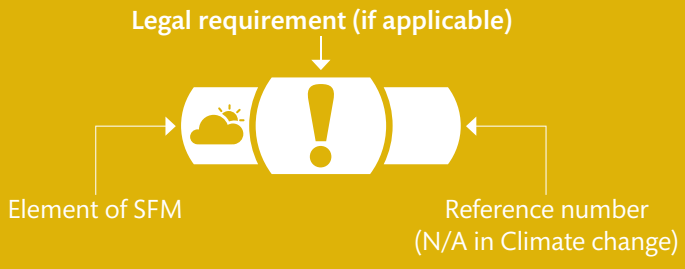
Forestry Commission

Forests and climate change

UK Forestry Standard Guidelines

Key to symbols

UKFS Requirements for sustainable forest management



UKFS Guidelines

Forestry Commission

Forests and climate change

UK Forestry Standard Guidