest cover has often protected historical features of woodland management, such as saw-pits, boundary banks and charcoal hearths, and earlier pre-woodland uses such as farms, settlements and burial mounds. Compared with open land, and in particular arable farming, woodland can protect historical evidence from disturbance and from physical pressures such as exposure, frost and erosion. Some evidence of earlier non-woodland use can even be found in long-established ASNW. Forest cover can be vital for enhancing the historical value of features by providing them with an appropriate setting and so contributing to the sense of place.

While tree cover may have afforded some protection to the historic environment, the management of trees and shrubs on or adjacent to significant heritage features needs to be considered. Earthworks may initially be protected from erosion by the binding action of roots, but under some circumstances, roots can become disruptive and pose a threat. Damage by windblown trees can also be considerable, for example, where root plates lift and disrupt buried archaeological remains. When this occurs, it is advisable to cut the trunk and return the root plate to its original position, and to consider commissioning a professional archaeological assessment to record the damage (obtaining prior consent from the relevant statutory historic environment authority in the case of Scheduled Monuments). Smaller trees and shrubs are likely to cause less damage, and pollarding and coppicing can help restrict growth. The remains of buildings and walls are best kept free of scrub vegetation and regenerating trees, but grass or moss may have protective qualities. Occasionally trees will have grown and become firmly established in the walls of standing structures. The tree may be holding the structure together, so removal needs to be undertaken with care and following appropriate specialist advice.

Open space within forests can provide an appropriate setting for designated heritage assets and significant heritage features. However, thought needs to be given to monitoring these areas and, if necessary, undertaking conservation management. Keeping these areas free from scrub vegetation and regenerating trees can help to preserve the features, provide physical access and capture something of the visual context and sense of place. Open space can also provide biodiversity benefits by maintaining open-ground plant and animal communities, improving forests' ecosystem services and natural capital.

A low level of browsing can be advantageous as it will discourage the encroachment of woody vegetation, particularly in wood pasture systems, but care has to be taken to ensure overgrazing does not result in erosion. This is particularly important when livestock are introduced to woodland. For example, cattle can cause poaching in areas of open ground where grazing is better, and pigs or wild boar turn over a lot of soil, so additional measures such as fencing may be required to protect the ground around individual sites. However, once grazing by livestock ceases, most open areas will start to revert to woodland through vegetation succession. Succession can take decades in areas where there is a dense grassy sward from a previous grazing regime but may be rapid where the ground is disturbed in some way – for example, by rabbits or where trees have been removed.

An alternative to grazing is mowing, cutting or flailing. Even one cut per year can help control coarse vegetation, favour low-growing ground cover species and grasses, and encourage incidental grazing. Bracken obscures features and rhizomes can disturb buried archaeological remains. Once established, it will prevent grazing and lead to vegetation succession. Repeated cutting, just when the fronds have unfurled, will help keep it in check.

Regular visits to significant heritage assets to monitor their condition will identify any new threats or damage, such as a new badger sett in an earthen barrow, a canopy gap that could lead to windblow or increased scrub growth, or excessive recreational activities causing erosion on the ramparts of a hillfort. A useful method of monitoring is to keep a photographic record that includes the date of inspection. Statutory historic environment agencies may be able to offer condition monitoring of scheduled monuments and follow up management advice.

13 Manage woodland heritage such as veteran trees, old coppice and pollards; where appropriate, select and manage suitable replacement trees that will eventually take their place.

14 Manage trees and shrubs that may damage designated heritage assets and significant heritage features in existing forests; where appropriate, limit the establishment of scrub vegetation, rhododendron and regenerating trees and consider removing large trees vulnerable to windthrow.

15 Aim to maintain the open settings for designated heritage assets and significant heritage features; where appropriate, monitor changes in vegetation and consider using grazing or mowing as part of the management plan; where grazing does take place, monitor its impact on the condition of relevant heritage features.

16 Monitor designated heritage assets and significant heritage features, including woodland heritage, to check they are not being damaged or degraded.

17 Manage public access so that designated heritage assets and significant heritage features are not subject to erosion or damage caused by visitor pressure or excessive recreational activities.

Forestry operations

Forestry operations and civil engineering activities involve heavy machines and occasionally earth-moving equipment. These activities can destroy or damage heritage features and buried archaeological remains, while even the close proximity of machines presents risks of physical damage, soil vibration, compaction and erosion.

Ground disturbance may be required for tree establishment, and operations involving deep cultivation, scarification and drainage can all destroy buried archaeological remains. The construction of roads, trails, paths and car parks all involve earth moving, and quarries are frequently opened to provide materials. Other engineering works can involve modifying watercourses and the construction of drains and other structures such as bridges. The felling and extraction of timber usually involves large harvesting machines and sometimes a winch to drag heavy loads of timber. In addition, some habitat restoration projects involve considerable ground disturbance, such as pulling out tree stumps and inverting soil layers to reduce the surface nutrient content. As with any soil disturbance, this can have potentially damaging consequences and the possible effect on heritage features and buried archaeological remains needs to be considered before proposals are finalised.

The first stage in protecting a site is to identify all known elements of the historic environment, including woodland heritage features such as veteran trees, in the forest management plan. The plan should include both the location and extent of all designated heritage assets and significant heritage features. This information, together with any more detail provided by site examination, can be transferred to a site-level operational plan when operations are proposed. The operational plan sets out how site works are to be organised, together with measures to avoid damaging relevant heritage features. Where there are designated heritage assets and significant heritage features, advice should be sought from the statutory historic environment authority and local historic environment service. Obtaining consent is a legal requirement where operations may affect a Scheduled Monument. This liaison process can take time and will need to be planned in advance.

The historic environment is particularly vulnerable to unintentional damage during site operations. It is important to ensure that all those working on site understand why measures are in place and how best to avoid damage. The final stage in the planning process is to mark out relevant heritage features on the ground – ensuring that site workers are fully aware of the operational constraints. In addition to the operations themselves, heritage features will also need to be protected from incidental activities such as the stacking of timber or storage of other materials on site. Where operations are necessary near to heritage features, measures can be taken to ensure the impacts are minimised. These include limiting work to periods of dry weather, planning racks and extraction routes in advance, and protecting the ground with brash mats. Low-impact harvesting and extraction methods, such as felling by hand, extraction by winch, or by using horses, may also help minimise site impacts under some circumstances. Felling and thinning should be planned to minimise the risk of consequent windblow affecting heritage features in the vicinity.

Steps can also be taken to lessen future impacts and improve management options, for example, by thinking carefully about the position of fence lines and the provision of access routes to features.

18 If operations are planned near a designated heritage asset such as a Scheduled Monument, consult the relevant statutory historic environment authority before site operations commence; if operations are likely to affect other significant heritage features, seek advice on operations from the local historic environment service.

19 Identify relevant heritage features in the operational plan and identify them on the ground; ensure they are excluded from the operational area and that the plan is communicated to all those working on site.

20 Where operations near heritage features are a necessity, or it is desirable to remove trees from them, take precautions to avoid damage and take particular care with felling and extraction.

21 Avoid heritage features when planning areas for storing material, stacking timber or as a parking area for machinery.

Access and interpretation

Forests often have an interesting history that enhances the contribution they make to society. There is considerable public interest in cultural heritage and the historic environment and interpretation of these aspects of forests can provide a focus for visitors. This may be as part of a wider access or recreation strategy or an informal opportunity to appreciate a specific heritage feature.

The history of an individual wooded area is often wide ranging and can include heritage features associated with previous land uses, as well as the management of the forest itself. Evidence of past land use may include the remains of agricultural fields and farms, prehistoric burial mounds, settlements and fortifications. The history of woodland management might be linked to the establishment of a strategic timber reserve, the iron industry, shipbuilding, hunting or some other impetus for the use of woods. The ancient woodland, veteran trees, historic parklands, wood pasture and coppice woodlands that we see in the landscape today all have a story to tell. Some woods contain features that span several thousands of years of history.

Heritage features can sometimes be linked by paths and trails, and explained using interpretative panels, leaflets and maps. However, such facilities need to be managed to avoid negative impacts on the heritage features or the surrounding area. For example, increased visitor numbers may lead to an increased risk of erosion. Monitoring and, where necessary, mitigating action, will be required to ensure that heritage features and visitor facilities remain of a good standard. For example, paths may need to be re-routed and interpretation boards relocated to remove risks to sensitive locations.

22 Consider providing access to heritage features of significant cultural and historical interest.

23 Consider how relevant heritage features could be interpreted for visitors as part of an integrated access strategy.

24 Ensure that relevant heritage features and any visitor facilities associated with them are well maintained.

6. Forests and Landscape

Landscape is a uniquely broad and overarching element that provides the setting for forestry and contributes a range of design principles, techniques and processes that facilitate effective forest planning, design and management. The UKFS approach is to assess landscape character and reflect it in forestry practice through an appreciation of the landscape context and the application of forest design principles. Other guidance and information may need to be used in conjunction with the UKFS.

Conserving and enhancing landscapes

The UK has a great diversity of landscapes arising from the interaction between natural processes and human interventions. This diversity is reflected in the rich variety of forested landscapes across the UK. Landscape is well known for being appreciated for its visual contribution to our surroundings. A landscape is also a resource in its own right, requiring an understanding of the interaction between natural components, human influences and cultural values. Considering all the factors that make up a landscape and its functions provides a way of appreciating our surroundings and is a useful spatial framework for thinking about a wide range of environmental, land-use and development issues such as forestry.

The creation of new areas of resilient, multifunctional forests is a high priority for the UK so it is more important than ever to apply forest design principles and process. This will ensure forests are well-designed and managed in an efficient manner, resolving complex design issues, delivering on multiple objectives and conserving and enhancing landscape character.

Forests in the landscape

Forests are important elements in the landscape that change over time. They can enhance and enrich the environment and make a significant contribution to the character of a particular landscape. In some landscapes they are the dominant element, enclosing space, providing seasonal colour, texture and scale, masking some landscape features and views while framing others.

The UK has lost a greater proportion of its natural forest cover than most countries in Europe, because of a long history of clearance for agriculture, development, as well as demand for timber, especially in times of war. In the first half of the 20th century, creating a strategic timber reserve was a priority for the UK government and that was often characterised by large-scale blocks of non-native conifers with limited species and age diversity, laid out in geometric shapes that followed ownership boundaries. These new forests were frequently in visually prominent locations and from this time onwards landscape professionals were commissioned by the forestry authorities to provide guidance and advice, primarily about how to ameliorate visual impacts. Visual force analysis was a technique specifically designed to address this issue by using the analysis of landform to influence more natural forest shapes, enabling better landscape fit. Some of these legacy blocks are still undergoing management and adaptation but, since the 1960s, an increasing amount of attention has been given to the impact of forestry on the landscape.

In terms of visual design, forests and trees have long been appreciated in the layout of grounds of great houses, parks and sporting estates, while the idea of a romantic 'wild' landscape still influences how landscapes are appreciated. Two guiding principles set the foundation for the design of forests:

- Forest landscape design should emulate 'natural' patterns and forms.
- Principles of visual design, used by designers in other fields, should be applied to the landscape design of forests.

Although visual matters remain integral to landscape, forest design principles are also applied more broadly to address the needs and aspiration of modern forestry and woodland creation. Forest design principles cover the holistic nature of landscape character and its functionality in an integrated approach across the UKFS elements. They are relevant and effective for designing and managing the more diverse, resilient, multi-functional forests and woodlands of today.

In urban areas, there is increasing interest in the contribution that forests can make to improving health, well-being and quality of life, regenerating urban communities, restoring derelict land and improving perceptions of the area. They can be used in the landscape restoration process to help visually integrate otherwise disparate elements, as well as reducing any unwelcome visual prominence in the wider landscape of infrastructure such as roads and buildings.

Forests are often significant components of protected areas such as National Parks, National Scenic Areas and Areas of Outstanding Natural Beauty, and the landscape impacts of afforestation, clearfelling and forest roads are considered in the context of the country designation(s) and policies that apply.

Forestry and the planning system

Woodland creation and forest management activities are not defined as 'development' and so do not come within the scope of the Town and Country Planning Acts. However, some construction associated with forestry proposals such as an access track or a quarry may be subject to planning controls, particularly in areas with landscape designations.

At a local level, planning authorities have responsibility for landscape issues. They have the power to define areas of high landscape importance and to provide for their conservation and enhancement through policies in their local plans and supplementary guidance. Local planning authorities are consulted on forestry proposals, with landscape and visual impacts frequently considered as important issues.

When the scale or sensitivity of a forestry scheme warrants an EIA, the landscape might need special consideration through a Landscape and Visual Impact Assessment (LVIA). A LVIA provides a consistent and recognised method for assessing the effects of landscape change and can be tailored to the complexity of a forestry proposal and the sensitivity of the landscape.

Local authorities can apply Tree Preservation Orders and designate Conservation Areas to protect trees that are important in the landscape, and they may also apply planning conditions to protect existing trees or plant new ones as part of a development consent, entering into 'planning gain' agreements for additional woodland creation or protection.

Developed by local authorities and statutory authorities across the UK, an LCA is a recognised method to analyse the key characteristics that make landscapes distinct, and to categorise and map landscape character types. LCAs can operate at a range of scales, from broad regional studies to local areas of land. Many local authorities take a proactive role in co-ordinating registers or inventories of landscapes of design interest, and some also work with the statutory authorities on historic landscape, parks and gardens. These sources of information can help develop a comprehensive picture of the landscape context for forest design.

Forest landscape design

Forest landscape design – the design of forested landscapes – is important both for woodland creation and for redesigning existing forests at the rotation stage, when felling and restocking (or regeneration) provides management with an opportunity to reassess their design and enhance the visual contribution they make to the landscape.

The setting or 'context' in which forestry is practised today is shaped by the influences of the renowned beauty and diversity of the UK's landscapes and our long history of human settlement and land use, combining to create a strong and locally distinctive 'character', often with historical and cultural associations. Through the appreciation and analysis of landscape context, forests can be planned and designed to make a positive contribution to the character of a local area and create attractive new landscapes. Most landscapes can accommodate more trees and forests, especially where this contributes to resilience. However, in a limited number of situations, the landscape context will be such that forests and their associated infrastructure will be inappropriate or restricted, in terms of siting, extent or composition.

The UKFS approach uses both the landscape context and forest design principles, and provides a rationale to underpin the design process. By following the UKFS, landscape change relating to forestry can be developed in an informed way and communicated to a wide range of audiences. Photographs, annotated plans and three-dimensional visual representations of the forest can be useful to explain what is proposed, playing an important role in understanding and communicating the potential landscape change.

UKFS Requirements for Forests and Landscape

Landscape context

The landscape context concerns the relevant characteristics pertaining to the site, situation and local area of a proposed or existing forest. This will include the landscape character, sensitivity, distinctiveness, historical and cultural significance.

The European Landscape Convention (ELC) promotes the protection, management and planning of all European landscapes, including natural, managed, urban and peri-urban areas, and landscapes that range from special to everyday and even degraded. The UK has agreed to its core principles of:

- putting people from all cultures and communities, and their surroundings, at the heart of spatial planning and sustainable development;
- recognising that all landscapes are important, whether beautiful or degraded, and that they are an inheritance shared by everyone;
- increasing awareness and understanding of landscape and its value, as a unifying framework for all stakeholders whose activities affect it;
- promoting a more accessible, integrated and forward-looking approach to managing the landscapes we have inherited, and in shaping new ones.

Some local authorities have developed specific plans for forestry that identify opportunities and sensitivities through forestry and woodland strategies, forestry frameworks and community forest plans. In some urban areas, local strategies have been established to improve the landscape and promote regeneration through woodland creation, for example, The National Forest, Community Forests and Central Scotland Forest.

1 Forests should be designed and managed to take account of the landscape context, considering the sensitivity, character and distinctiveness of the local area in line with the European Landscape Convention.

2 Forests should be designed and managed in consultation with statutory bodies to take account of landscape designations, designed landscapes, historic landscapes and the various policies and strategies that apply.

Forest design principles

The factors that determine the landscape context provide the framework for assessing the forest site and local area, determining the sensitivities and refining the forest design objectives. Informed by this assessment, forest design principles, based on the principles of visual design, can be applied (Box 6.1). These have stood the test of time and give a proven rationale for improving the visual quality of forests.

3 Forest design principles, informed by the landscape context, should be applied to ensure landscape and visual aspects are appropriately addressed.

UKFS Guidelines on Forests and Landscape

Landscape context

Landscape character

The UK has a rich variety of landscapes, and understanding their character is fundamental to planning for landscape change and informing forest design. Landscape character in the UK has often developed over a long period of time – sometimes, as with woodland, growing subtly and imperceptibly by responding to gradual shifts in land management or climate; other times changing abruptly and dramatically, such as when new development takes place, quarries and mines are worked (or restored), when financial incentives drive rapid afforestation, or when a large area of diseased trees is clearfelled.

An LCA is an accepted approach used to identify and analyse the consistent pattern of elements (e.g. geology and geodiversity, landform, watercourses, land-use and settlement patterns) that make landscapes distinct, and to categorise and map these as landscape character types. This approach can be applied at any scale and can be used in the forest design process to gather and appraise landscape baseline information and inform forest design concept options. LCAs have become strategic landscape planning frameworks across the UK. Frequently they have developed through partnerships between local authorities and the statutory landscape agencies, where approaches may differ.

An LCA will usually include:

- A description and mapping of the landscape, including the key characteristics and special qualities of a landscape, including those relating to trees and forests.
- An evaluation of the landscape, its condition and strength of character.

An LCA may also provide guidance on a variety of issues that may result from landscape change, including potential woodland creation proposals.

Where available, formal LCA studies provide an essential starting point for forest design, and will inform how the siting, extent and composition of forests can be planned so that they make a positive contribution to the landscape. This is particularly important for significant areas of new woodland or large-scale felling and restocking (or regeneration) proposals that may impact on sensitive landscapes.

1 Refer to relevant Landscape Character Assessments and other design guidance as part of the forest planning process.

2 Study the landscape character at a local level, identifying the key characteristics of the landscape; use the analysis to inform the forest design.

3 Where woodland creation is proposed, consider the sensitivity of the landscape to accommodate change, and design it to have a positive impact on landscape character.

Landscape and visual sensitivities

Landscapes may be considered sensitive to change for a variety of reasons, such as for their valued landscape character, geological diversity, natural heritage, historic importance or scenic qualities and, on occasions, a combination of these values. Nationally and locally valued areas may be protected by designation (meaning that woodland creation might be considered inappropriate), or by guidance on how the location and type of woodland can be designed to benefit the character and sensitivities of the landscape.

The particular quality of a locality that gives it its identity and makes it unique and special to the people who live there or visit is known as local distinctiveness (Figure 6.1). The quality is the way that natural and human influences – such as landform, vegetation patterns, land-use and built structures – combine to form what is essentially a cultural landscape. Local distinctiveness contributes towards local people's identity and helps them to enjoy, remember and value particular places. Forestry proposals should both respect and build on local distinctiveness.

Figure 6.1
This dominant hill adds local distinctiveness to the landscape. Any proposals for afforestation or tree planting which could affect well-known local views should be discussed with the local community.

The creation of new forests and the felling and restocking (or regeneration) of existing ones has the potential to dramatically alter landscapes. An essential part of the forest design process is the consideration of the effect that woodland creation and forest management will have on both the character of the local landscape and visual amenity of those who will experience the changes proposed. Any proposals for afforestation or tree planting that could affect well-known local views should be discussed with the local community.

Changes should be considered and assessed in terms of:

- Landscape sensitivity – natural heritage and cultural or historical associations all contribute to landscape and scenic value and may be supported by designation.
- Landscape character – an appreciation of the description of the current key characteristics of a local or regional landscape and how this may change as a consequence of the proposals is the starting point for the design process.
- Landscape visibility – determined by the prominence and topography of the landscape, the number of agreed viewpoints, and the presence of elements that may screen or frame views (Figure 6.2).

Figure 6.2
This landscape is sensitive to change as it is in a National Park, visible from major roads and settlements and seen by many people – including tourists.

- Number of viewers – depends on the size of the local population, settlement pattern and how the landscape is used by local people, those in transit and visitors.
- Nature of viewing experience – influenced by factors such as whether the view is seen from a moving vehicle or a neighbouring dwelling, or provides the backdrop to a visitor attraction, or is a view glimpsed through a forest opening.

Proposals for change need to be considered for their potential effect on the character of the existing landscape, specifically the recognised key characteristics and their relationship to each other. They will also need to be considered for their potential effects on visual amenity throughout the area from which the proposals will be visible, considering the nature of the view and the potential impacts on the viewer. This is typically done from a range of representative viewpoints. The changes should then be illustrated to provide the basis for an assessment of people's responses to proposed changes, and to the overall effects on visual amenity.

The potential visual effects of forestry proposals from each selected viewpoint should be considered against six criteria:

- Visual sensitivity – the relative sensitivity of a landscape scene to accommodate a forestry proposal.
- Importance of view – a judgement on the relative value of a view with respect to the viewer and the effect of the proposals on local distinctiveness.
- Description of effect – the proximity of the viewer to the proposals, the extent of the effects on the view, how the visual effects may change over time and whether the effects make a positive or negative contribution to the scene.
- Cumulative effects – the impact of the proposals in combination with other local forestry proposals.
- Mitigation – any practical measures that could reduce negative visual impacts.
- Significance – a summary statement representing a judgement of the potential effects of the forestry proposals on visual amenity from each viewpoint, incorporating potential cumulative effects and mitigation.

For all forestry proposals, assessing the landscape context will involve an appreciation of landscape and visual sensitivities as part of the forest design process. For the more extensive and environmentally significant proposals, for example, where an EIA is required, an LVIA may also be needed, to guide the forest design and communicate the landscape change. This involves an assessment of landscape and visual sensitivities, evaluation of design options, and the impacts of the design proposal that represents the best overall solution. Where visual sensitivity and local distinctiveness are important, taking account of local opinion will help inform the development of proposals and provide assurances about the nature, scale and rate of change.

4 Analyse the local distinctiveness and visual sensitivity of the landscape; consider visibility, how people view the area, the nature of the viewing experience and the importance of views.

5 Where local distinctiveness and visual sensitivity are important, communicate the predicted visual effects of proposals to interested parties and consider local opinions in developing the best overall solution.

6 Ensure established tools are used including landscape character appraisal and Landscape and Visual Impact Assessment (LVIA) to survey and analyse landscape and visual sensitivities and to ensure forests are appropriately integrated into the landscape.

Designed landscapes

Designed landscapes are an important part of the cultural heritage of the UK, and trees and forests are often their defining components. The more prominent examples of designed and historic landscapes are usually listed in the registers or inventories maintained by government agencies and local authorities, where special policies and restrictions (such as Conservation areas) may apply. However, these lists are not always complete and in many landscapes it may be possible to identify a fading design history for conservation and restoration. Further relevant information may be obtained from Historic Land-use assessments and the Gardens Trust.

7 Check if the landscape is listed in the relevant register or inventory of designed or historic landscapes; if so, seek specialist advice to inform the development of proposals.

8 If the landscape is not listed, but there is evidence that it is part of a park or designed layout, investigate the original design intentions and use these to inform design proposals.

Forest design principles

The assessment of landscape context will inform how forest design principles should be applied to ensure that forests make a positive environmental contribution. Many existing forests were planted with little attention to landscape, but felling and restocking (or regeneration) provides an opportunity to reassess their design and enhance the visual contribution they make. Common forest design terms are defined in Box 6.1.

Box 6.1 Definitions of forest design terms

Landscape

Connectivity A key characteristic in the landscape contributing to character, resilience and natural beauty/scenic quality.

Integrated design The comprehensive, holistic approach to forest design that brings together specialisms often considered separately. It applies to the UKFS elements of sustainable forest management and enables efficient working through the integrated, spatially defined design process considering landscape context and applying the design principles.

Landscape Takes account of the overall composition, spatial structure and aesthetic values of an area, including its spirit of place and identity that communities and individuals attach to their local environment.

Landscape character The distinct combination of natural components, human elements and experiences that creates a recognisable and consistent landscape pattern. The most persistent, dominant and influential are known as 'key characteristics'.

Landscape Character Assessment and Appraisal The process of systematic description, classification and analysis of landscape in order to identify, describe and understand its character. The scale and detail of the assessment will depend on the scope, complexity and sensitivity of the proposals. Assessments at local authority and other scale may be available. They can be applied at any scale and can be used in the forest design process.

Landscape characteristics Repeated and consistent patterns of natural components and human elements that recur across a landscape. The most persistent, dominant and influential are key characteristics.

Landscape sensitivity The degree to which specific types of land-use changes or development affect the character and qualities of the landscape. Sensitivity depends upon the type, nature and magnitude of the proposed change and the characteristics of the host landscape.

Local distinctiveness The characteristics and qualities of a particular locality that give it a spirit of place and identity that makes it unique and special to people.

Spirit of place The intangible factor that gives a specific location special character and makes it unique to people. Often it is a combination of character, features, quality, space and associations that creates the sense of identity of a location.

Visual

Foreshortening The reduction of the amount of canopy that can be seen and therefore the visible extent of a forest with the lowering of a viewpoint.

Form Describes a three-dimensional shape, such as landform and forestry.

Perception How we experience landscape; seeing combined with the thought processes of recognition, expectation and experience.

Proportion The visual relationship of landscape elements, such as forestry, to open ground. As a guideline, the proportion of thirds (one-third to two-thirds) is promoted to avoid the repetition of similar proportioned elements in the landscape.

Scale The relative size of visual elements in a landscape as perceived by the observer. Scale varies with the position and distance of the observer from the landscape and visual elements being considered.

Spatial How elements fit together and their relationship to each other. In landscape, how hills relate to valleys; how forestry relates to open ground.

Texture The visual appearance of a surface due to the size, nature and density of surface elements, coarser textures having larger elements at wider spacing and finer textures having smaller elements at closer spacing. In forestry, different ages and species of tree appear as different textures in the landscape.

Visual diversity The number of different elements in the landscape and degree of visual complexity this generates. It is an observation, not a value like biodiversity.

Visual force analysis The analysis of the ridges and gullies in landform carried out as a tool in forest landscape design to create forests that fit more naturally into pronounced topography.

Shape

Shape is a powerful factor that has a major influence on how we perceive our surroundings. The perception of a particular shape is influenced by its overall proportions, how edges are defined and the viewer's position in the landscape. Compatible shapes achieve harmony in a composition, whereas shapes that are incongruous have a visually jarring effect. Landscapes contain many shapes but there is always an underlying influence that can be used to help integrate new forest shapes.

Studies of public preferences for forest landscapes have confirmed 'shape' as one of the most important visual factors. The distinction between naturalistic (usually meaning organic) and geometric (implying human-influenced) shapes is particularly significant and plays a major part in forest design. This applies to both the overall shape of forests in the landscape and to the patterns within them made by species compartments, felling coupes, access tracks and fence lines (Figure 6.3).

Shapes in a forest design that are influenced by the landscape appear better integrated with their surroundings. The dominant landscape influence differs according to whether the landscape is upland, lowland or flat:

- In the uplands, the landform is the dominant influence on shapes and on the patterns of vegetation and rocky areas; the hills and terrain may be rugged and angular, or smooth and rolling. The use of irregular shapes that reflect these landforms will help integrate the forest with its surroundings.
- In the lowlands or on undulating farmland, the field or enclosure pattern may be more dominant than the landform. In these landscapes, forest shapes can be based more on these influences.
- In flat landscapes, where there are no vantage points for people to see the overall shape of a forest, its edge and internal spaces (e.g. felling coupes) are the main influences and considerations in deciding shapes.

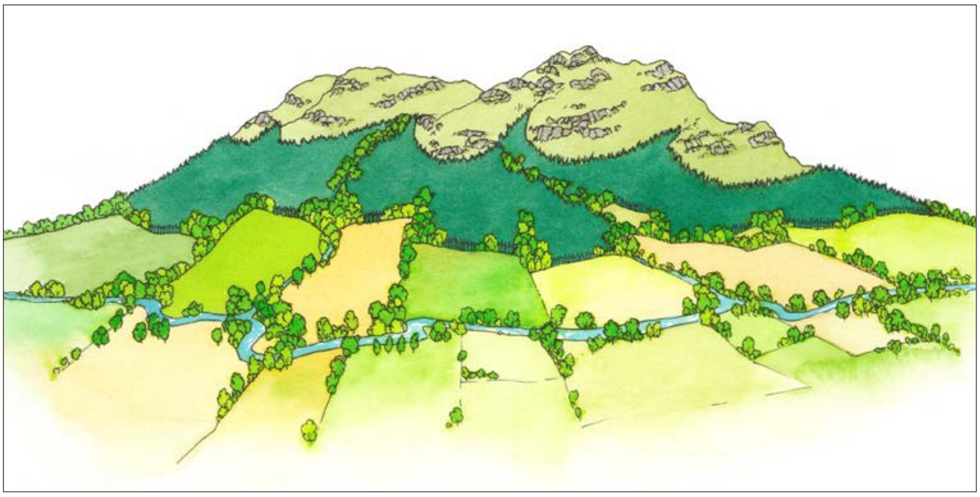


Figure 6.3
Example of how forest shape should be influenced by the key characteristic of a landscape. On the upper and mid slopes, the shape of the forest and internal structure are organic, reflecting the underlying landform. On the lower margin, the external shape reflects the geometry of the enclosure pattern, while internal shape reflects the organic pattern of the main body of the forest.

For woodland creation schemes, existing semi-natural vegetation patterns can help guide planting shapes and species choices (Figure 6.4). Vegetation responds to soil type, drainage, aspect and exposure, and these patterns are often related to the underlying landform. However, the existing vegetation may have been modified to a greater or lesser extent by enclosure and management such as fencing, re-seeding, fertilisation and drainage.

9 Analyse the main landscape influences and base forest shapes on either the landform or the enclosure pattern.

10 If the enclosure pattern is dominant, use the field pattern and links to existing hedges and woodlands to guide the design of forest shapes.

11 In landscapes where the landform dominates, design forest shapes that reflect the landform; try to avoid geometric shapes, symmetry and parallel lines.

12 On hillsides, where the landform predominates, use curving diagonals to run across slopes rather than straight, horizontal or vertical lines.

13 Use the natural or near-natural vegetation pattern to help guide new planting shapes and species patterns.

14 Consider how management practice will achieve the most appropriate forest shapes over time, including the effects of fences, felling coupes and access tracks.

Figure 6.4 Scale and forest and woodland design.

a. A landscape where the vegetation pattern is very well defined, related in part to the local landform. Vegetation often indicates soil condition.

b. Replacing the isolated woods with a single, larger area of woodland creates a better balance of scale.

Landform

When viewing a landscape, the eye tends to look around a scene, for example, along a river or a winding road. This applies in particular where landform is the dominant landscape influence, and it has been widely recognised that there are directional forces that affect how a landform is observed. These directional forces 'flow' down the main spurs, ridges and convex landforms, and up into hollows, valleys and concave landforms. This perception of movement in landform holds true for all but the flattest landscapes where the eye is led across the horizon. Known as 'visual forces', these directions can be identified and analysed. The most prominent landform features have the strongest visual forces, and lesser forces relate to the more minor features. Identifying visual forces and using them to help shape a forest design ensures landscape coherence and a more natural looking forest (Figure 6.5).

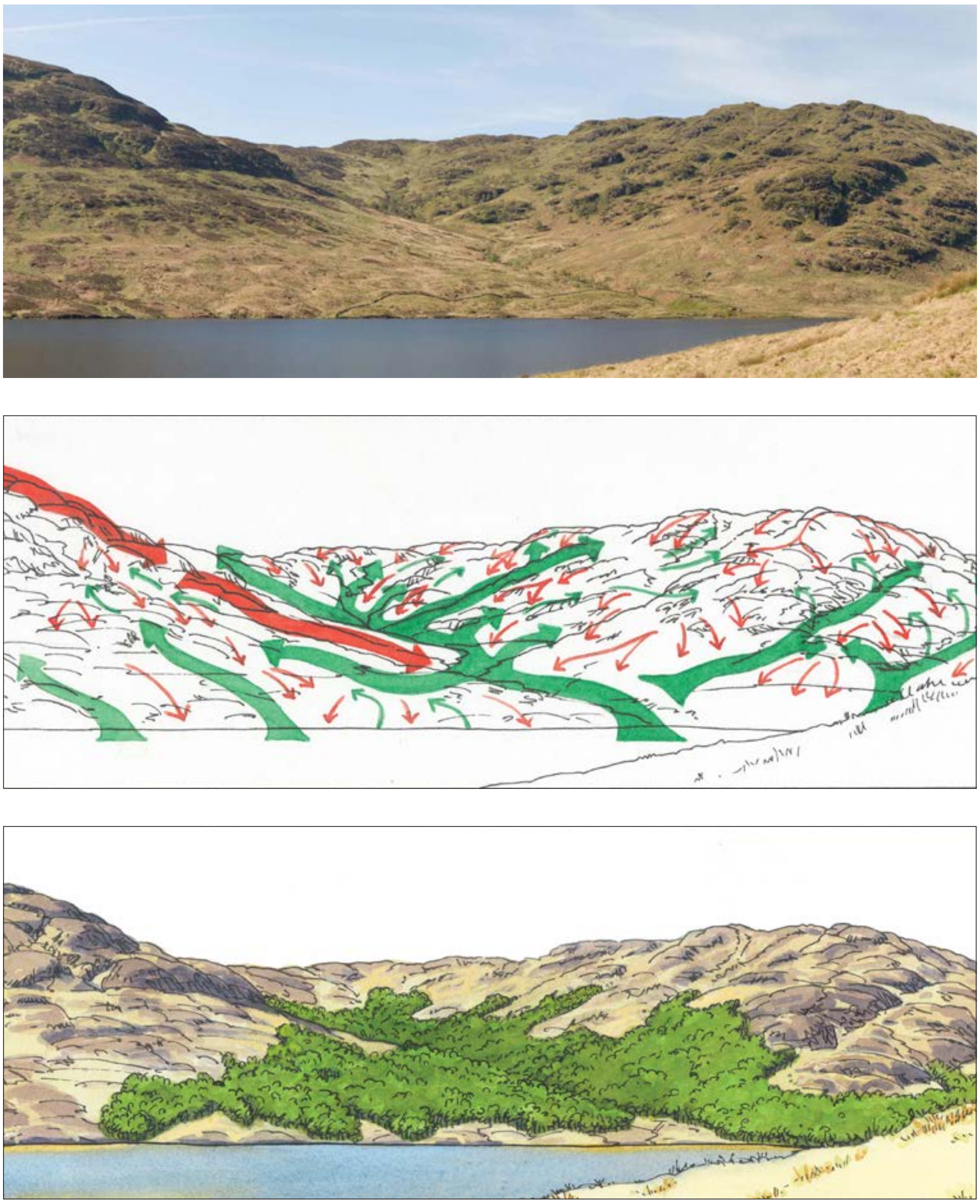


Figure 6.5
An example to show how landform and an analysis of visual forces can be applied to the design of the forest.

a. The original landscape.

b. The visual force analysis of landform using red and green arrows to follow the ridges and hollows, respectively. The strongest arrows illustrate the largest and most pronounced forms, the smaller arrows the more subtle shapes.

c. A woodland design based on this analysis, where the trees run up into the hollows and the open ground runs down the ridges.

Natural forests and other vegetation patterns tend to reflect the underlying landform, with the upper tree line on exposed ridges tending to be lower and extending higher up the slope in sheltered valleys. Forests look less natural when their shape and edges cut across the flow of the landform pattern, and thereby fail to respond to visual forces. An example is where an upper forest margin follows a horizontal line (often a fence line or ownership boundary) rather than an irregular margin that natural vegetation would follow by rising up into sheltered valleys and falling back on exposed ridges.

15 Analyse the landform by identifying lines of visual force using a combination of contour maps, site observation, aerial and perspective photographs or a digital terrain model of the landscape.

16 Design the edges of forest shapes, such as planting areas or felling coupes, so that they respond to landform.

17 Vary the degree to which the shapes respond to the landform, with the main forest shapes reflecting the major landforms, and the more detailed design such as edges and internal features reflecting the minor landforms.

18 Avoid putting straight lines of forests across distinctive landforms or over skylines; where this is unavoidable, take forest margins across skylines at low points.

Pattern of enclosure

An enclosure pattern refers to the network of hedges, walls, ditches, fences and trees that define field boundaries in most of the lowlands and upland fringes of the UK. Enclosure has a historical and cultural value and is a cherished and distinctive visual feature of the countryside. Broadly, there are two main categories of enclosure (Figure 6.6):

- **Ancient countryside** enclosure can be traced back to prehistoric times and is characterised by irregular field boundary shapes, winding lanes, hedges of many species and patches of ancient woodland linked to the hedgerow pattern.

a. Ancient countryside

b. Planned countryside

Figure 6.6 These diagrams illustrate the visual differences between 'ancient' and 'planned' countryside. **(a)** shows the irregular fields and winding roads while **(b)** shows straight field boundaries and roads.

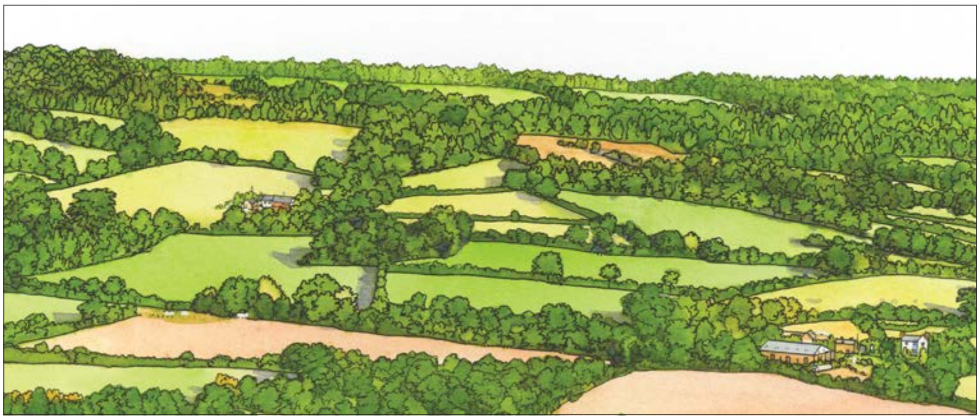
- **Planned countryside** enclosure dates from when open common fields and other land were enclosed by the Parliamentary Enclosure Acts of the 18th and 19th centuries. It is characterised by a more geometric and regular patchwork of fields, simple hedges and 'plantation' woodlands.

An important step in the forest design process is to assess whether the landform or the enclosure pattern is dominant, and which should be the main influence on the design. Where the enclosure pattern is dominant, woodland creation and forest management can help reinforce the pattern, especially where hedges have been removed and trees have been lost. The layout and proportion of forests can be designed to reflect and build on the established pattern (Figure 6.7). New forests or areas of short rotation coppice can be incorporated to reinforce and strengthen the existing pattern while conserving the key and dominant characteristic of field enclosures.

Figure 6.7 Designing woodland in landscapes with strong enclosure patterns.

a. A hillside where the enclosure pattern is strong and intact.

b. An illustration to show how extra woodland could be fitted in among the field pattern, enhancing it yet not creating a geometric woodland structure.



19 Survey and analyse the enclosure pattern in the landscape context and assess its contribution to landscape character; use this to guide forest design and planning.

20 Take account of the character and quality of the enclosure pattern in the forest design, positively integrating it within new woodland, conserving and enhancing local distinctiveness.

Scale

Scale has a major effect on perception. In landscape, it is defined as the relative size of one visual element to another, and the relative size of the whole landscape to the observer. The scale increases with the elevation of the observer and the expanse of the view.

Scale is an important visual factor in fitting forests into the landscape. This applies both to the forest overall and to its constituent elements, such as felling coupes, species compartments or open space. In assessing scale, the position of the viewpoint is all-important. In general, this results in small elements being appropriate in valley bottoms, on lower slopes and along lower forest edges, whereas much larger elements fit in at higher elevations and on hilltops where the scale is greater (Figure 6.8).

Problems of scale in forest design may be seen as a consequence of:

- a single felling coupe that is too extensive or a number of coupes that are perceived as a single element because previous restocking (or regeneration) of felled adjacent coupes has not yet established;

Figure 6.8 Examples of different scale landscapes.

a. A large-scale landscape. The size of the cottages at the foot of the mountain gives a measure of the scale.

b. A medium-scale landscape. The size of the trees becomes quite important relative to the size of the hills.

c. A small-scale, intimate and enclosed landscape.

- large-scale swathes of uniform forest in intimate landscapes;
- small-scale unrelated elements at higher elevation;
- thin strips of forest on skylines.

It is important to assess the scale of the landscape and to ensure that, as far as possible and within limits imposed by ownership boundaries and site fertility, the proposed forest relates to landscape scale (Figure 6.9).

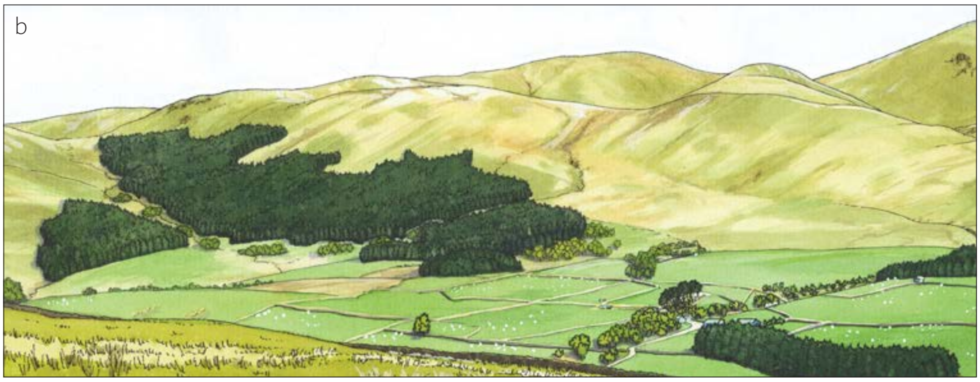


Figure 6.9 Scale and forest and woodland design.

a. A large-scale landscape. The small patches of woodland seem to float and are too small for the scale.

b. Replacing the isolated woods with a single, larger area of woodland creates a better balance of scale.

There are four aspects to scale that can help with issues of visual design:

1. The rule of thirds – a one-third to two-thirds proportion between elements can help to resolve the visual balance between elements such as forest and open ground. When a landscape, or part of it, is seen as divided into two major elements, a ratio between them of around one-third to two-thirds is usually the most satisfying visual proportion (Figure 6.10). This ratio also applies to proportions of visual elements within a forest, or the size of felling coupes – providing the resultant scale is commensurate with the landscape. The visual balance will change with the viewpoint – when applying the rule of thirds, priority should be given to the most important views.

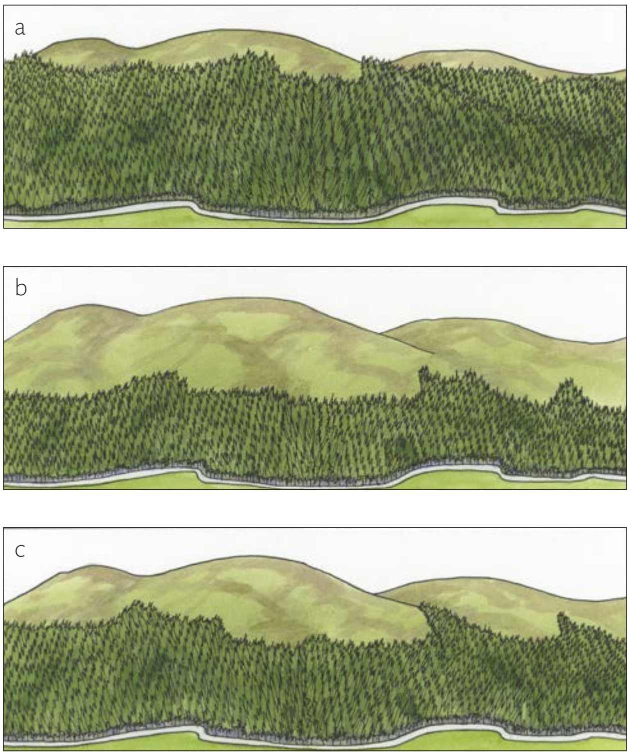
2. Enclosure can be used to define space and break down the scale of the landscape. This applies in flatter areas where the height of trees confines the view and creates a visual separation.

Figure 6.10 The rule of thirds.

a. The forest occupies more than two-thirds of the scene and leaves a small, poorly scaled open area at the top of the hill.

b. The forest and open ground are split 50:50 so that neither is dominant and a horizontal split occurs, despite the shape of the margin.

c. The forest occupies two-thirds of the visible area and the open ground one-third, which is more visually pleasing.



3. Nearness is a way to increase the apparent scale of small woods or clumps of trees and ensure they do not appear isolated and incongruous in a large-scale landscape. When woodland elements are positioned far apart they appear completely separate, but when relatively close together they tend to be seen as a group and the apparent scale is increased.

4. Coalescence can also be used to give the appearance of a more heavily wooded landscape than is actually the case. Small woods and trees can be positioned so that they overlap each other when seen from important viewpoints.

21 Consider the relative size of woodland elements and aim to fit with the scale of the landscape.

22 Use smaller-scale woodland elements in valleys and progressively larger elements at higher elevation.

23 On hilltops and ridges, avoid narrow slivers or patches of both trees and open ground.

24 Consider a visual proportion of one-third to two-thirds where there are two main visual elements in important forest views.

25 Make use of enclosure, nearness and coalescence to increase apparent scale and resolve design issues.

Diversity

Visual diversity refers to the number of different elements in a landscape or design. Landscapes in the UK have a high degree of diversity, which is described and classified in an LCA.

Diversity is a complex factor; it applies both to the wider landscape and to the constituent elements such as a forest. Diversity has many benefits for forest habitats and provides resilience in the face of climate change. In general, diversity creates visual interest and is welcomed, whereas a lack of diversity can result in visual monotony. However, it is not always the case that more diversity equates to a higher quality landscape; too much diversity can be visually confusing and appear cluttered, chaotic and incoherent – for example, a very diverse mixture of tree species in a uniform arable landscape would stand out rather than blend in like a natural forest. It should also be appreciated that some landscapes have an intrinsic quality based on their very simplicity.

In the wider landscape, forests introduce diversity into treeless scenery, but extensive uniform forests can hide landscape features and reduce visual diversity and habitat diversity. An assessment of landscape character will help identify the degree of diversity and the key characteristics within a given landscape type.

Within forests, public preference research shows a strong affinity for diversity. Internal diversity can be achieved by using a range of silvicultural approaches to cultivate different ages, densities and species of trees – providing these are suited to site conditions. From a distance these will appear as a visual composition of contrasting textures and colours, with subtle changes marking the passage of the seasons. Diverse and graded forest edges, together with species mixtures, can help in creating visual diversity. Other landscape elements, such as water, wetland, rocky outcrops and open spaces, also contribute to forest diversity and should be revealed and emphasised rather than hidden within the trees.

26 Consider the appropriate level of visual diversity in relation to the context, location, scale and character of the landscape.

27 Match elements of diversity to the scale of the landscape; use a greater number of small elements where the landscape is contained, such as in valleys, and progressively fewer and larger elements within simpler landscapes at higher elevations.

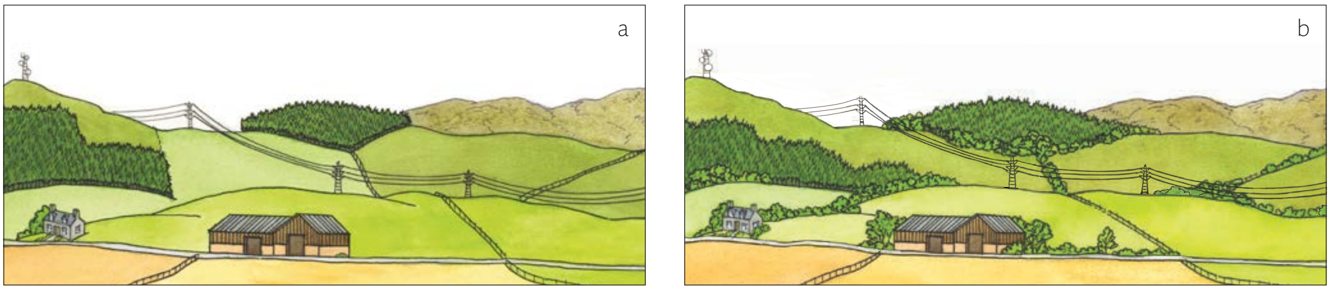
28 Emphasise natural features and non-woodland elements as part of the visual diversity of a forest.

29 Pay particular attention to the diversity of external and internal forest edges; vary the tree density and consider adding additional tree and shrub species.

Unity

Unity is achieved when the component parts of a design contribute harmoniously to the whole and all the visual design factors work well together. In landscape, this is achieved when the elements fit together well and relate to the site context and landscape characteristics, and nothing looks out of place or unbalanced (Figure 6.11).

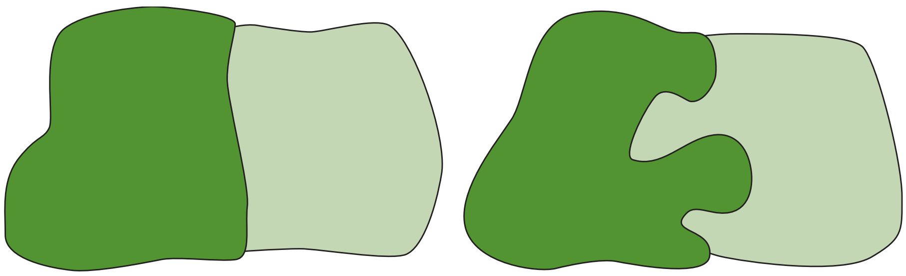
Figure 6.11 These sketches illustrate the concept of unity. The various elements in **(a)** are not compatible with the landscape or each other in shape, scale, colour and position. **(b)** shows how the woodland and the building could be better unified within the landscape.



In forest design, unity means that the wooded elements should appear to be an integral part of the landscape, fitting in with or defining local character, and not standing out from it. Similarly, within a forest, the various component parts should appear to fit together.

The interlock of shapes in the landscape provides coherence to various patterns by giving them a stronger visual connection to one another (Figure 6.12).

Figure 6.12
The shapes on the left abut one another and do not interlock. The two shapes on the right interlock and appear as a single unit.

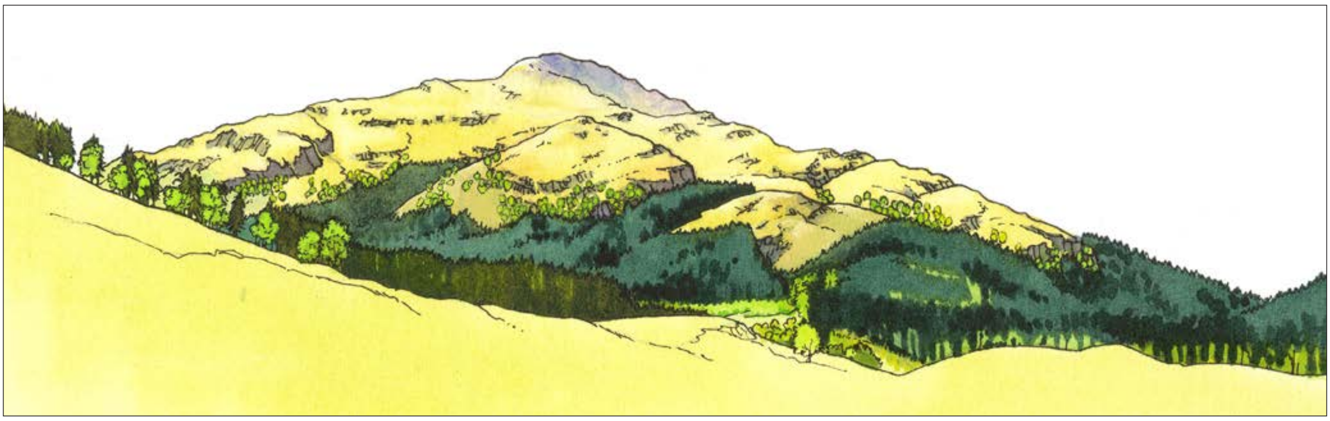


Interlock can be at a large scale, as in the broad pattern of open space and forest, or at a very small scale, for example, between two tree species. A high degree of interlock gives more unity to a design (Figure 6.13).

30 Apply the forest design principles, particularly shape, scale and diversity, to achieve unity in design proposals.

31 Design interlocking shapes with forest margins and edges to make the internal forest elements fit together and to tie the forest into the wider landscape.

Figure 6.13 a. The forest on this hillside has an organic shape to its upper edge which interlocks quite strongly with the open hill above.



b. The patterns of different tree species in this view are organic in shape and strongly interlock with one another.

Spirit of place

Spirit of place is linked with the factors affecting landscape context but is included here as one of the well-established principles of forest design. It is a term for the intangible factor that gives a specific location special character and makes it unique to people. Often it is a combination of things, and it is important to identify what makes a place special so that this quality is not lost or damaged when changes occur. Dramatic landform or rocks, the presence of water or ancient trees, striking views, or a sense of wildness and tranquility, may all define a 'spirit of place' (Figure 6.14). Human elements, such as historical or artistic associations and archaeological elements, are also likely to contribute.

Trees can be fundamental to the spirit of place, or the forest environment may enhance the setting of other features, or the access to them. Forest design and management needs to be undertaken with sensitivity to ensure that changes enhance the special quality of a place rather than detract from it.

32 Identify what makes a place special or unique and consider how forest design can conserve and emphasise these qualities rather than detract from them.

Figure 6.14
a. Waterfalls like this frequently have a strong spirit of place.

b. These 'Ancient and Ornamental Woods' have a strong spirit of place.

7. Forests and People

Forests provide wide-ranging and diverse benefits to people in the UK. In addition to supporting livelihoods and employment, either directly or indirectly, sustainably managed forests provide opportunities for recreation and learning, and health and well-being activities. Forests are a part of our historical and contemporary culture, an integral part of the landscape around us, and an essential element of our cities, towns and villages.

The benefits of forests to people

There is growing interest and progress on understanding the wider social and economic benefits that well-managed forests can deliver. These benefits include developing and maintaining livelihoods based on the production of forest products and services, access and provision for recreation and the associated social integration, health and well-being that arises from it.

There are also the benefits of connecting people with nature and the associated development of learning, skills, understanding of the environment and improved quality of life. Recent years have seen recognition of the benefits of greater community involvement in forest design and management, and new forms of forest ownership and tenure have emerged with community groups taking on ownership or management responsibilities. However, as society in the UK becomes more diverse, not all social groups in the UK benefit equally from access to forests, often because of economic, geographical, social and cultural circumstances.

Access

Forests, particularly those close to where people live, are often highly valued by both rural and urban communities for the recreational opportunities that access to them provides. Across the UK, access legislation builds on public rights of way and traditional uses, but specific access rights and responsibilities differ across the four countries. Forest managers therefore need to understand the context they are operating in when developing forest plans and proposals and undertaking forest operations.

Forests in areas close to where people live and work can provide opportunities for groups in society who may not have previously made use of them. In some areas, maintaining and extending public access to forests has supported public health campaigns involving walking or cycling routes to schools and workplaces.

Public health policy increasingly recognises the importance of day-to-day physical activity for a person's long-term well-being, so forests are an important and valuable resource for public health. The use of forests is also recognised for its important role in childhood development.

Economic development

To support the expansion of forestry and land-based employment opportunities, new services, products and markets that support local economies have been developed, such as enterprises related to recreation and tourism. In addition, a focus continues on developing a diverse forestry workforce by providing training and skills development through, for example, vocational training and encouraging new entrants into the workforce. Partnerships with forest owners, and including community owners, provide opportunities for new forest-based businesses and community development.

Public involvement

To enable plans to be better informed by local knowledge and the experience and understanding of those using the forest or land, or living close by, forest managers should provide appropriate opportunities to involve stakeholders and the public in the development of forest management plans and woodland creation proposals. There are many examples where naturalists, historians and others with local knowledge and expertise have been of great value to forest managers, making them key contributors to forest planning and management.

The public can also play an important role in alerting forest managers and emergency services to incidents and problems in the forest, for example, the location of unsafe trees close to infrastructure, or the occurrence of pests and diseases (e.g. the Observatree project).

The forestry sector and the voluntary sector have developed processes of consultation and collaboration designed to incorporate the views of interested parties into the forest planning process, using a range of digital and face-to-face methods and practices.

Education and learning

Technical skills are increasingly important for today's mechanised and digital forestry industry and the forestry sector competes for skilled new entrants. Developments in technical training and apprenticeships provide opportunities for forest owners to contribute to the long-term success of the sector by assisting in the training of young people.

Forests provide an excellent opportunity to use a safe and stimulating space for learning and to encourage an interest in forests and the wider environment. This can range from one-off teacher-led visits to programmes of learning offered by forest schools and bushcraft practitioners as well as outdoor play.

Rights and constraints associated with forest land

Forest land frequently bears constraints and rights that are enjoyed by people other than the forest owner and can be important locally. It is good practice to identify these in forest plans. Because of their historic nature, certain rights might not be documented in detail or be based simply upon custom and practice.

Wayleaves and easements for utilities and services are legal agreements enabling third parties to access land. Existing forests and proposed woodland creation sites can sometimes be the source of water supplies for local houses, businesses and communities. Agreements such as sporting leases, fencing and boundary arrangements with neighbours and access agreements are also likely to be of interest to local people. Historic rights such as pannage, pasture and estovers exist in some forests.

For local land-based businesses such as cycle hire, dog sledding and pony trekking, access to forests (where necessary with the forest owner's agreement and sometimes for payment) can be important. Local communities and the wider public also value the opportunity to hold organised events such as orienteering and sponsored charity activities in forests.

Forest environments can present a range of natural and man-made hazards that could put visitors at risk. Guidance is available to forest managers on mitigating and communicating hazards and risks.

UKFS Requirements for Forests and People

Public rights of way

All four countries of the UK have legislation covering public rights of way. In England and Wales, highway authorities have a duty to maintain legally recognised maps of rights of way known as the definitive map and statement, held by the local authority and available to the public. Ordnance Survey maps show definitively recorded public rights of way but should not be relied upon as a legal record. The situation is similar in Northern Ireland, where district councils hold maps showing 'asserted' and 'alleged' rights of way. The landowner or land manager and the highway authority have responsibilities for rights of way that cross private land.

In Scotland, rights of way are recorded at a national level in the National Catalogue of Rights of Way. The National Catalogue is maintained by Scotways and local authorities hold a copy of records for their area. In addition, each local and National Park authority publishes a core path plan to provide a framework for supporting reasonable local access.

1 Rights of way must be respected and not obstructed.

2 In England, Wales and Northern Ireland, permission must be obtained from the local authority before structures are installed across public footpaths or bridleways; the landowner must maintain these permitted structures in a safe condition and adhere to relevant standards.

Public access rights to forests

All occupiers of land and parties engaged in forest management activities are subject to a range of public access laws and regulations.

In England and Wales, there is no general statutory right of public access to forests. However, the Countryside and Rights of Way Act 2000 provides for public access on foot to land mapped as 'access land' by Natural England or Natural Resources Wales. The Act also allows for owners, or long leaseholders, to dedicate their forests voluntarily as access land in perpetuity. Access land includes 'open country' (generally mountain, moor, heath and down), registered common land or land that has been voluntarily dedicated by its owners for public access. The Act also enables an owner to restrict or de-restrict access in some circumstances by a direction granted by a relevant authority.

3 In England and Wales, foot access must be allowed on mapped access land, including woodland dedicated under the Countryside and Rights of Way Act 2000, unless a direction is in place to restrict or exclude access.

In Scotland, the Land Reform (Scotland) Act 2003 establishes a statutory right of responsible non-motorised access for recreational and other purposes to land and inland water throughout Scotland with a few exceptions. This right allows people to pursue a wide range of recreational activities such as walking, cycling, canoeing, horse riding and ski touring, the commercial equivalents of these activities, and educational activities that increase understanding of the natural or cultural heritage. People must not be obstructed from using their access rights responsibly. Access rights are not exercisable over some land, including land used wholly for cultivation of tree seedlings in beds or on which building, civil engineering or demolition works are being carried out. Detailed guidance for the public and landowners can be found in the Scottish Outdoor Access Code.

In Scotland, the provisions of the Land Reform (Scotland) Act 2003 must be complied with; as an owner or manager of land or water in Scotland, you must manage that land in a way which is responsible in respect of the public's statutory access rights.

In Northern Ireland, the Access to the Countryside (Northern Ireland) Order 1983 gives district councils the power to enter into public path creation agreements with landowners to create public rights along linear routes, and access agreements permitting persons to have access to 'open country' (land consisting wholly or predominantly of mountain, moor, heath, hill, woodland, cliff, foreshore, marsh, bog or waterway) for responsible recreation. The Forestry Act (Northern Ireland) 2010 provides a right of pedestrian access to land managed by the Forest Service, subject to byelaws. There is also considerable informal access to the countryside that takes place outside the above.

In Northern Ireland, the provisions of the Access to the Countryside (Northern Ireland) Order 1983 must be respected; this provides for access agreements between landowners and district councils, where there is a duty to permit the public to have access to open country for responsible recreation.

In addition to statutory rights of access, many owners permit or encourage additional public use of their forests. This may be for recreation or other uses, sometimes exercised over many years. The provision of visitor facilities and site interpretation can help manage access and increase the public benefit.

Forests are sometimes subject to irresponsible use, including trespass, damage, arson, tipping and vandalism. Such anti-social behaviour can damage the forest environment and is a nuisance to other members of the public.

Landowners and managers should consider providing access to their forest, in addition to that required by statute.

Where uses of a forest are established by long tradition they should be respected and allowed to continue, providing the use is sustainable and not detrimental to management objectives.

Where public access for recreation and other responsible uses is well-established and recognised as a public benefit, or a potential benefit, consideration should be given to the design and provision of appropriate facilities.

Reasonable steps should be taken to discourage anti-social behaviour; where anti-social behaviour continues, the local authority or police should be informed and advice sought.

Equality in service provision

Equality is about creating a fairer society, where everyone can participate and have the opportunity to fulfil their potential. Equality is supported by legislation that covers the whole of the UK and is designed to eliminate unfair discrimination against different groups in society.

In England, Scotland and Wales, the Equality Act 2010 protects people with disabilities and other defined 'protected characteristics' from being discriminated against in the provision of all facilities, goods and services. The Act describes a wide range of illegal discrimination and makes a requirement for reasonable adjustments to allow access to facilities, goods and services. For public sector organisations, the Act has an impact on forestry policies and management, for example, in the provision of forest access and recreation. Activities that affect people that are carried out by public bodies, or supported by public funds, are required to demonstrate that the interests of relevant groups have been accommodated. In implementing forestry policies and setting standards, the forestry authorities will address equality and diversity to ensure that all requirements are fulfilled.

In Northern Ireland, equality laws give protection from discrimination in accessing facilities, goods and services, which includes access to parks and open spaces by service providers, on five key grounds: sex (including gender reassignment and pregnancy/maternity), disability, race, religious belief or political opinion, and sexual orientation.

As well as complying with anti-discrimination law, service providers who are public authorities are subject to Section 75 of the Northern Ireland Act 1998 and must have due regard to the need to promote equality of opportunity for a range of groups: between persons of different religious belief, political opinion, racial group, age, marital status or sexual orientation, between men and women generally, between persons with a disability and persons without, and between persons with dependents and persons without. Public authorities must also have regard to the desirability of promoting good relations between people with different religious beliefs or political opinions, or from different racial groups.

6 In England, Scotland and Wales, the Equality Act 2010 must be complied with in the provision of facilities, goods and services.

7 In Northern Ireland, anti-discrimination laws, including the Disability Discrimination Act 1995 (as amended) and Section 75 of the Northern Ireland Act 1998, must be complied with in the provision of facilities, goods and services.

Employment and Health and Safety

Landowners and managers need to be fully aware of their obligations under both employment and health and safety legislation. This is extensive and includes equality of treatment for recruitment processes and contracts, and a duty of care for staff while at work. There is also a duty of care towards people visiting business premises or land, whether they are there with permission or not. In some circumstances, volunteers may legally be considered as employees, whether engaged directly by the landowner or undertaking activities for a third party.

The rate of accidents within the forestry sector has always been a cause for concern. Addressing this requires attention to safety protocols and training, and a commitment to the health and well-being of the workforce. Guidance on managing health and safety in forestry is produced by the Forest Industry Safety Accord (FISA).

8 Those responsible for forestry businesses and activities must be aware of the range of legislation relating to employment and ensure compliance.

9 Responsibilities under health and safety legislation must be complied with in relation to employees, contractors, volunteers and other people who may be affected by their work.

10 Safe working practices must be implemented, and the safety of plant and machinery must be ensured, as set out in legislation and the guidance produced by the Forest Industry Safety Accord (FISA).

11 Insurance must be in place where it is a legal or contractual condition in relation to employment, third parties and public liabilities.

Visitor health and safety

The Occupiers' Liability Acts 1957 and 1984 in Great Britain, the Occupiers' Liability (Scotland) Act 1960, and the Occupiers' Liability (Northern Ireland) Act 1957 and Occupiers' Liability (Northern Ireland) Order 1987 direct landowners and managers to ensure that visitors to forests are not put at risk by any act or omission by the landowner, or from risks that it would not be reasonable to assume a visitor should be aware of. This includes visitors exercising rights of access or using permissive ways and dedicated land, and also covers responsibilities to people who are not invited or permitted to be on the land in question. In this case, a duty of care still exists if one or both of:

- the landowner or manager is aware of a danger or risk, and it is known that people may be in, or come into, the vicinity of the danger;
- the risk is one against which the landowner or manager may reasonably be expected to offer some protection.

12 The landowner or manager must discharge their statutory duty of care in relation to people visiting land, whether or not they are there with permission.

13 In England and Wales, reasonable care must be taken to ensure the safety of visitors using permissive ways and land dedicated under the Countryside and Rights of Way Act 2000.

Forest environments can present a range of natural and man-made hazards that could put visitors at risk. Natural hazards may include diseased trees and unstable rock faces. Man-made hazards include quarries, mineshafts and abandoned structures, as well as potentially hazardous activities such as forest operations, pest control measures and some sports. Guidance on managing visitor safety is available from the Visitor Safety Group.

Guidance is available on managing public safety in relation to forest operations, such as that required for harvesting sites. This includes the definition of roles and responsibilities and the selection and management of control measures – for example, diverting routes and providing information and signs.

5 Hazards that pose significant and foreseeable risks to visitors should be managed to ensure the risks are minimised, whether or not the area is open to the public; where access is restricted due to hazardous forestry operations, provide and maintain clear signs to inform people of the restrictions and to signpost alternative routes.

6 Those involved in forestry should follow industry-standard health and safety guidance on managing public safety.

Public involvement

Involving people in the design of a forestry proposal can help improve and enhance the social and economic benefits delivered, particularly if the proposal is developed in a transparent way and the engagement begins early in the development process.

Engaging a wide range of people from diverse backgrounds and interests will help ensure that the facilities and benefits provided by the proposal are suitable for the widest range of people.

Once submitted to the forestry authority for approval, most felling, planting or management plan proposals are made available for public comment. Arrangements for this vary across the UK. Where an EIA is required, the consultation process is more extensive.

7 People with a recognisable interest in a forestry proposal or its outcomes should be given the opportunity to be involved in its development.

Local livelihoods

Forests can be the basis of a wide range of enterprises, whether these are undertaken directly by the landowner or in partnership with other businesses, or by individuals, and include the processing of timber products, provision of recreation and tourism opportunities, and craft-based or foraging activities. Forest-based enterprises make an important contribution to the local economy and support livelihoods.

8 Consideration should be given to promoting and facilitating local forest-based enterprises and economic activities.

UKFS Guidelines on Forests and People

Public involvement

Local people and interested parties can offer valuable knowledge and insights that can be of great assistance when formulating forest management proposals. Moreover, developing a proactive dialogue can help improve decisions, implement forestry proposals more effectively and lead to a culture of co-operation and support. Guidance is available to support the delivery of effective participation.

Before approval, most forestry proposals are subject to a consultation procedure and available for public comment. Where the proposals are significant, an environmental statement is likely to be required and consultation processes are more extensive. For the public to be involved in forest planning, clear information is required in a form that suits their likely levels of knowledge and expertise. The objectives for consultation need to be shared to ensure all those involved are clear about their role and how their input will be used. Public participation does not mean that the public has a veto on forest management decisions.

Public support and understanding can be fostered by good communication with interested parties and users of the forest. This can help with issues such as temporary closures due to forest operations, and dealing with anti-social behaviour. Forests can have a profound effect on the local landscape and in many situations contribute to the character and the 'sense of place' felt by local communities. When planning public engagement, it is important to consider all groups in society, including those with protected characteristics. Where public bodies introduce changes that affect people, an equality analysis will be required.

1. Aim to engage local communities appropriately by seeking their views, developing proposals that are responsive to them, and building co-operative partnerships.

2. As part of the forest design and planning process, consider which individuals and organisations from all groups in society may have an interest in the formulation of proposals or have something to contribute.

3. Communicate forestry proposals and their operational impacts clearly; consider presenting several options and try to accommodate local needs.

4. Consider the cultural significance of woodland features, taking account of local opinion, and develop measures to protect important features in forest management plans.

Accessibility

Where public access is provided, incorporating an overview of arrangements into the forest design and management plan will allow a strategic view to be taken. If access is a significant issue, a risk assessment will show that the duty of care towards visitors has been considered. As part of this, regular inspections by the forest owner or manager together with records of work done will help minimise risks to the public and demonstrate that appropriate actions have been taken. This will include inspections of potentially dangerous trees in areas that are more intensively used by the public or adjacent to facilities such as car parks.

5 Consider increasing public access to forests.

6 Consider all members of society, including those who may not have been traditional forest users, when planning access provision.

7 Where public access is a significant issue, consider producing an access management plan.

Visitor information

The provision of information for visitors can range from simple waymarks and signs to visitor centres with a range of educational and other resources. Signs and notices are important for managing visitor access as part of an access management plan, including the zoning, where appropriate, of conflicting activities. The public also needs to be made aware of temporary closures of access routes due to forest operations and alternative routes to take.

The provision of accessible information can also positively influence visitor behaviour (e.g. biosecurity awareness), as can codes such as the Scottish Outdoor Access Code or the Countryside Code in England and Wales.

Information is also useful to help people plan their visit and find out which routes and facilities are most suitable for them. For example, details of route lengths, path surfaces, walk gradients and the availability of facilities such as handrails, benches and toilets will help many people. In providing such information, the needs and interests of different groups in society are an important consideration and may have a bearing on the format or language used. Considering alternative formats such as pictograms, Braille, large print and audio can help those with learning difficulties or visual or hearing impairments.

Public enjoyment and educational value can be enhanced by providing information about the forest environment and location. A simple leaflet can make visitors feel welcome and on-site interpretation can be supplemented by off-site information such as websites.

8 Provide signs and information in order to manage visitors' use of forests; guide visitors away from hazards and help avoid conflicting uses in the same area of forest.

9 Where access is restricted due to forestry operations or other potential hazards, provide and maintain clear signs to inform people of the restrictions.

10 Provide information that will help people to plan their visit, in consideration of disabilities and other special requirements.

11 Consider the use of signage and interpretation to enhance visitor experience for all groups in society.

12 Promote codes of responsible access.

Recreation

Forests have the capacity to absorb large numbers of people, while maintaining an experience of nature without a perception of overcrowding. This is particularly important in or near urban areas, where forests can provide valuable greenspace. Forests provide an ideal environment for many types of activities such as horse riding, mountain biking, orienteering, walking and running and also provide for country sports such as shooting. Some forests are suited to organised events such as mountain bike races, car rallies or paintballing. Zoning the various activities, and leaving some quiet areas, as part of the forest management plan, will ensure that incompatibility between various pursuits and damage to the environment is minimised.

There is an increasing understanding that supporting people's mental and physical health requires not only effective medical approaches but also healthy environments and lifestyles. Medical referrals for programmes of activity are becoming more widespread in the UK. In this respect, forests are well placed to provide spaces for people to improve their health through physical activity or by contributing to a sense of mental and social well-being.

A range of guidance is available on the detailed design of recreation facilities. Designing facilities together with local communities will help ensure the facilities are appreciated and respected by all groups and interests. Safety is an important consideration, especially in urban areas where it can be built into the forest's design. Forest managers should also manage access to mitigate the impact of recreation on the environment, particularly wildlife at sensitive times of the year. The impact of recreation on biodiversity may need to be considered as part of a Habitats Regulations Appraisal or Assessment (HRA).

Unauthorised trail building by mountain bikers is a growing issue across the UK. Trails and associated structures may be built using hand tools or mechanised equipment and construction activity may include vegetation management, such as removing branches from trees, digging and building structures in timber or other materials. Constructing unauthorised trails on someone else's land may be unlawful.

Unauthorised trails may also present a potential risk of liability for businesses and landowners should an accident occur. Forest managers have a duty of care under various pieces of legislation to consider the impact on staff, contractors, visitors, members of the public and the environment when managing unauthorised trails. Particular care should be taken where promoted trails or forest roads interface with unauthorised trails.

13 Consider providing facilities for public recreation within forests.

14 Where recreation use is extensive, consider how activities can be zoned or timed to minimise potential conflicts between different interest groups.

15 Consider developing partnerships with health interests to establish and promote forest recreation activities in relation to health and well-being.

16 Take account of environmental objectives and the impact of recreation on biodiversity.

17 If there is evidence of unauthorised trails being built, consider assessing the risks to determine the most appropriate course of action, including engaging and working with forest users. Refer to country guidance where available.

Traditional and cultural uses

Some traditional uses of forests include rights of pannage (feeding pigs on acorns and similar), estovers (taking wood) and agistment (grazing). There are also many low-key informal uses that are not defined as rights, for example, the collection of fruits, berries, fungi and other seasonal products. Forests also provide cover for game, and country sports take place in many forests across the UK. Another traditional use of forests may be to visit well-known natural or built landmarks. Other than in Scotland, access to these may be at the discretion of the landowner. Some religious and immigrant cultures have strong links to nature and trees and value access to forests to celebrate traditional festivals.

All these uses are important in helping people to maintain traditions and developing connections between different cultures and the local environment. The benefits of such uses extend to increasing people's understanding of, and care for, local forests.

18 Consider supporting the use of forests for sustainable activities, especially where such uses are linked to cultural activities or are established by tradition.

Education and learning

Promoting and delivering education and learning activities provides an important opportunity for people of all ages and backgrounds to engage with and experience their local forests. Contact with the outdoors often leads to an increased interest in the natural environment and respect for plants and animals, as well as a greater understanding and knowledge about forestry, the benefits of forests and trees, and the effects of climate change on tree health and resilience. In addition to the natural environment, forests provide learning resources for subjects such as mathematics, geography and orienteering, and natural play can help develop social skills, confidence and a sense of worth and help establish pro-environmental behaviours.

Natural play for children is an important aspect of the learning process. Building dens and climbing trees can help with children's personal and social development as they learn to take considered risks and interact with others. In addition, natural play can help people with learning difficulties or mental health issues and can assist in the rehabilitation of adults at risk and offenders. Forests provide a dynamic and stimulating resource for education and learning for all groups in society.

Guided walks and interpreted trails can also provide learning opportunities in forests, for all ages.

19 Consider supporting the use of forests for education and learning activities for all.

20 Consider providing, or encouraging others to provide, educational interpretation for visitors, especially if there are distinctive ecological, historical or cultural features, as well long-term learning and play programmes.

Volunteering

Voluntary work in forests can extend to a wide variety of tasks, from manual work, such as coppicing or building paths, to leading guided walks and talks. Volunteering in the form of tree planting is a popular activity, particularly for schools and communities. Volunteering can also help people find a job in the forestry sector, and can generate benefits for all members of society, as well as contributing to forest management and providing assistance to the landowner or manager.

A duty of care rests with the landowner or manager for all visitors to forests, and there are liabilities associated with the use of volunteers. It is important that the legal status of both managers and volunteers is understood as it encompasses safety and security and can extend to employment rights if volunteers have a contract or any form of payment beyond expenses. The involvement of children and adults at risk needs specific planning, potentially including disclosure procedures and agreed methods for engaging vulnerable groups.

21 Consider providing, or encouraging others to provide, opportunities for volunteering in forests, particularly from groups who would benefit most, such as young, old or disabled people, or those who have not traditionally used forests.

22 Manage the health and safety of volunteers and follow appropriate procedures in working with young people and people at risk; ensure that the liabilities of the landowner or manager in relation to volunteers are understood and insurance policies cover their activities.

Vandalism and anti-social behaviour

The design of the forest, particularly the layout, access and design of facilities, can help control unacceptable behaviour. Places that are little used or are out of sight can be more susceptible than those that are regularly used or are on view. Fly-tipping is most prevalent in places that have easy and unseen vehicular access. Evidence suggests that once vandalism, fly-tipping or littering have occurred, recurrence is much more likely unless prompt action is taken to deal with it.

Fly-tipping and dropping litter are offences, although the legal provisions vary across the UK. Where forests are at risk, good maintenance and regular visits to check for damage will generally result in reduced vandalism and anti-social behaviour. Encouraging access and engaging with local communities can help win their support in keeping forests free of problems. There are a range of campaigns and initiatives aimed at tackling anti-social behaviour and advice can be obtained from the local authority. People's perception of what constitutes anti-social behaviour differs and care must be taken not to stigmatise people or groups on the strength of complaints from other users.

23 In forest management plans, use good design to mitigate the problems of vandalism and anti-social behaviour.

24 Where vandalism or litter occurs, aim to act promptly to remedy the situation and thus remove the likelihood of further problems.

25 Encourage regular users of forests to act responsibly and report emerging problems so they can be dealt with quickly.

26 Co-operate with public agencies and partnerships to manage the misuse of forests; consider working with others to develop community policing or wardens in areas where problems are significant.

Enterprise development

Forest-based enterprises provide social and economic benefits and can make an important contribution to the sustainability of local communities. As well as timber and timber-related goods such as charcoal and firewood, forest-based enterprises can include country sports, the production of non-timber goods such as venison, and recreation and leisure businesses such as bike hire, forest bathing, adventure play and corporate events.

Forests can also make a major contribution towards local tourism, bringing people into an area, which in turn benefits local businesses such as shops, restaurants and hotels. The role of forests in this respect is increasingly recognised by bodies responsible for local and regional development.

27 Consider the potential for developing sustainable forest-based businesses and livelihoods and how this might be explored with interested parties and through local co-operation.

8. Forests and Soils

Soil is a fundamental component of the forest ecosystem. It is a complex and variable medium comprising mineral particles, organic matter, water, air and living organisms. The characteristics of the forest's soil largely determine the nature of the flora and fauna that live in it, sustaining its biodiversity and its productive potential. It is a vital but fragile resource that must be used in a sustainable way by knowing and working to soil type and condition.

Soils in the UK

Geology, topography, historic human activity and climate all play a part in creating the many different soil types found across the British Isles, which often vary within short distances. The physical, chemical and biological properties of soils are continually modified by a number of natural processes, which include leaching, waterlogging and the addition and decomposition of organic matter. Soil is a valuable habitat in itself and it forms a living system that includes organisms belonging to many plant, animal and microbial species.

The actions and complex interactions of soil biota help to maintain the nutrient, energy and water flows that support the forest ecosystem. Soils provide an important filtering and buffering action that protects other parts of the ecosystem from pollution and damage, and they can be a major source or sink of carbon dioxide and other greenhouse gases. Some of the least disturbed soils in the UK are found in ancient woodlands, untouched by agriculture for hundreds of years.

Forest soils

For the purpose of the UKFS, 'forest soils' are defined as those soils supporting forests, including post-industrial, or brownfield, soils that are being restored. Historically, UK forests tend to have survived on, or have been planted on, ground of generally poorer quality than agricultural land, for example, steep slopes, peats and gleys subject to periodic waterlogging, and low nutrient podzols and ironpan soils (see Glossary). A smaller proportion of forests are located on better, well-drained brown earth soils, particularly in England and Wales. Forests created in recent decades for social and environmental reasons have often been established on a wider range of soil types.

Forest soils are usually slightly acidic, unless underlain by calcareous rock or sediment. Inputs of atmospheric pollutants, particularly sulphur and nitrogen, can have significant impacts on acidity and nutrient status. Forest soils naturally have a high organic or carbon content, on average about 75% of total organic carbon contained in the forest. Climate change has the potential to affect forest soil function both directly and indirectly. Rising temperatures can accelerate mineralisation rates and soil nutrient availability, while nutrient leaching may be enhanced by higher winter rainfall. Increasing soil moisture deficits in summer could decrease both nutrient uptake by trees and leaching losses. The risk of physical soil disturbance and erosion may increase as a result of greater run-off, waterlogging and windthrow, especially if the frequency of storm events increases. All of these effects will have implications for the nutrient and carbon balance of forest soils.

In general, forest soils have low and infrequent levels of disturbance, particularly under a LISS such as continuous cover forestry. However, some forest management activities, such as cultivation, drainage, harvesting and engineering works, can impact on forest soils or expose them to greater risk, for example, erosion after intense rainfall. More subtle changes to forest soils can be induced by species choice, stocking density and brash management.

Some practices may also result in a short-term loss of soil carbon until this is replaced over the rotation as the forest grows. Deep peat is particularly vulnerable to disturbance and the process of woodland creation will generally result in a net loss of stored carbon.

Some high impact forestry practices, such as excessive ground preparation and regular applications, are no longer acceptable within modern forest management standards. Identifying the extent and distribution of different soil types is essential to help make decisions about which tree species are ecologically suited to the site under a changing climate – meaning that the ecological requirements of different tree species and woodland communities can be met by the site, and thus sustainable forest management practised. Managers should seek to match the species to the site rather than alter the site to suit the tree species.

Cultivation should only be used where it is clearly demonstrated to be the most effective means of providing a favourable environment for tree survival and early growth. Where soil cultivation is required, the least intensive method possible should be used to successfully establish woodland.

Brownfield soils

Brownfield soils are those that have been used for industry or development in the past. They are likely to have been substantially modified physically, chemically and biologically by their previous use. Forests provide a way of reclaiming post-industrial areas and establishing a productive and environmentally beneficial resource. However, the restoration of brownfield sites can present a range of challenges: the soils can be very acidic or very alkaline, contain toxic compounds or low levels of organic matter, and be either too compact or too loose. Successful restoration often requires intensive management and the importation of soil or soil-forming materials from elsewhere. Brownfield site restoration is thus a complex task and one that requires specialist input. The UKFS takes the remediation of brownfield land to be a specialised arena and beyond the capacity of the forestry sector to address without appropriate expertise.

Forest soils and ecosystem services

The term 'ecosystem services' describes how ecosystems and the biodiversity contained within them produce a range of resources useful to people. Forest soils provide a number of ecosystem services, including:

- A store of carbon: organic matter is accumulated in the soil itself and in the wider forest ecosystem that soil supports.
- A growing medium for trees: forest soils provide physically, chemically and biologically for tree growth and forest products.

- Water management: the high infiltration capacity of most forest soils helps to reduce rapid run-off, with potential benefits for managing local flooding and controlling or abating diffuse pollution.
- A historical archive: forest soils may contain archaeological and palaeo-environmental evidence of the past.
- Revitalisation of derelict or neglected land: woodland creation and the development of forest soil on derelict or neglected land can play a vital role in economic regeneration.
- Habitat creation and restoration: forest soils support the creation and restoration of habitats for flora and fauna and soil biodiversity.

Maintaining these ecosystem services remains a challenge, and work is underway to develop methods for assessing the specific role of soils in their delivery.

UKFS Requirements for Forests and Soil

Waste management

Country waste management regulations apply to sewage sludge and other waste materials (such as waste soil, bark, wood or other plant material) that may be applied to forest or other soils. Any operations covered by these regulations must be registered with the relevant authority. Exemptions may apply for the application of materials not considered to be 'waste', such as approved or acceptable use of brash and some composts, providing these ameliorate the soil. Sewage sludge may be applied to forest land, providing this results in ecological improvement and does not cause levels of potentially toxic elements in soils to exceed those permitted under the regulations.

1 The regulatory authority must be consulted prior to the application of wastes to forest soils, including sewage sludge, waste soil, waste wood, bark or other 'listed substances'; conditions applied to permissions or licences, including 'relevant objectives', must be complied with.

Soil protection

The physical structure of a soil affects the movement of gases, water and nutrients. A good structure is vital for soil fauna and the growth and reproduction of trees and other flora. Ancient woodlands in particular are a valuable resource of relatively undisturbed soils, which are likely to be of high biodiversity value. The nature and structure of soil is strongly influenced by the amount and quality of organic matter present and by the inorganic constituents of the soil matrix. These also determine the chemical properties of soils and soil fertility.

Soil fauna and microorganisms play a vital role in the retention, breakdown and incorporation of organic matter and influence soil structure and porosity. Soil microbial activity is also directly linked to carbon and nutrient cycles and breakdown of pollutants. A decline in levels of soil organic matter can lead to an increase in the susceptibility of soil to compaction, lower infiltration rates and, possibly, increased run-off or erosion. Climate change projections of rising temperatures suggest that these could accelerate mineralisation rates and soil carbon loss.

Woodland creation and forest management, as well as changes in environmental conditions, can have impacts on soil structure and fertility, including influencing the availability of nutrients and the capacity of soils to buffer adverse effects. Forests can increase soil organic matter and ecosystem carbon through large inputs of decomposable material such as foliage, woody material and fine roots. However, soil disturbance, erosion, forest fires and harvesting or burning brash and stumps can impoverish soil organic matter, in turn reducing soil carbon stocks and increasing greenhouse gas emissions. Cultivation and drainage pose a particular risk of depleting the organic content of peaty soils through soil drying and oxidation, and the carbon cost of different cultivation and drainage methods is increasingly recognised.

Note that the hydrological continuity of peat soils, not just peat depth, should be adequately accommodated in planting proposals. This is especially important in areas where adjacent peatland restoration and woodland planting is simultaneously proposed.

1 At planning and operational stages, the quality of forest soil in terms of its physical, chemical and biological properties should be protected so that it is maintained and, where appropriate, enhanced.

2 Forest operations should be planned and managed to minimise compaction and damage to soil structure and function by using appropriate measures. Should damage occur, reinstatement should be undertaken and adverse effects mitigated.

3 The environment adjacent to forests should not be subject to adverse effects due to soil disturbance associated with woodland creation or forest management practices.

4 New forests should not be established on soils with peat exceeding 50 cm in depth – or a depth specified in country guidance – or on sites that would compromise the hydrology of adjacent bog or wetland habitats.

Note: woodland creation on certain sites where deep peat soils have historically been highly modified may be considered, provided that it complies with the relevant country policy.

UKFS Guidelines on Forests and Soil

Acidification

Forests in the UK tend to occur on poorer soils that, particularly in the uplands, are often characterised by their natural acidity. Long-established forests on neutral soils usually develop a marginal acidity of surface layers due to the enrichment of the soil with organic matter. This natural acidity reflects normal forest processes and rarely leads to any adverse effects.

However, the addition of acidity to the environment, largely from atmospheric pollution, can result in soil acidification. This leads to a gradual depletion of calcium and other soil base cations from the surface layers and a reduction in the natural ability of soil to neutralise or buffer acidic inputs. Enhanced soil acidification generally has adverse effects, leading to:

- decreased pH of water draining from the soil, which can harm aquatic organisms;
- increased aluminium and heavy metal mobilisation, which can be harmful to tree roots and aquatic organisms;
- a reduction in tree growth and changes to the ground flora;
- a change in the predominant groups of soil organisms.

Whole-tree harvesting and the removal of harvesting residues can further reduce the ability of soil to buffer acid deposition. Repeated cropping for short rotation forestry or coppice could also lead to the acidification of sensitive soils if base cations are not replaced by soil treatments. Artificial and non-permanent measures can be taken to combat soil acidity, including the controlled application of liming materials.

1 On soils classified as at high risk of increased soil and water acidification, avoid short rotation forestry or short rotation coppice, and the harvesting of whole trees, forest residues and tree stumps.

Contamination

Contamination arises when soils become contaminated from the introduction of waste or polluting substances that cause instability and harm. Potential contaminants of forest soils include fuel oils, lubricants, pesticides and other chemicals, sewage sludge and inorganic nutrients. Pathogens such as faecal coliforms (from sewage sludge) can be a source of microbial contamination. Contaminants can have a range of adverse impacts on soil function and tree growth, water quality and public health. For all operations involving the use of potential contaminants, a risk assessment should be undertaken when planning operations to eliminate or minimise the risk of soil contamination.

It is a requirement of the UKFS that a plan is in place in case of spillages, to help limit incidents and ensure clean-up procedures are effective. It is also a legal requirement to have permission before some potential contaminants (e.g. sewage sludge) are applied or the aerial application of pesticides takes place.

On brownfield sites, forests offer a beneficial land-use option for site restoration, but some industrial sites have high levels of contaminants and dealing with them requires specialist advice beyond the scope of the UKFS.

2 Plan and use risk assessments to eliminate or minimise the risk of contamination of forest soils; have contingency plans in place to deal with accidental spillage and pollution.

3 Place any waste or recovered oil in an impermeable container and remove from the site for disposal at a suitable licensed site.

4 Where it is necessary to store fuel oils on site temporarily, use double-skinned or bunded lockable tanks and place them well away from watercourses.

5 When restoring brownfield sites, seek specialist advice, especially if measures are needed to ameliorate excess soil acidity.

Compaction

Soil compaction is an increase in soil bulk density and a reduction in pore space due to compression. This affects the movement of water and air through the soil, reducing water infiltration and storage, and increasing the risk of water run-off and erosion. Compaction may also affect the growth and functioning of roots and soil organisms, which in turn can adversely affect tree stability and growth. Natural processes such as freeze–thaw cycles, wetting–drying cycles and root penetration can mitigate compaction and, in some situations, these processes can restore soils to their original condition over time. However, on some soil types, compaction is virtually irreversible.

The ground pressure of heavy machines used for harvesting or forwarding timber can compact the soil and cause rutting and puddling (peaty and clayey soils being the most vulnerable), particularly with frequent passes over a sustained period and when logs are skidded along the ground. Compaction to topsoil can usually be ameliorated, but damage to the subsoil (greater than 20 cm depth) is more difficult to rectify. Brownfield sites are often subject to repeated vehicle traffic during restoration, leading to severe compaction. Soils with a previous history of intensive grazing can be compacted and agricultural ploughing sometimes leads to a compacted layer just below the reach of the plough. Soil stacked temporarily, for example, for road construction and mineral extraction, can become compacted and degraded if it is stacked too high and for too long.

Compaction, leading to rutting and erosion, can be minimised by good planning and management of forest operations, such as using extraction routes made from layers of fresh brash to spread the load. A well-designed road infrastructure, with stacking and turning areas, will help minimise skidder haul tracks and other incidental causes of compaction on forest soils. Machine choice and working method affects the ground pressure and the risk of damage. Wheeled vehicles pose the greatest risk, but the use of lower tyre pressures and controls on the frequency and speed of vehicle movements can reduce this. Tracked vehicles exert less ground pressure, while cable extraction poses virtually no risk of compaction and is the least environmentally disruptive for particularly sensitive sites. Dry soils have a greater bearing capacity than wet soils and so harvesting in dry periods reduces the risk of compaction. Compacted soils may require remedial treatment, such as subsoiling, carefully matched to the depth of compaction, to minimise the extent of disturbance.

6 Minimise compaction, rutting and erosion during forest operations by selecting the most appropriate working method for site conditions; monitor operations and modify, postpone or stop procedures if soil damage starts to occur.

7 On sites vulnerable to compaction and erosion, consider the weather and avoid working during periods of heavy or exceptional rainfall; plan ahead for changes in the weather that could affect site conditions, and suspend operations if necessary.

8 Maintain adequate brash mats throughout extraction where operations provide this material. If brash is not available, use other techniques to protect the soil.

9 Where compaction has occurred and will affect tree growth or lead to other detrimental effects, apply remedial treatment, but minimise the soil disturbance involved.

Disturbance

Soil disturbance is defined as any activity that mixes or moves soil material. Disturbance affects a wide range of soil characteristics and processes by altering the continuity of soil pores and the relative position of soil material. Various forest operations and engineering works disturb the soil, including cultivation and drainage, and these operations are now considered alongside species choice at the planning stage so that soil disturbance during site preparation for afforestation or restocking is minimised.

Cultivation is used to improve tree survival and growth by preparing a favourable, elevated planting site above the water table (it does not, nor should it be used to, lower the water table). This can increase permeability, rooting and nutrient availability. Drainage is carried out to collect and remove excess water, to reduce the local water table and provide greater rooting depth.

Although soil disturbance can assist with forest management, it can also have a range of detrimental effects, including:

- releasing greenhouse gases through the oxidation of soil organic matter, damaging soil structure, and increasing the risk of erosion, leaching of nutrients and contaminants;
- water pollution;
- destroying palaeo-environmental and archaeological remains;
- subsidence/shrinkage of peat soils.

Removing tree stumps disturbs and can damage forest soils; there is a presumption against this, and it should not be carried out unless a site assessment has been undertaken. However, on some sites stump removal may be necessary for tree health reasons (e.g. controlling the fungal pathogen *Heterobasidion annosum*) or for the restoration of formerly afforested peatlands.

10 Base forest management decisions on an informed knowledge of its soil types.

11 Consider the potential impacts of soil disturbance when planning operations involving cultivation, harvesting, drainage and road construction; minimise the soil disturbance necessary to secure management objectives, and amend practices to manage the risks posed.

12 Avoid removing stumps unless for tree health reasons or the purposes of restoration, or where a risk-based assessment has shown that adverse impacts on soil carbon can be mitigated.

Erosion

Forests have an important role in helping to reduce the risk of soil erosion – risks that are likely to increase with climate change. This is because:

- tree canopies reduce rainfall intensity on the soil;
- windbreaks reduce erosion of agricultural soils;
- riparian woodland stabilises riverbanks and reduces soil erosion;
- buffer areas along watercourses reduce diffuse pollution from agriculture.

Conversely, care is required to ensure that the type of forest and choice of management regime do not increase the potential for erosion and landslips on vulnerable sites.

Soil erosion results in a loss of rooting medium, including nutrients and organic matter. This has several potentially detrimental effects to the forest environment, downstream water bodies and surrounding areas. These include the formation of erosion scars, water pollution through sedimentation and nutrient enrichment, and loss of habitat and greenhouse gases. Most soil erosion is caused by water flows, but wind can also erode soil. Trees can be useful as windbreaks in exposed areas with light soils and to stabilise windblown sands on the coast. Erosion can be increased by poor forestry practice and is likely to be worsened by the more frequent and severe extreme weather events as the UK's climate continues to change. By contrast, well-managed forests can stabilise soil and protect it from erosion.

Erosion is likely where the vegetation cover is lost, and ruts and water channels concentrate and accelerate water flows. These conditions often occur after clearfell or during site preparation for woodland creation, especially when creating steep gradients or linear channels, for example, by ploughing.

On steeper slopes, trees and shrubs have an important role in reducing the risk of landslip. The binding action of roots increases soil strength and the canopy helps intercept rainfall and reduces soil wetness. Employing a LISS will help to reduce the risk of slope failure and erosion by maintaining a protective cover of vegetation. Clearfelling has the opposite effect, by removing the protective canopy and causing the death of tree roots.

The risks of soil erosion, together with those of compaction and disturbance, can be minimised through effective forest planning, at both a forest and site level. The choice of silvicultural system, design of riparian areas and timing and arrangement of felling coupes, all affect the risks. At a site level, planning detailed arrangements and contingencies for operations such as forest cultivation and drainage, harvesting and engineering, will help ensure erosion does not become a problem.

13 Consider woodland creation to protect erosion-prone soils, stabilise slopes and intercept sediment run-off from upslope.

14 Address the risks of soil erosion as part of the forest and operational planning processes, ensuring mitigation measures are implemented when the soil will be exposed.

15 On steep slopes where there is a risk of slope failure or serious erosion, use native species and low impact silvicultural systems including continuous cover forestry where possible.

Soil fertility

Soil fertility is defined as the amount, availability and balance of nutrients required for plant growth. The availability reflects the soil conditions as modified by nutrient inputs and outputs, and the effect of soil micro-organisms. Nutrient inputs include the breakdown of organic matter, the weathering of mineral particles, water inflows, atmospheric deposition and the application of fertilisers. The principal losses are from the removal of timber and harvest residues from the site, soil leaching and erosion, and gaseous emissions.

Fertility has a major influence on the nature of forest ecosystems and their flora and fauna. The use of fertiliser in UK forests has generally declined in recent years because nutrient deficiencies are less common in the subsequent rotations of productive forests, and there is less new planting on marginal sites of low nutrient status. The UKFS seeks to minimise the use of chemicals such as fertilisers in forestry, and tree species should be selected based on their tolerance of existing nutrient levels rather than manipulating the site to support species with larger demands.

The loss of nutrients can undermine the long-term productivity of some forest sites. Most nutrients in a tree are contained in the crown and foliage and these are normally left on site after harvesting. However, whole-tree harvesting and the removal of forest residues such as brash and tree stumps can contribute to a net loss of nutrients and impoverish the soil, particularly where naturally nutrient-poor and shallow soils coincide with high rainfall. The removal of forest residues by burning or harvesting of woody biomass under short rotation coppice and short rotation forestry systems can similarly deplete nutrient levels.

In general, forests are effective at retaining nutrient inputs but problems can arise if fertiliser run-off or nutrient leaching leads to eutrophication or enrichment of watercourses. This is most likely when heavy rain follows fertiliser application, especially on steep topography. Atmospheric nitrogen deposition can sometimes exceed the absorption capacity of a forest, leading to soil nitrogen saturation and nitrate-enriched run-off.

16 Unless the site is part of an approved peatland restoration project, ensure the removal of forest products from the site, including non-timber products, does not deplete site fertility or soil carbon over the long term and maintains the site potential.

17 Choose tree species and silvicultural systems that are well suited to the site and, with the exception of short rotation forestry or short rotation coppice, do not require continuing inputs of fertilisers.

18 Minimise the use of fertilisers and confine these to areas where analysis clearly shows management benefits; if they will be used, plan applications to minimise the risk of nutrient loss.

Organic matter and soil carbon

Soil organic matter is made up of compounds that originated from living organisms and is distinct from inorganic or mineral material. It includes plant and animal residues at various stages of decomposition, substances produced by plant roots, roots themselves and living soil organisms. The organic matter content of soil affects:

- Physical properties – including structure and water-holding capacity.
- Chemical properties – including carbon content and the retention of nutrients and contaminants.
- Biological properties – including the nutrients and energy available for plants and animals.

In general, forest soils contain high levels of carbon and maintaining forest cover will help ensure these stocks of carbon are protected. Forest management methods that minimise intervention and create less soil exposure (e.g. LISS) will help preserve soil carbon stocks, and the continual input of organic materials from decomposable material such as foliage, woody material and fine roots will gradually increase the soil carbon content.

However, soil organic matter can be impoverished through disturbance, erosion, forest fires and the harvesting or burning of brash and stumps. Cultivation and drainage pose a particular risk of depleting the organic content of soils, especially peaty soils, through soil drying and oxidation. This causes the soil organic matter to decompose, which releases carbon dioxide. This effect is most marked in deeper organic or peat soils, although it is important to consider the fluxes of all the greenhouse gases, especially methane.

On most soils, long-term carbon gains from woodland creation are likely to outweigh initial carbon losses due to soil disturbance. The carbon benefits associated with woodland creation are generally greatest on soils with low levels of organic matter, such as mineral soils. On some peat soils the magnitude of soil carbon losses due to cultivation can be greater than carbon uptake by tree growth over the long term. Oxidation and degradation can also result from changes to the local hydrology by planting adjacent to these sites. For this reason, and for reasons of habitat and biodiversity value, there is a general presumption against woodland creation on deep peat soils. More detailed policies on this are determined at a country level.

The decision to restock (or regenerate) forests on deep peat should be carefully considered, taking into account the balance of benefits for carbon and other ecosystem services. In some situations, for example, on sites with certain conditions of soil type, peat depth, area, slope or tree growth, restocking on deep peat can lead to positive ecosystem gains – including for carbon. Decisions will be taken on a site-by-site basis in line with the detailed policies for restocking on peat soils that are determined at a country level.

19 To minimise soil carbon loss, employ techniques for ground preparation that create the minimum amount of soil disturbance but are still adequate to ensure successful establishment.

20 Consider, informed through tools such as a peat assessment, the balance of benefits for carbon and other ecosystem services before making the decision to restock (or regenerate) on soils with deep peat, ensuring the decision complies with relevant country policies.

9. Forests and Water

Sustainable forest management is essential to ensure the supply of good quality fresh water, provide protection from natural hazards such as flooding or soil erosion, and protect aquatic species.

Water and climate change

Having forests that are well planned, designed and managed as regards their impact on the water environment is more important than ever. Climate change is expected to have a marked impact, with wetter winters and more extreme rainfall events affecting the timing and volume of river flows and the extent of groundwater recharge, in turn increasing the risk of flooding and soil erosion and the consequent negative impacts on water quality and ecology. Reduced summer rainfall coupled with increased demand for water may have potentially serious implications for water supplies and ecosystem flows, while increased water temperatures will threaten the survival of salmonid fish and other sensitive freshwater life. Greater soil drying will exacerbate the decomposition of soil organic matter and the release of dissolved organic carbon, in turn affecting freshwater ecology and increasing the treatment costs of public water supplies. Many current water management systems are historic and preserve important heritage features such as sluices and weirs. As well as being important irreplaceable features, they add significant value and character at a landscape level.

Forests and forest management practices can help to moderate these impacts and so there is a need to develop appropriate strategies for managing and redesigning forests for water protection and enhancement. Forests that are well designed and managed can reduce the effects of acid deposition, avoid eutrophication, decrease sediment delivery and help manage local flood risk. In turn these will help improve the quality of aquatic habitats and support aquatic species, improve ecological status and enhance fish populations and dependent fisheries.

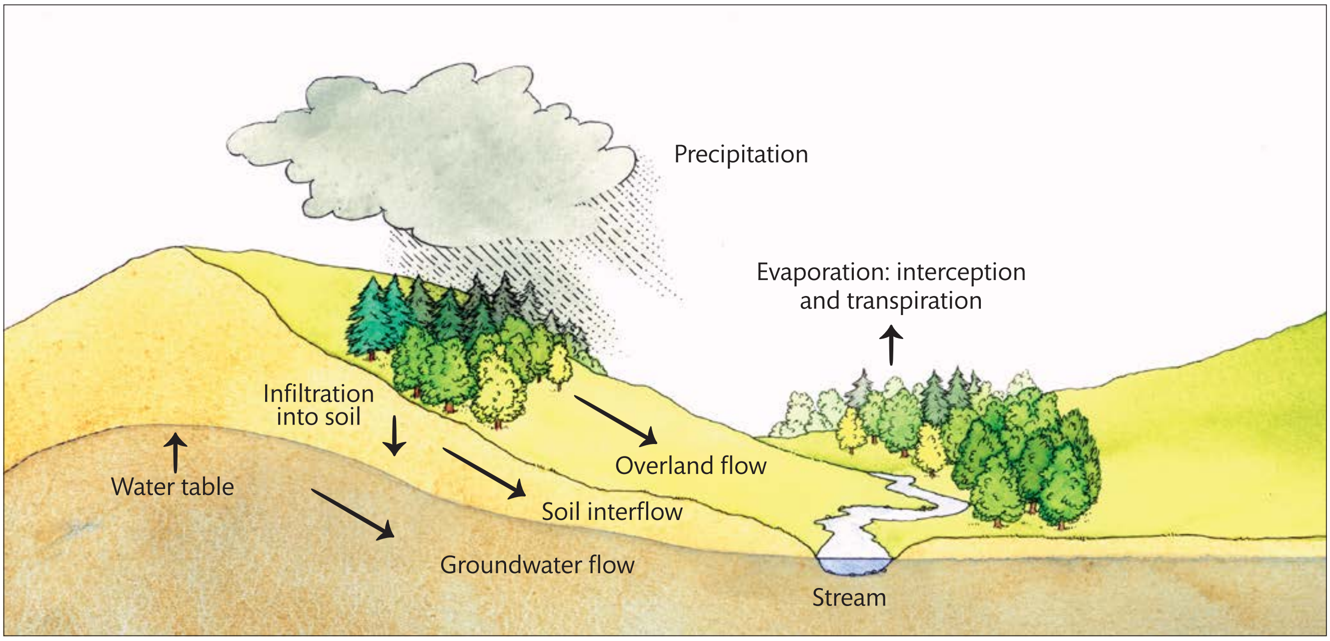
Where drinking water is abstracted, good forest management can reduce water treatment costs and help maintain the high quality of public and private supplies. The low usage of pesticides and general absence of contamination within well-managed forests means that woodland creation can help to offset the pollution threat from more intensive land uses. In particular, targeted woodland creation on farmland can help protect watercourses from pesticide spray drift and leaching, and pesticide run-off after crop applications.

Water catchments and drainage pathways

A water catchment is a defined area of land from which a proportion of the precipitation falling on it runs off or drains to a given collection point (Figure 9.1).

Trees and vegetation within the catchment can exert a strong influence on the quantity of water reaching the ground as some precipitation is intercepted and evaporated back to the atmosphere, and also on water quality, because evaporation can concentrate chemicals present in the atmosphere, which adds to chemical interactions within the vegetation layer. Having passed through the vegetation layer and into the soil, some water is taken up by

Figure 9.1 The water cycle. Water can follow a number of different pathways through a river basin.



vegetation and returned to the atmosphere through the process of transpiration, while the rest is either retained by the soil or drains away.

The amount of water following each of these routes is influenced by the catchment's vegetation and soil, and therefore by land-use practices. Interception and transpiration losses vary between different types of forest and non-forest vegetation, and are strongly affected by rainfall amount and pattern. Removing vegetation because of harvesting will reduce evaporation and result in more water leaving the soil as drainage, until the vegetation is restored.

Drainage water takes different pathways over and through the soil and bedrock to the river basin outlet, reflecting geology, topography, soil and human intervention. These pathways will have a marked influence on the timing, volume and quality of water travelling through the catchment into watercourses and water bodies:

- Rapid run-off in response to precipitation is characterised by superficial pathways and occurs on steep slopes, poorly draining or compacted soils, and shallow, impermeable bedrock. Superficial waters tend to be low in base cations, brown (due to high dissolved organic carbon) and acidic, reflecting their short passage through the upper organic soil horizons.

- Slow run-off in response to precipitation is characterised by deeper pathways leading to a delayed and moderated response, reducing flood flows and increasing groundwater recharge. This occurs on gentle slopes, freely draining soils, deep drifts and porous bedrock. Waters following deeper pathways tend to have higher base cation levels and be clearer and more alkaline, due to the longer period in which rainfall is in contact with soil and rock minerals and is able to react with them.

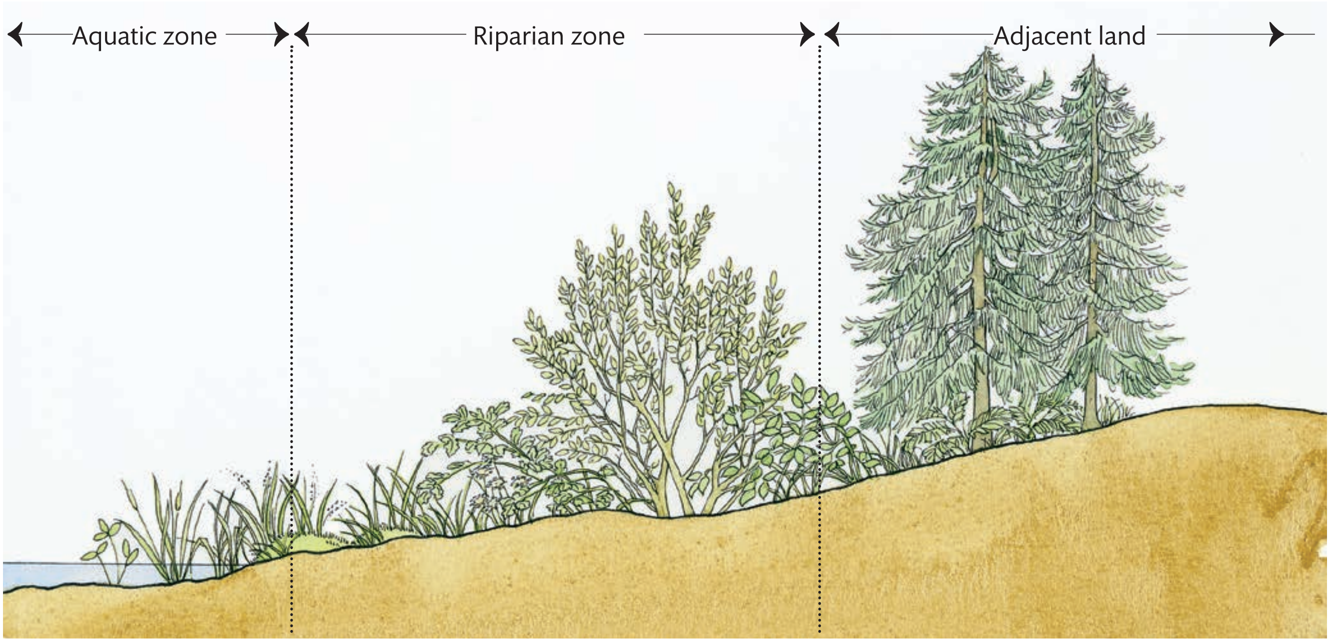
Groundwater

Where the geology is porous, water drains to the underlying water table, forming groundwater. Groundwater is important for public and private water supplies, maintaining river flows in drier months, and sustaining wetlands. Groundwater bodies with both a high porosity and high permeability are defined as aquifers. They are very sensitive to contamination such as from diffuse pollution: pollutants may not reach a river or borehole abstraction point for several decades, but once groundwater is contaminated, it may be difficult or impossible to restore good water quality.

Riparian zones

When drainage waters eventually emerge from the soil and bedrock they pass through the riparian zone before forming the aquatic zone. The riparian zone is the area of land adjoining the aquatic zone and influenced by it, which includes the riverbank but not the wider floodplain (Figure 9.2). Riparian woodlands are therefore the wooded areas of land adjacent to waterbodies such as rivers, streams, lakes, marshlands and reservoirs. Riparian landowners are responsible for maintaining the bed and banks of the watercourse and the trees and shrubs growing on the banks.

Figure 9.2 Diagram showing the transition from the aquatic zone through the riparian zone to the adjacent land.



Riparian zones can be ecologically rich, with long and convoluted edges that host a wide variety of habitats. They can also link other ecologically-rich habitats and offer migration corridors for invertebrates, birds and mammals. In places where natural flooding occurs, large tracts of wet woodland habitat may extend from the riparian zone across the floodplain. These wet woodlands are now rare throughout the UK and are identified as priority habitat types in country biodiversity strategies.

Aquatic zones

The aquatic zone is frequently or permanently under water, forming streams, rivers, ponds, lakes, wetlands, estuaries and coastal waters, as well as canals and reservoirs. Aquatic zones can be divided into discrete water bodies, each with a defined water catchment area. These water bodies – and their assemblage into river basins – are recognised in law as being the units for how pressures on the water environment from human activity are managed through environmental objectives and standards set to protect and improve their quality.

Forests and freshwater ecology

Streams, rivers, lakes, ponds and wetlands all provide habitats for a wide range of plant and animal species, and forests play a major role in the ecological functioning of the freshwater environment.

The ecological requirements of freshwater plants and animals differ from species to species, encompassing a natural range in water chemistry, temperature, oxygenation, flow velocity, depth and substrate type. Some of the broad ecological requirements of organisms and how forests and forest management can help sustain these are shown in Table 9.1. The needs of protected and priority species such as the otter, water vole, Atlantic salmon and freshwater pearl mussel require particular attention.

The spread of invasive non-native species is an increasing problem, which, if unchecked, has the potential to degrade riparian and freshwater habitats and lead to a loss of native species and increase the risk of bank erosion. Co-ordinated action between landowners and authorities will be required to control the spread of invasive animal and plant species such as the North American signal crayfish, Japanese knotweed and Himalayan balsam.

Small streams, including those less than 1 m wide, can form very important spawning habitat for salmonid fish. Their protection is therefore fundamental to the sustainability of fish populations and downstream fisheries, as well as for maintaining other freshwater life.

Estuarine and coastal waters are less influenced by forestry due to dilution and other factors, but some water bodies are very sensitive to disturbance, such as designated shellfish waters in shallow marine lochs. Shellfish and salmon farms could be adversely affected by increased sediment and nutrient inputs associated with larger-scale forestry operations.

Flooding

Flooding is a serious issue in many areas of the UK and flood events are expected to increase in frequency and severity with climate change. To address this, recent years have seen a more sustainable approach to flood risk management involving greater working with natural processes. This has led to the concept of natural flood management, in which natural features and characteristics are used to slow down and store more floodwater within upstream catchments.

Table 9.1 Broad requirements of aquatic wildlife and how forests can help sustain them.

Ecological requirement	Forest contribution
Well-oxygenated water free of contaminants or containing contaminants at a concentration that is not harmful.	Well-designed and managed forests protect the soil and can act as a trap or sink for contaminants. Riparian woodland and riparian buffer areas form an important habitat and help to protect and enhance the freshwater environment, including by intercepting sediments, nutrients and pesticides draining from adjacent land.
Adequate light reaching the water to support aquatic plants and algae and to maintain temperatures suitable for animal metabolism.	A variable density of tree cover is a key component of riparian habitat, although open areas are also important for light-demanding species. A forest canopy can provide the right balance of light and shade and help control temperature extremes – this is increasingly important for fish survival as climate change progresses, because some species are very sensitive to water temperature.
A range of natural features and habitats, such as pools, riffles, gravel bars, fringing wetlands, ponds and backwater channels; dry river terraces; alluvial floodplains connected to the river and banks that are steep, shallow or undercut.	The binding action of tree roots helps to strengthen and stabilise riverbanks, reducing erosion and bank collapse. Tree stumps and underwater tree roots also provide important refuges for fish and other aquatic wildlife, including white-clawed crayfish; they can also provide nests or holts for otter. Natural accumulations of woody debris increase habitat diversity in rivers and streams.
Vegetation appropriate to the site, such as algae and mosses on stony beds; rooted plants in the silt or sand of less turbulent waters; also bankside trees, shrubs and ground vegetation.	Native riparian woodland generally provides an ideal cover for protecting river morphology. Floodplain and riparian woodland can link disconnected habitats to form an extended forest habitat network, benefitting the movement and dispersal of wildlife.
Natural range in acidity and alkalinity.	As the pH falls below 6.0, the physiology and growth of fish, invertebrates and other freshwater life are increasingly affected. Forest canopies, especially conifer, can increase the capture of acid pollutants in the atmosphere and thereby reduce stream pH where acid geology renders waters susceptible to increased acidity. Forest restructuring can help to reduce pollutant capture by increasing open space and species diversity, and by reducing the area of closed canopy.
Appropriate inputs of organic matter and nutrients.	The variety and seasonality of leaf litter inputs and microbial processes in the root zone are critical to maintaining energy and nutrient flows and the effective ecological functioning of aquatic ecosystems. Twigs, leaves and terrestrial invertebrates that fall from forest canopies into the water provide an important source of food for aquatic organisms.
Natural range in water flow and depth.	Reduced water flows can impede fish access and decrease available habitat for freshwater life. Under certain circumstances and conditions some forests can reduce water flows, but this effect can be ameliorated by good forest design and management.

Forests are known to reduce flood flows and can make an important contribution to natural flood management. Trees tend to use more water than other vegetation types (including via interception loss during major rainfall events), and they protect soil and increase water infiltration and storage. Trees and the natural accumulations of deadwood slow flood flows by increasing flow resistance, and also reduce downstream siltation, increasing the capacity of river channels to hold and convey floodwaters. On the other hand, forest operations such as cultivation, drainage, road construction and harvesting can have the opposite effect if not appropriately managed.

The UKFS supports the concept of working with natural processes to deliver a more sustainable, catchment-based approach to managing flood risk. The composition and location of a forest, and the way it is managed, will influence the ability of its trees to affect flood flows. The UKFS Practice Guide *Designing and managing forests and woodlands to reduce flood risk* explains how to meet the UKFS Requirements and Guidelines on flooding.

Climate change itself is also likely to have an impact on how forestry affects flooding, water yields and flows. Forest interception losses are likely to increase, emphasising the difference in water use between forest and non-forest land cover. However, the impact on water supplies could be offset in some areas by higher winter rainfall, while increasing carbon dioxide concentrations could increase the efficiency of water use by trees and reduce water losses.

UKFS Requirements for Forests and Water

The water environment

UK and country legislation provides a comprehensive system for the protection, improvement and sustainable use of the water environment, including the development of River Basin Management Plans. There are controls over water abstractions, impoundments and engineering activities in or adjacent to watercourses that may have impacts on river and lake hydromorphology. A number of protected and priority conservation species rely on the water environment, and the potential adverse effects of forestry operations can extend over a considerable distance downstream.

Note: the definition of 'in or adjacent to watercourses' is dependent on regional byelaws, but often refers to within 7 or 8 m of a watercourse.

1 Prior authorisation must be obtained from the relevant authority for building, engineering and other activities in or adjacent to watercourses that affect river hydromorphology; this includes water abstraction, impoundments, constructing culverts and extracting river gravel. Authorisation for gravel extraction may also be required from the relevant nature conservation authority if the river is designated as, or flows through, a Special Area of Conservation, Special Protection Area, Ramsar site or Site of Special Scientific Interest (Area of Special Scientific Interest in Northern Ireland).

2 In Scotland, all forestry operations must meet relevant General Binding Rules and any divergence must be licensed or registered with the Scottish Environment Protection Agency (SEPA).

3 In Wales, all new developments where the construction area is 100 m^2 or more must have sustainable drainage systems (SuDS) for surface water, designed and built in accordance with published standards, and relevant approvals obtained before construction work begins. This is relevant to any forest infrastructure construction work including roads, stacking areas and quarries.

4 In-stream work involving the use of plant or machinery (or other works nearby that may release sediment into watercourses) must not be carried out when fish are spawning in the affected surface water, or in the period between spawning and the subsequent emergence of juvenile fish. If in doubt about these times, contact the responsible authority or advisory body for advice.

5 Any plant, vehicles or equipment must not be operated in any watercourse or waterbody if there is a reasonable likelihood that there are protected species in the same or a connected watercourse.

1 Any damage caused by the operation of machinery to the bed and banks of a waterbody should be repaired, including re-establishing vegetation on any areas of bare earth on the banks resulting from the operation, by using green engineering techniques.

Pollution control

Under country legislation it is an offence to cause or knowingly permit the entry of poisonous, noxious or polluting material into any controlled waters (all streams, rivers, lakes, groundwaters, estuaries and coastal waters to three nautical miles from the shore).

Regulations also specifically protect groundwater from pollution caused by the disposal of potentially harmful and polluting substances. Under these regulations, permission or prior authorisation is needed from the relevant authority to dispose of 'listed substances' (or, in Scotland, any pollutant) to ground, including sprayer washings. Furthermore, some areas are designated as having groundwater that is nitrate-vulnerable, and restrictions on applying fertilisers within these areas may apply (details are given in country guidance).

The Control of Pesticides Regulations 1986 (as amended) in Great Britain and 1987 (as amended) in Northern Ireland provide details of pesticides subject to control, and prescribe approvals required for their supply, storage and use (including aerial application). Authorisation is not required for normal use of pesticides covered by relevant codes of practice, except in Scotland, where authorisation is given subject to General Binding Rules. In all cases, users are required to take all reasonable precautions to protect the health of humans, animals and plants, safeguard the environment and, in particular, avoid the pollution of water. The Health and Safety Executive Code of Practice for Using Plant Protection Products defines what is meant by a certified person in this regard.

Forestry operations frequently involve the permanent or temporary storage of oils and fuel, including containers, mobile bowsers and drums. Country legislation imposes requirements aimed at preventing leakage and pollution.

6 The entry of poisonous, noxious or polluting material into the water environment must not be caused or knowingly permitted (unless authorised by the relevant authority).

7 Any water containing fish, or any tributary of that water, must not be rendered poisonous or injurious to fish, their spawning grounds, fish spawn or the food of fish (unless authorised by the relevant authority).

8 Groundwater must be protected from harmful and polluting substances, including sprayer washings; the relevant authority must be consulted regarding the disposal of such substances to land.

9 Where a designated site or priority habitat or species might be affected, appropriate regulators and conservation agencies must be consulted prior to the aerial application of pesticides and the use of pesticides in or near water, and, where appropriate, authorisation obtained.

10 All those employed to use pesticides must be trained to the required standard and have an appropriate certificate of competence; operators must comply fully with instructions on pesticide product labels.

11 Oil and fuel must be stored and managed in a way that minimises the risks of leakage and pollution.

12 In Wales, nitrogen fertiliser must not be spread on land if there is a significant risk of it getting into surface water, taking into account the slope of the land, any ground cover, the proximity to surface water, weather conditions, soil type, ground conditions including if the soil is waterlogged, frozen or snow covered, and the presence of any land drains.

2 Fertiliser and pesticide applications should match the needs of the stand and should be planned with careful attention given to buffer and storage areas, weather and ground conditions, and the risk to water supplies. Contingency plans should be in place in case of a spillage.

Water supplies for human consumption

Country regulations set standards for the quality of all public and private water supplies, to protect human health by ensuring that water intended for human consumption is wholesome and clean. Drinking Water Protected Areas have been established to reduce levels of water purification treatment required for public supply.

Country water regulatory authorities ensure that the water in the environment meets certain standards to enable it to be used for human consumption, and country drinking water authorities regulate public and private water supplies. Private water supplies are particularly vulnerable to disturbance because they often undergo limited or sensitive forms of water treatment and there may be little scope for finding replacement sources in the event of pollution.

13 Forestry operations must not lead to harmful or polluting substances contaminating public or private water supplies.

Water quality and buffer areas

Water quality can be maintained or enhanced through good forest planning and management, and in particular through the identification and management of buffer areas. Buffer areas are the minimum working distances from a waterbody, set aside to help buffer any potentially adverse effects of adjacent land management. Special measures apply to buffer areas in terms of forest planning and operations, and these measures ensure that soil disturbance, siltation and the risk of pollution are minimised.

A buffer area is fundamental to woodland creation and the management of existing forests, and needs to include the riparian zones next to watercourses, springs and flushes which form run-off source areas, and their dependent terrestrial ecosystems. Key aspects of the design of the buffer area are width, structure, choice of species and management regime. In general, the aim in buffer areas is to establish and maintain a variable cover of riparian woodland comprising species native to the location and soils. It is important, for landscape and water environment reasons, to avoid parallel-sided corridors and design the margin in response to the landform.

Factors such as climate, altitude, slope and soil type all have a bearing on the effectiveness of the buffer area and therefore on the desired width, which is why only minimum widths are given. The width of the buffer area depends on the width of the watercourse and forest managers will need to use their professional judgement on the width beyond the minimum that is needed in a given situation (e.g. on ground that is sloping). In addition, where there are sensitivities in the aquatic zone, such as salmonid spawning beds or the presence of the freshwater pearl mussel, wider buffer areas may be required.

Table 9.2 sets out the recommended **minimum** widths of buffer areas from the bank top of the waterbody or the edge of standing water. These minimum widths apply to all forestry activities, except for:

- hinge mounding;
- inverted mounding;
- direct planting of native trees and shrubs and other ecologically appropriate broadleaved trees to create riparian woodland.

Table 9.2 Minimum buffer widths for forestry activities (other than the exceptions listed above) from forest edge to watercourse, waterbody or abstraction point.

Buffer width	Situation
10 m	Along permanent watercourses with a channel less than 2 m wide.
20 m	Along watercourses with a channel more than 2 m wide and along the edge of lakes, reservoirs, large ponds and wetlands.
50 m	Around abstraction points for public or private water supply, such as springs, wells, boreholes and surface water intakes.

These buffer widths and precautions apply on both sides of the watercourse and around the whole perimeter of the waterbody, and apply to all waterbodies, including connected ditches and drains, wetlands, large ponds, lakes and reservoirs. Ditches and drains that are disconnected from a watercourse and so do not carry water into them do not require a buffer area.

The minimum buffer widths, or minimum working distances, given in Table 9.2 are recommended as part of the Good Practice Requirements of the UKFS, but wider buffer areas might be required by a regulatory body as a condition of consent or permit (and this might be to address other interests such as a nearby priority habitat, private water supply, designated site or historic environment feature).

Narrower widths of buffer area might be appropriate along minor watercourses with a channel less than 1 m wide, especially on steep ground. The UKFS takes this pragmatic approach for minor watercourses to accommodate situations where, on the one hand, they could be valuable habitats such as spawning streams, but in other situations they may be ephemeral drains leading to a watercourse.

3 The buffer widths in Table 9.2 should be observed.

4 Woodland creation and management should be planned and undertaken in a way that protects or restores the quality of the freshwater environment and reduces the impact of more intensive land management activities and environmental change.

5 All watercourses, including connected drains/ditches (whether dry or running), water bodies, wetlands and flushes, should be identified and appropriate buffer areas established and maintained to protect the water environment and riparian zones from adjacent activities.

6 Forest drainage (including road drains) should be planned and, where necessary, existing drains should be realigned and disconnected from waterbodies to ensure that water is discharged before the edge of a buffer area, and never directly into a waterbody.

7 Forest operations should be conducted to prevent watercourses being affected by sediment or discoloured; monitoring should be carried out during forestry works and any incidents involving contamination of the water environment reported to the relevant authority without delay; remedial action should be taken immediately if pollution starts to occur.

8 Where extensive fertiliser applications are being planned within the same catchment, phasing should be considered to ensure impacts on downstream waterbodies are limited.

9 Where felling is planned, and there are potential risks to water quality, activities should be phased to reduce those risks.

Acidification

Despite ongoing recovery due to the control of emissions, acidification continues to impact water quality in some parts of upland Great Britain. The contribution of forestry through the scavenging of acid deposition has declined but can still pose a threat to vulnerable waters. A range of measures and assessment procedures therefore remain in place to protect vulnerable waters from adverse effects.

10 Where new planting or restocking (or regeneration) is proposed within the catchments of water bodies at risk of acidification, an assessment of the contribution of forestry to acidification and the recovery process should be carried out; details of the assessment procedure should be agreed with the relevant authority.

Flooding and water resources

Flooding is a serious issue in many areas of the UK and flood events are expected to increase in frequency and severity with climate change. Forests can help reduce damaging flood flows in a number of ways: trees tend to use more water than other vegetation types, and they protect soil and increase water infiltration and storage. Trees and natural accumulations of deadwood slow flows by increasing flow resistance, and also reduce downstream siltation, increasing the capacity of river channels to hold and convey floodwaters.

The composition and location of a forest, and the way it is managed, will influence the ability of trees to affect flood flows. However, if left unmanaged, woody debris can wash downstream during heavy rainfall causing blockages, which can result in flooding.

On some watercourses in England and Wales, particularly those designated as a 'main river' for flood protection purposes, periodic access for maintenance is required. In such access areas, consent may be required from the relevant authority to plant trees within 7 m of the watercourse. Restrictions may also apply on selected watercourses in Scotland and Northern Ireland.

Forestry practitioners also need to be aware that, in certain circumstances, there is the potential for woodland creation and management to reduce water supplies, especially in the light of changed weather patterns resulting from climate change. In some areas of the UK there is a growing imbalance between water demand and supply that can lead to water shortages, diminish aquatic habitats and concentrate waterborne pollutants.

14 The relevant authority must be consulted when planning new woods next to main rivers and flood defences, and the necessary consents obtained.

11 Where communities or assets are vulnerable to flooding, woodland creation or the management and redesign of existing forests in relevant upstream water catchments should be considered as a way of mitigating flood risk.

UKFS Guidelines on Forests and Water

Acidification

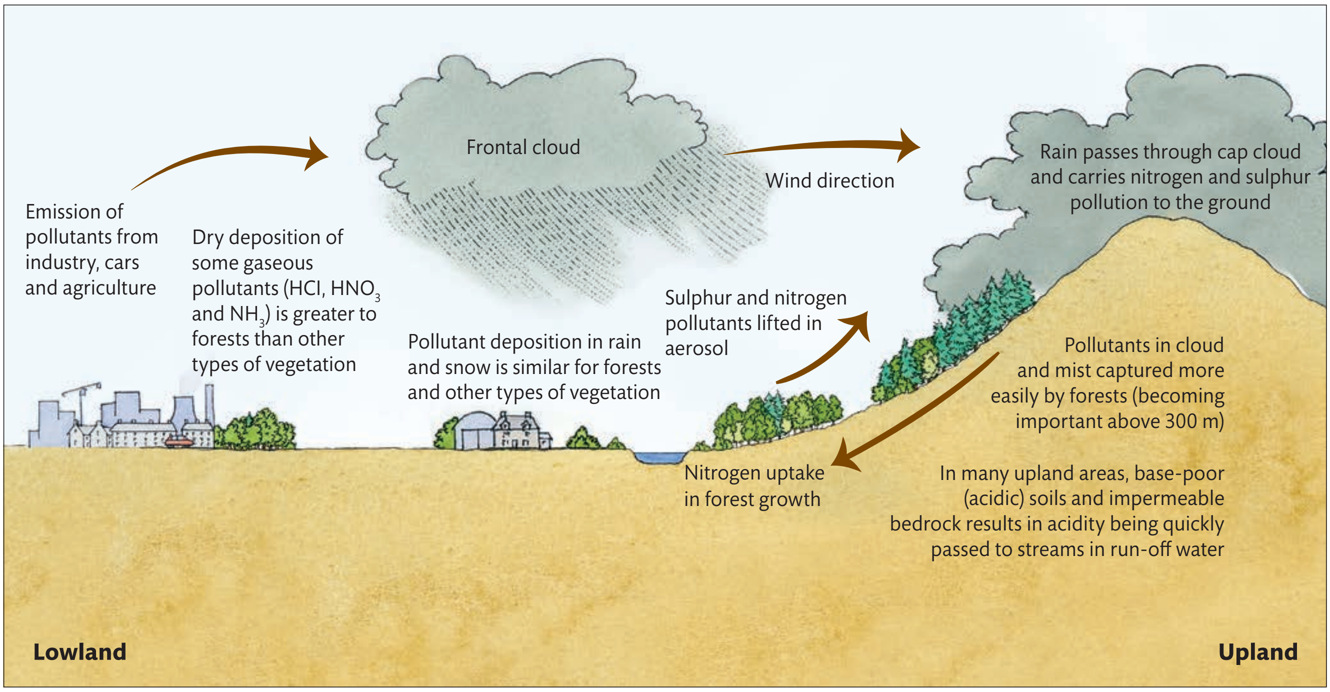
The most acidified areas in the UK are in the uplands, where base-poor, slow-weathering rocks and soils have coincided with high pollutant inputs in the form of large volumes of moderately polluted rainfall (Figure 9.3). Emission control has resulted in major reductions in pollutant inputs, although modelling and monitoring data predict that soil recovery may take decades and could be further delayed by nitrate leaching and climate change.

The starting point for forest managers is to assess where new planting or restocking (or regeneration) could contribute to increased acidification or delay recovery, and the agreed approach is to undertake a catchment-based critical load assessment for waters that are failing or at risk of failing good status due to acidification.

The UKFS Practice Guide *Managing forests in acid sensitive water catchments* offers guidance on how to assess whether the freshwater critical load is exceeded and, if so, ways to reduce pollutant capture, such as restructuring closed canopy conifer stands. This Guide also explains how to carry out a site impact assessment to determine the potential impact of clearfelling operations, and provides helpful measures to reduce the risk of nitrate leaching enhancing acidity.

Note: Guidelines 1–5 apply to catchments of water bodies identified by the water regulatory authority within River Basin Management Plans as failing or at risk of failing good status due to acidification.

Figure 9.3 Interactions between forests and acid deposition.



1 Where the area of new planting or restocking (or regeneration) could contribute to increased acidification or delay recovery, undertake a catchment-based critical load assessment.

2 Avoid new planting or restocking (or regeneration) where catchment assessments based on critical load calculations and relevant supporting information indicate this will lead to deterioration in water body status or prevent recovery to good status.

3 Where an area to be felled will exceed 20% of the acidified catchment in any three-year period, undertake a site impact assessment.

4 Co-ordinate the phasing and timing of felling of conifers in riparian zones and encourage the transition to a variable cover of native woodland to promote the ecological recovery of watercourses.

5 Limit the planting of alder to less than 10% of the area within all riparian zones.

Sediment delivery, cultivation and drainage

Well-managed forests protect the soil from disturbance and improve soil structure due to high inputs of organic matter and the action of tree roots. These conditions enhance soil infiltration pathways and water storage capacity, thereby reducing direct surface water run-off, erosion and downstream siltation. New woodland can therefore help to reduce the higher rates of sediment delivery and resulting turbidity and siltation that are associated with more intensive land uses such as arable cropping. A reduction in sediment delivery will also reduce soil carbon loss. The bare cultivated soils associated with autumn-sown winter cereals and spring cropping are particularly at risk of soil loss by heavy rainfall and strong winds, respectively. Strategically placed tree cover in the form of shelterbelts or riparian zones can help to intercept run-off from such sites and reduce sediment delivery to watercourses.

Conversely, poor forest management can lead to large quantities of sediment entering surface waters; this can cause unacceptable turbidity levels, introducing high levels of nutrients, carbon, metal (such as iron and manganese) and pesticides. This will impact on local and downstream drinking water supplies, aquatic habitats and species.

Large inputs of coarse sediment can also have a significant impact on hydromorphology. This can de-stabilise stream beds and channels, reduce the depth of watercourses and reservoirs, as well as block pipelines and water intakes. Shallow coastal waters can also be vulnerable to siltation, especially where these support shellfish populations.

The financial consequences of such incidents can be significant and may require the construction of new treatment works and payment of fines issued by the relevant authority. Following the UKFS guidelines on water management during cultivation, drainage, harvesting, road building and quarrying will help avoid these problems.

Guidance on planning and undertaking good practice sediment management is in the UKFS Practice Guide *Managing forest operations to protect the water environment*.

6 Prior to clearfelling, assess the drainage system, identify watercourses, and plan restoration work to reduce the risk of erosion and sediment delivery.

7 Where there is a need for drainage, design drains so that they discharge before the edge of a buffer area and never directly into a waterbody.

8 Consider the influence of slope when installing drains; align forest drains to run at a maximum slope gradient of 2° (3.5%) and lead them towards the heads of valleys.

9 When culverts are to be installed, site them at the point where a watercourse is intercepted by a road or track to avoid discharging the watercourse into the roadside drain.

10 Ensure the installation of bridges or culverts does not present barriers to fish movement or promote channel erosion or bank collapse.

11 Assess whether existing drains, culverts or other structures are de-stabilising the banks or beds of watercourses, or forming a barrier to fish access; if so, plan for their replacement or removal.

12 Avoid clearfelling more than 20% of the catchment of an area that drains to a public water supply, fish farm or waters supporting freshwater priority species or habitats within any three-year period.

13 During forestry operations, keep streams and buffer areas clear of brash as far as practicable; avoid felling trees into watercourses and remove them or any other accidental blockages that may occur.

14 Avoid fording streams and rivers, unless there is an existing purpose-built ford and measures are taken to minimise the potential risk to the water environment.

Nutrient enrichment

The leaching and run-off of phosphate and nitrate from the land represents a loss of soil fertility and can reduce surface water and groundwater quality. Of principal concern are naturally nutrient-poor upland waters in which biological activity is usually limited by phosphorus. Enrichment can lead to unwelcome ecological changes and a reduction in water status. In extreme cases, phosphorus enrichment can produce excessive algal growth, resulting in dissolved oxygen fluctuations and disruption of the ecosystem. Excess phosphate may result in increased water treatment costs and may require improvements to water treatment works.

Forests can be an effective land use to intercept and remove excess nutrients from agricultural land, helping to protect water quality and freshwater ecology. This is especially beneficial in catchments of water bodies at risk from diffuse nutrient pollution, particularly within Nitrate Vulnerable Zones (NVZs) and Source Protection Zones (SPZs). The main exception is conifer forest in polluted and drier areas, where there is evidence that the enhanced capture of nitrogen pollutants from the atmosphere can lead to concentrated nitrate levels in groundwater.

High nitrogen inputs can result where forests are downwind of local pollutant sources, such as intensive pig and poultry rearing units, although this effect can be used to protect more vulnerable habitats from nitrogen deposition, providing local groundwater supplies are not affected. In general, these require that neither organic nor inorganic fertiliser be spread on land if there is a significant risk of it getting into surface or groundwater.

Organic pollution of watercourses can occur following the spreading of organic wastes, and this can result in microbial contamination, bacterial growth and oxygen depletion, which in some cases may kill fish.

15 When planning and cultivating restocking sites, seek to minimise the amount of brash placed into mounding spoil trenches

16 Where water bodies are sensitive to nutrient enrichment, including shallow coastal waters designated for shellfish, limit any clearfelling to less than 20% of the catchment in any three-year period.

17 Within Nitrate Vulnerable Zones (NVZs), ensure any fertiliser applications or organic soil amendments adhere to NVZ regulations.

18 Ensure fertilisers are only applied when the weather and ground conditions are appropriate.

19 On restock (or regeneration) sites in catchments of water bodies sensitive to nutrient enrichment, avoid applying fertiliser until sites have re-vegetated.

20 Apply fertiliser according to prescriptions that are based on an analysis of foliar nutrient levels compared with reference values for target species.

21 Consider opportunities for woodland creation to reduce nutrient or pesticide spray drift, leaching and run-off from adjacent land to watercourses and groundwater.

Pesticides

Pesticide use (in the form of herbicides, insecticides and fungicides) in UK forestry is very low and is declining in response to policies and plans for chemical reduction. The approach of the UKFS is to:

- restrict pesticides to those approved by international agreement;
- seek alternatives to pesticide use;
- confine necessary usage to the absolute minimum.

This involves rigorous attention to legal requirements in relation to pesticide usage, storage, disposal (including waste packaging) and aerial applications, and to good working practices, avoiding adverse effects such as off-site drift and contamination from discarded planting bags, and contingency planning for spillages. Further guidance on planning and undertaking good practice pesticide use is in the UKFS Practice Guide *Managing forest operations to protect the water environment* and the UKFS Practice Guide *Reducing Pesticide Use in Forestry*.

22 Only apply pesticides if the weather and ground conditions are suitable.

23 Prior to spraying pesticides, check that the drainage channels in the area to be treated do not discharge directly into watercourses; extend buffer areas to incorporate individual drains where they are not separated from watercourses.

24 Only fill pesticide sprayers with water taken directly from the water environment if a device preventing back-siphoning is fitted, or the water is first placed in an intermediate container.

25 Do not store or soak pesticide-treated planting stock in any surface water or wetland prior to planting.

26 Avoid applying pesticides onto or over impermeable surfaces, infrastructure, roads and railway lines that drain directly into a surface water drainage system unless measures are taken to minimise the risk of pollution.

Water yield and low flows

The water yield (or average streamflow) from a forest needs to be considered so that low water flow is avoided. A forest can affect water flow if it has a high water use, which in turn could result in a low water yield.

Water yields from newly planted, young or felled forests are unlikely to differ significantly from moorland catchments until canopy closure is achieved. However, once that point is reached, water yields from upland catchments with significant proportions of closed-canopy conifer forest are lower than those from moorland or grassland catchments, due to higher interception losses. Interception losses are greatest in the wetter and windier parts of the UK and increase with forest height and canopy development. Research suggests there may be a 1.5–2% reduction of potential water yield for every 10% of a catchment under mature conifer forest.

In lowland areas, the drier and less windy climate reduces interception loss in absolute terms, but tree transpiration rates may be higher due to roots reaching deeper soil water reserves. The net effect can be a marked reduction in potential water yield, amounting to as much as 7% for every 10% of a catchment under mature conifer forest. This can have important implications for the quality and quantity of lowland groundwater resources and the maintenance of river flows.

Annual evaporation from mature broadleaved forest is generally much less than from conifers due to reduced interception losses during the leafless period. Therefore, planting broadleaved forest can help to protect and may enhance chalk groundwater resources. However, recharge under broadleaved forest on drier sandy soils is likely to be reduced compared with grass. This is because the deeper rooting of trees enables transpiration to continue unaffected by water stress for a longer period during the summer than for grass.

Fast-growing species such as poplar and willow used in short rotation coppice systems, and novel species sometimes used in UK forestry such as *Eucalyptus* or hybrids of *Paulownia* are able to sustain high transpiration rates, resulting in a greater reduction in potential water yield in covered parts of the catchment when compared with grassland.

Adequate summer baseflows in rivers are critical for wildlife, water supply and the dilution of effluent. Research suggests that the reduction in water yield due to upland conifer forests has a relatively small effect on these flows. However, large areas of lowland conifer forest or short rotation forestry could cause a significant decline in summer baseflows. This is due to the greater potential reduction in water yield and because baseflows often form a much larger proportion of the annual run-off.

Climate change could exacerbate the effect of forestry on water yields and low flows. Forest interception losses are likely to increase, accentuating the difference in water use between forest and non-forest land covers. However, the impact on water supplies could be offset in some areas by higher winter rainfall, while rising carbon dioxide concentrations could increase the efficiency of water use by trees and reduce water losses.

27 Where there is a risk of low water flow, consult the relevant authority before planning large-scale woodland creation – especially involving a high proportion of conifer or fast-growing broadleaved species used in short rotation forestry with a high water use; consider the projected impacts on future water yield, including the effects of climate change.

Flood risk management

Forestry has great potential to impact on surface water and river flooding, with the magnitude of effect generally decreasing with increasing distance between the forest and the downstream community or asset at risk of flooding. Woodland creation can reduce flood risk depending on the location of the nearest vulnerable downstream community or asset. Target areas and communities are usually identified by flooding authorities, and the catchment areas draining to them. Coniferous forest has a greater capacity to reduce flood run-off due to a higher interception loss compared with broadleaved forest.

Forest felling can have the opposite effect and temporarily increase flood flows until trees are replanted and regrow. As a guide, the scale of felling is unlikely to be large enough to significantly increase flood risk where there is less than 40% forest cover present within the upstream catchment of vulnerable communities or assets. The UKFS Practice Guide *Designing and managing forests and woodlands to reduce flood risk* gives more detail on how to apply these Guidelines.

28 Consider opportunities to restore riparian and floodplain woodland, create ponds and install leaky woody dams to increase flood storage and slow flood flows, ensuring the consent of the relevant authority is obtained if needed.

29 Where downstream communities and assets are vulnerable to flooding, consider opportunities for woodland creation and management to reduce flood risk; this includes their use as part of sustainable urban and rural drainage systems.

30 Where it is identified that households, businesses or other key assets are potentially at risk from large-scale forest felling, phase felling to minimise the impact on local flood flows.

31 When restocking or allowing regeneration, reassess requirements for forest drainage and wherever possible disconnect existing forest drains from watercourses.

Riparian zones

Ideally the riparian zone will be managed to develop a rich herb and shrub layer, with a light and broken tree canopy. Dappled shade, such as that provided by broadleaves, helps keep summer water temperatures down, which can be important for aquatic life, particularly salmonid fish. The occurrence of lethal temperatures is likely to become more commonplace as climate change progresses.

The best combination of shade and shelter is usually provided by a cover of predominantly native woodland. Too much canopy, especially of conifers, can shade out the lower layers of vegetation and result in bank erosion. For this reason, prioritising the clearance of riparian conifers and linking cleared sections with new native broadleaved woodland to create a network of wet woodland habitat will promote the recovery of fish and aquatic invertebrate populations.

Riparian zones present a major opportunity to enhance forest biodiversity by linking permanent habitats and establishing native trees, shrubs and ground flora. However, they can also facilitate the rapid spread of invasive species such as Japanese knotweed and giant hogweed, so control measures and careful management are required in areas where invasive species may be a problem. Water can often act as a pathway for spreading invasive non-native species. Where this is the case, consideration should be given to their distribution within a catchment and measures should address them at appropriate spatial scales, as far as possible tackling them higher in the catchment to prevent re-infestation.

In addition to providing shade, riparian vegetation can influence the condition of watercourses by providing an effective filter and buffer, which helps to trap sediment and absorb nutrients, thereby reducing the delivery of pollutants to watercourses. Riparian woodland will also provide a source of woody debris to watercourses, which is important for aquatic life and slowing flood flows. Identifying and establishing an effective buffer area is fundamental to the protection of the riparian zone and aquatic habitats; the wetness of the soils and the characteristic instability of stream banks mean that the zone is particularly sensitive to disturbance. Buffer areas will also help to protect watercourses from any potentially adverse effects of adjacent land use.

32 Aim for a mix of shaded and lightly shaded habitat within the riparian zone, guided by local objectives and the requirements of priority species.

33 Remove dense stands of conifers from riparian areas and from the edges of ponds and lakes; control excessive conifer regeneration and encourage the transition to a variable cover of native woodland.

34 Design and manage riparian woodland along watercourses to provide a source of leaf litter and woody debris; retain this within watercourses unless it poses a significant risk of damaging or blocking downstream structures.

Glossary

Access management plan Part of a forest plan used to channel and zone the recreational use of a forest. It should aim to ensure activities do not conflict with each other, facilities are used to best effect, visitors are not put at risk by forest operations and the forest environment and wildlife are protected.

Acid deposition The process by which acid pollutants, primarily sulphur and nitrogen compounds derived in part from the combustion of fossil fuels, deposit from the atmosphere to the ground. This can be in particulate form as aerosols or gases (dry deposition), or through indirect input in aqueous solution or suspension, as rain and snow (wet deposition) or cloud water (occult deposition).

Acidification A continuing loss of acid neutralising capacity manifested by increasing hydrogen ion concentrations and/or declining alkalinity; the term may be applied to a catchment, water or soils.

Adaptation Initiatives and measures to reduce the vulnerability of natural and human systems to actual or expected climate change effects. In this context, it means initiatives and measures to reduce the vulnerability of forests to climate change as well as using forests to reduce the vulnerability of society.

Adaptive management A systematic process for continually improving management policies and practices by learning from the outcomes of operational programmes.

Afforestation The process of establishing a new forest on land that was not previously forest or land which has not been forest in the recent past.

Ancient semi-natural woodland (ASNW) Ancient woodland composed of mainly locally native trees and shrubs that derive from natural seedfall or coppice rather than from planting. ASNW generally has the greatest level of woodland biodiversity.

Ancient woodland Woodland that has been in continuous existence since before AD 1600 in England, Wales and Northern Ireland, and before AD 1750 in Scotland. The term ancient woodland site refers to the site of an ancient woodland irrespective of its current tree cover. Where the native tree cover has been felled and replaced by planting of tree species not native to the site it is referred to as a Plantation on Ancient Woodland Site (PAWS).

Anticipatory (or proactive) adaptation Adaptation that takes place before impacts of climate change are observed.

Area of Special Scientific Interest (ASSI) An area or site designated in part IV of the Environment (Northern Ireland) Order 2002 as having special scientific interest.

Baseflow Sustained run-off consisting largely of groundwater. At times of peak river flow, baseflow forms only a small proportion of the total flow, but in periods of drought it may represent nearly 100%, often allowing a stream or river to flow even when no rain has fallen for some time.

Bioaccumulation The gradual accumulation of substances, such as plastics, in an organism.

Biodiversity The variety of plant and animal life (species), including genetic variation within species.

Biofuels Fuels derived from biomass (plant matter) rather than fossil fuels (coal, oil or gas).

Biosecurity A set of measures designed to prevent the introduction and spread of harmful organisms or diseases.

Brash The residue of branches, leaves and tops of trees, sometimes called 'lop and top', usually left on site following harvesting.

Brash mats Brash (mainly cut branches) laid along the route where forestry machinery will be driving to spread the load and reduce soil damage.

Brown earth A well-drained soil of high nutrient status, with a brown humus-rich surface layer.

Brownfield (sites) Land or sites that have been used in the past for industrial activity or development; sometimes abandoned, underused or contaminated by past activities. When work is required to restore them to useful purposes they are also known as derelict land. However, these sites can be or include heritage features and this should be taken into account when change is considered.

Buffer area An area of land that protects the watercourse or heritage feature from activities on the adjacent land, such as by intercepting polluted run-off. The buffer area will usually include the riparian zone and may extend into adjacent land. For heritage features, the buffer area will normally be an unplanted area maintained as open ground.

Carbon sequestration (or capture or uptake) The accumulation of carbon in the forest reservoir. Over the lifetime of a forest stand, there is a net accumulation of carbon in the forest up until the point when equilibrium is reached. Thus, the quantity of carbon accumulated is finite. The process is also reversible, and carbon can be returned to the atmosphere through dieback, decay, the burning of wood or disturbance to the soil.

Carbon storage The act of storing carbon, for a finite period, in a component of the earth system, or a carbon pool. Examples of carbon pools include trees, deadwood, litter and soil, as well as harvested wood products which retain carbon during their use.

Certification A voluntary scheme or standard that establishes a forest management standard together with an auditing system to verify compliance. Forestry certification schemes are owned by international non-governmental organisations and exist to promote good forestry practice. They offer product labels to demonstrate that wood or wood products emanate from well-managed forests.

Clearfelling The cutting down of an area of forest (or typically felling an area greater than 0.25 hectares in a larger area of forest). Sometimes a scatter or small clumps of trees may be left standing within the felled area.

Colonisation Occupation of previously unwooded sites by self-sown trees or the development of woodland on previously unwooded sites.

Compaction The compression of soil leading to reduced pore space, usually due to the weight of heavy machinery. Compacted soils become less able to absorb and transmit rainfall, thus increasing run-off and erosion.

Compliance Acting in accordance with something, particularly in accordance with the law. In the context of this standard, the term 'compliance' refers to meeting the requirements of the UKFS.

Connectivity A key characteristic in the landscape contributing to character, resilience and natural beauty/scenic quality.

Conservation management (historic environment) Any work that aims to protect a heritage feature from damage, improve its condition or increase our understanding. This may involve the development of a conservation management plan, creating a measured survey or record, or monitoring and improving its condition, such as by undertaking general vegetation management. Simple conservation management usually involves identification, avoidance and protection. Active conservation management, such as vegetation management, aims to slow decay, but in some cases more complex work or structural consolidation may be required.

Contingency plan A plan of action to address potential threats to the forest arising from accidents, unexpected or unplanned events such as spillages, pollution, pest attack or wind damage.

Continuous cover forestry An approach to forest management in which a range of silvicultural systems are used to maintain the forest canopy at one or more levels without clearfelling.

Controlled water All streams, rivers, lakes, groundwaters, estuaries and coastal waters to three nautical miles from the shore.

Coppice An area of woodland in which the trees or shrubs are periodically cut back to ground level to stimulate growth and provide wood products. *See also* Short rotation coppice (SRC).

Copse A small, wooded area historically used for small-wood production, often through coppicing.

Coupe An area of forest that is managed as a unit for forest operation purposes such as clearfelling or thinning.

Critical load (of acidity) The highest deposition of acidifying compounds that will not cause chemical changes leading to long-term harmful effects on the ecosystem structure and function.

Cultivation Any method of soil disturbance to aid the establishment of trees.

Cultural significance Conservation decisions should be based on a basic assessment of cultural significance that considers a range of different values, such as rarity, condition and group value.

Cultural value The weighting or worth attributed to the arts, customs, intellectual achievements, history and institutions of a nation, people, community or group.

Deadwood All types of wood that are dead, including whole or wind-snapped standing trees, fallen branch wood and stumps, decaying wood habitats on living trees such as rot holes, dead limbs, decay columns in trunks and limbs, and wood below the ground as roots or stumps. Deadwood of native species that exceeds 200 mm diameter and is associated with sites of high ecological value contributes the most to biodiversity.

Design plan The part of a forest management plan that predominantly addresses landscape and visual aspects.

Designated heritage asset Comprising World Heritage Sites, Scheduled Monuments, listed buildings, registered battlefields, registered parks and gardens and Conservation Areas. Designated heritage assets should be considered for active conservation management.

Designed landscape A pleasure ground, park or large garden laid out with the primary purpose of creating an aesthetically pleasing scene or sequence of vistas.

Diffuse pollution Pollution arising from land-use activities (urban and rural) that are dispersed across a catchment. These are distinct from 'point' sources of pollution associated with discharges of industrial wastes, municipal sewage, and deep mine or farm effluent.

Duty of care A legal, contractual or moral obligation, depending on circumstances. The obligation is to ensure that reasonable measures are taken to ensure that individuals will be safe when they participate in a forest-based activity.

Ecological connectivity Linkages between habitats, facilitating the movement of species.

Ecosystem The interaction of communities of plants and animals (including humans) with each other and the non-living environment. Ecosystems are considered to be 'in balance' when they remain stable over the long term (hundreds of years in the case of woodland).

Ecosystem services The benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as regulation of floods, drought, land degradation and disease; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious and other non-material benefits.

Enclosure An area of land defined by a boundary such as a fence, wall, hedge or woodland belt. The enclosure pattern is the distribution of such boundaries in a tract of landscape. A sense of enclosure is the degree to which views or spaces are limited by surrounding landscape elements.

Energy crops Crops grown to provide energy for heating or the production of electricity. In forestry these are usually fast-growing species. *See also* Short rotation coppice (SRC) *and* Short rotation forestry (SRF).

Environmental Impact Assessment (EIA) The process and documentation associated with a statutory requirement to ensure that environmental consequences of projects are evaluated and public opinion is taken into account before authorisation is given.

Environmental Statement/Report A statement or report of environmental effects that is required where an Environmental Impact Assessment is called for.

Establishment (period) The formative period which ends after young trees are of sufficient size so that, given adequate protection, they are likely to survive as woodland at the required stocking density.

Eutrophication *See* Nutrient enrichment.

Fertility The availability and balance of nutrients required for plant growth.

Field pattern *See* Enclosure.

Forest Land predominately covered in trees (defined as land that is under stands of trees with a canopy cover of at least 20%), whether in large tracts (generally called forests) or smaller areas known by a variety of terms (including woods, copses, spinneys or shelterbelts).

Forest carbon stock The sum of all the carbon in the forest ecosystem at a given point in time, including the whole tree, leaf litter and the forest soil.

Forest certification *See* Certification.

Forest infrastructure Structure and facilities practice of forestry such as roads, tracks, stacking and landing areas, and buildings.

Forest (or woodland) management plan A plan that states the objectives of management together with details of forestry proposals over the next five years and outlines intentions over a minimum total period of 10 years. Forest plans allow managers to communicate proposals and demonstrate that relevant elements of sustainable forest management have been addressed, and can be used to authorise thinning, felling and other management operations.

Forest management unit (FMU) A convenient management area determined by the nature of the forest, the management objectives and proposed operations, and which is subject to a forest management plan or proposal. Extensive FMUs allow a strategic approach to be taken to meeting UKFS Requirements and Guidelines. The term is synonymous with a Woodland Management Unit (WMU).

Forest potential The capability of a forest area to produce goods and services within the limits of sustainability. *See also* Sustainable forest management.

Forestry authority Government departments in England, Scotland, Wales and Northern Ireland responsible for regulating forestry activity in that country.

Forestry operations Work or procedures carried out within a forest such as felling, extraction, cultivation and planting.

Gley A soil that is permanently or periodically waterlogged, lacking oxygen and characterised by its blue-grey colours, often mottled with orange-red.

Greenhouse gases (GHGs) Gases in the atmosphere, both natural and man-made, that absorb and emit thermal infrared radiation emitted by the Earth's surface, the atmosphere itself and clouds. The primary greenhouse gases are water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3).

Groundwater All water that is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil. This zone is commonly referred to as an aquifer, which is a subsurface layer or layers of rock or other geological strata of sufficient porosity and permeability to allow a significant flow of groundwater or the abstraction of significant quantities of groundwater.

Habitat (or Herbivore) Impact Assessment A Habitat (or Herbivore) Impact Assessment (HIA) can be used to establish a baseline and then to monitor and record changes in impacts (generally by herbivores) over time. An HIA makes it easier to monitor whether an impact mitigation effort is sufficient to enable land management objectives to be achieved.

Heritage feature The majority of heritage features are archaeological sites, where the cultural significance predominantly lies in its material fabric (both above ground as earthwork or masonry, and below ground as buried archaeological remains). The appropriate management regime for a heritage feature is usually protection as part of simple conservation management, although significant heritage features may require or warrant more active or complex conservation management.

Historic environment All aspects of the environment resulting from the interaction between people and places through time, including the surviving physical remains of past human activity, whether visible, buried or submerged, and including designed landscapes and planted or managed flora.

Historic Environment Record Many national and local historic environment services maintain a register of all the known archaeological sites in their area, generally known as a Historic Environment Record (HER). Only a small proportion of these sites are protected as Scheduled Monuments or listed as being of special architectural or historic interest, but many other recorded sites merit protection for their regional or local importance. HERs represent the major information source for understanding the historic environment. The inclusion of a site on an HER gives it formal recognition in the planning process and local planning authorities take account of this in drawing up development plans and reaching planning decisions.

Historic landscape The wider context of historic land use and character beyond individual heritage features and historic buildings. Historic landscapes vary from individual ancient woodlands and designed parks and gardens to entire landscapes with distinctive or unique characteristics.

Hydromorphology The physical characteristics of the shape, the boundaries and the content of a water body.

Infiltration The entry of water into soil.

Integrated design The comprehensive, holistic approach to forest design that brings together specialisms often considered separately. It applies to the UKFS elements of sustainable forest management and enables efficient working through the integrated, spatially defined design process considering landscape context and applying the design principles.

Interception The evaporation of rainwater from the wetted surfaces of leaves, branches and tree trunks, resulting in less water reaching the ground.

Invasive species Any animal or plant that has the ability to spread, causing damage to the environment, the economy, our health or the way we live. Many invasive species are not native or locally native (called invasive non-native species).

Ironpan A soil with a hardened impervious layer, in which iron oxides are the chief cementing agents that impair drainage and plant growth.

ISO 14001 An international standard for environmental management systems developed by the International Organization for Standardization (ISO). ISO 14001 does not set specific performance targets, other than legal compliance, and therefore sector-specific performance targets can be linked with the standard.

Landform The three-dimensional shape of the land or terrain.

Landscape An area, as perceived by people, the character of which is the result of the action and interaction of natural and/or human factors.

Landscape character The distinct and recognisable pattern of elements that occur consistently in a particular type of landscape and combine to describe its essential nature.

Landscape Character Assessment (LCA) The process of systematic description, classification and analysis of landscape in order to identify, describe and understand its character. The scale and detail of the assessment will depend upon the purpose for which it is being undertaken.

Landscape characteristics Repeated and consistent patterns of natural components and human elements that recur across a landscape. The most persistent, dominant and influential are key characteristics.

Landscape context The relevant circumstances pertaining to the site, situation and local area; in landscape these will include the landscape character, sensitivity, distinctiveness, and historic and cultural significance.

Landscape function The capacity of the landscape to provide goods and services to society; the term is comparable in certain respects to the concept of ecosystem function.

Landscape sensitivity The degree to which specific types of land-use changes or development affect the character and qualities of the landscape. Sensitivity depends upon the type, nature and magnitude of the proposed change and the characteristics of the host landscape. High sensitivity indicates landscapes are vulnerable to the change; low sensitivity that they are more able to accommodate the change and that key characteristics of the landscape will essentially remain unaltered.

LiDAR (Light Detection And Ranging) This remote sensing technique uses airborne lasers to record and map the landscape below.

Low impact silvicultural system (LISS) A forest management system, such as continuous cover forestry, that encourages structural and species diversity and evolutionary adaptation by promoting natural regeneration.

Main river Designated stretches of river in England and Wales where the Environment Agency or Natural Resources Wales have permissive powers for flood defence purposes to construct and maintain defences and to control the actions of others through byelaws and the issuing of consents.

Mineralisation The production of inorganic ions such as nitrate in the soil by the oxidation of organic compounds.

Minimum intervention Management with only the basic inputs required to protect the forest from external forces or to ensure succession of key habitats and species.

Mitigation (climate change) A human intervention to reduce the sources or enhance the sinks of greenhouse gases; in a forestry context, establishing and managing forests and their products to enhance their potential as a 'sink' of greenhouse gases.

Mounding The process of forming a small mound on which to plant a tree, thus increasing the aerobic zone of soil and maximising root extension. Hinge mounding is where an excavator scoops out and inverts a mound of soil with one edge of turf remaining intact.

National Scenic Area (NSA) A conservation designation used in Scotland for areas of outstanding scenic value in a national context.

Native species Species that have arrived and inhabited an area naturally, without deliberate assistance by humans. For trees and shrubs in the UK, this is usually taken to mean those present after post-glacial recolonisation and before historical times. Some species are only native in particular regions. Differences in characteristics and adaptation to conditions occur more locally – hence 'locally native'.

Native wood(land) A wood mainly or entirely composed of native species, and including ancient woodland.

Natural regeneration Plants growing on a site as a result of natural seedfall or suckering. The term is also used to describe the silvicultural practices used to encourage natural seeding and establishment.

Nitrate leaching The removal of nitrate in solution from the soil via water movement, with the potential to contaminate surface water and groundwater.

Nitrate Vulnerable Zones (NVZs) Designated areas of land designed to protect waters against nitrate pollution from agriculture.

Nutrient enrichment (eutrophication) Excessive richness of nutrients in waters or soils that results in adverse effects on the diversity of the biological system, the quality of the water and the uses to which the water may be put.

Open space/ground Areas within a forest without trees, such as glades, stream sides, grass or heathland, water bodies, rocky areas, roads and rides.

Operational plan The operational details of how planned work will be implemented at site level within the framework of a forest management plan. May also be called a site plan.

Organic matter The organic fraction of the soil exclusive of undecayed plant and animal residues.

Organo-mineral (peaty) soil Soil with a peat topsoil (i.e. containing more than 20% organic matter) that is less than the depth of deep peat, as defined in each country.

Origin The geographic locality within the natural range of a species where the parent seed source or its wild ancestors grew.

Peat A largely organic substrate consisting of partly decomposed plant material forming a deposit on acidic, boggy ground.

Permissive (use) Use by permission, whether written or implied, rather than by legal right.

Pesticide Any substance, preparation or organism prepared or used, among other uses, to protect plants or wood or other plant products from harmful organisms, to regulate the growth of plants, to give protection against harmful creatures or to render such creatures harmless.

pH A logarithmic index for the hydrogen ion concentration in an aqueous solution, used as a measure of acidity. A pH below 7 is considered to be acidic and a pH above 7 is considered to be alkaline.

Planning gain Provision by a developer to include in a proposal those projects that are beneficial to a community in exchange for permission for a commercially promising but potentially unacceptable development.

Plantation An area that has been intentionally planted with trees; usually more recent sites and can include commercial timber-producing plantations using non-native trees, as well as new native woods planted for wildlife and carbon capture.

Plantation on Ancient Woodland Site (PAWS) Planted forests of native or non-native tree species that have replaced the original 'natural' woods on sites with a long history of woodland cover. *See* Ancient woodland.

Podzol An infertile or low nutrient status acidic soil with an ash-like subsurface layer (from which minerals have been leached) and a lower dark stratum, where organic carbon has accumulated, occurring typically under heathland and some temperate coniferous forests.

Pollard/pollarded tree A tree cut 2–4 m above ground level, managed to produce a crop of branches that can be harvested in subsequent years.

Priority habitat or species Habitats and species that have been listed as priorities for conservation action in biodiversity strategies.

Productivity (of a forest) The capacity to produce forest goods and ecosystem services.

Protected habitat or species Habitats or species protected by law including UK and country wildlife; countryside and conservation legislation provides protection for special sites and listed species.

Provenance Location of trees from which seeds or cuttings are collected. Designation of Regions of Provenance under the Forest Reproductive Material Regulations is used to help nurseries and growers select suitable material. The term should not be confused with 'origin', which is the original natural genetic source.

Regeneration The regrowth of a forest through sowing, planting or natural regeneration, or regrowth following coppicing.

Resilience The ability of a social or ecological system to resist or absorb disturbances while retaining the same basic structure and ecosystem provision, by having the capacity for self-organisation and the capacity to adapt to stress and change while providing the same services.

Restocking (or regeneration) Replacing felled areas by sowing seed, planting, or allowing or facilitating natural regeneration.

Restructuring Diversifying the distribution of age classes of a forest, usually by advancing felling in some areas and retarding it in others. Restructuring is usually associated with wider measures to redesign a forest as part of a forest management plan.

Ride Open space used to separate forest areas and provide an access route.

Riparian Relating to, or situated adjacent to, a watercourse or water body.

River basin The area of land from which all precipitation eventually drains to the sea at a single river mouth or estuary, through a sequence of streams, rivers and lakes.

River Basin Management Plan A detailed document describing the characteristics of the basin, the environmental objectives that need to be achieved and the pollution control measures required to achieve these objectives through a specified programme of work.

River morphology The term used to describe the shapes of river channels and how they change over time due to sedimentation and erosion processes.

Rotation The period required to establish and grow trees to a specified size, product or condition of maturity. The period varies widely according to species and end use.

Rutting (vehicle) Making deep tracks in the ground by the repeated passage of the wheels of vehicles.

Scarify A method of shallow cultivation designed to create suitable positions for tree planting or a seedbed for natural regeneration.

Scheduled Monument A monument or area of archaeological remains of national importance that is entered into a schedule maintained by the Secretary of State under the relevant legislation and is subject to legal protection under that legislation.

Semi-natural woodland Woodland composed of mainly locally native trees and shrubs that derive from natural seedfall or coppice rather than from planting and include a range of age classes and deadwood and a representative native woodland ground flora.

Setting (historic environment) The surroundings in which a heritage feature is experienced. Its extent is not fixed and may change as the heritage feature and its surroundings evolve. Elements of a setting may make a positive or negative contribution to the significance of a heritage feature and may affect the ability to appreciate that significance.

Short rotation coppice (SRC) Trees (usually willow or poplar) typically grown as an energy crop and harvested at intervals of about three years.

Short rotation forestry (SRF) The practice of growing single or multi-stemmed trees of fast-growing species on a reduced rotation length.

Siltation Deposition of waterborne, mainly soil-derived, particles within a watercourse, other body of water, or wetland.

Silviculture The growing and cultivation of trees, including techniques of tending and regenerating forests, and harvesting their physical products.

Site of Special Scientific Interest (SSSI) A site in Great Britain, referred to as an Area of Special Scientific Interest (ASSI) in Northern Ireland, that is protected by law for nature or geological conservation.

Site plan *See* Operational plan.

Soil carbon Carbon stored within the soil; primarily associated with the organic component of soil, it can be classified into three main fractions: rapidly cycled carbon stored in microbial biomass and easily decomposed plant residues; slowly cycled stable carbon held through chemical and physical processes for around a hundred years; and an inert or passive store that takes more than a thousand years to recycle.

Soil horizons Individual layers of soil differing in colour, texture or composition.

Soil structure The combination or arrangement of primary soil particles into secondary units. The secondary units are characterised on the basis of size, shape and grade (degree of distinctness).

Source Protection Zone (SPZ) An area of land supplying groundwater to a well, borehole or spring for public supply that is designated by the competent authority as being at risk from potential polluting activities.

Spatial How elements fit together and their relationships with each other. In landscape, how hills relate to valleys; how forestry relates to open ground.

Species assemblages Collections of species making up any co-occurring community of organisms in a given habitat.

Species compartment A geographically recognisable unit of forest land forming the basis for planning and management activities. In the UK, compartments are usually identified by species composition and planting year.

Stand A discrete area of trees characterised by homogeneity in attributes such as yield class, age, condition, distribution and thinning history.

Statutory body/bodies The authorities and bodies responsible for nature conservation (Natural England, NatureScot, Natural Resources Wales and Northern Ireland Environment Agency); environmental protection (Environment Agency in England, Natural Resources Wales, Scottish Environment Protection Agency and Northern Ireland Environment Agency); and the historic environment (Historic England, Historic Environment Scotland, CADW (historic environment service of the Welsh Government) and Northern Ireland Environment Agency).

Structural consolidation (historic environment) Any repair or maintenance work that aims to maintain or improve the structural integrity of a heritage feature or historic building.

Structural diversity The degree of physical variation in the elements of a forest, particularly the spatial distribution of trees, and vertical distribution of the canopy and other layers of vegetation.

Stump removal Harvesting of the basal part of the tree that remains after felling of the stem or log.

Substitution The use of wood products in place of other more energy-intensive materials such as concrete, metals and glass, or the use of wood as a fuel in place of fossil fuels such as coal, oil and gas.

Sustainable forest management The stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity and vitality, as well as their potential to fulfil, now and in the future, relevant ecological, economic and social functions at local, national and global levels, and that does not cause damage to other ecosystems.

Texture The visual appearance of a surface due to the size, nature and density of surface elements, coarser textures having larger elements at wider spacing and finer textures having smaller elements at closer spacing. In forestry, different ages and species of tree appear as different textures in the landscape.

Thinning The removal of a proportion of trees in a forest after canopy closure to promote growth and greater value in the remaining trees.

Transpiration The evaporation of water through the stomata on the surface of leaves.

Veteran tree A tree of considerable age that is of interest biologically, culturally or aesthetically because of its age, size or condition, including the presence of deadwood micro-habitats.

Visual sensitivity An attribute determined by the visibility of the landscape, the main views of the forest, by whom and how it is seen, the nature of the viewing experience and the value placed on the landscape. Cultural or historical associations all contribute to this value.

Watercourse Any natural or man-made channel through which water flows continuously or intermittently.

Wetlands Transitional areas between wet and dry environments, ranging from permanently or intermittently wet land to shallow water and water margins, and including marshes, swamps and bogs and the intertidal zone. When applied to surface waters, it is generally restricted to water shallow enough to allow the growth of rooted plants.

Whole-tree harvesting The removal from a felled site of every part of the above-ground tree, except the stump.

Wildness (wildland) A quality of the landscape, usually due to natural character, remoteness or lack of obvious human influence, experienced by people through such values as feeling close to nature and experiencing a sense of solitude.

Windthrow (or windblow) Uprooting of trees by the wind.

Wood pasture Areas of historical, cultural and ecological interest, where grazing is managed in combination with a proportion of open tree canopy cover.

Woodfuel Wood used as a fuel, available in various forms such as logs, charcoal, chips, pellets or sawdust.

Woodland heritage Veteran trees and evidence of previous woodland management can be of interest biologically, culturally or aesthetically, and can include the presence of valuable micro-habitats such as deadwood and soil biodiversity. In particular, veteran pine and oak trees can help dendrochronologists build regional reference chronologies.

Woodland management unit (WMU) A convenient management area determined by the nature of the forest/woodland, the management objectives and proposed operations, and which is subject to a forest management plan or proposal. Extensive WMUs allow a strategic approach to be taken to meeting UKFS Requirements and Guidelines. The term is synonymous with Forest Woodland Management Unit (FMU).

www.forestresearch.gov.uk/ukfs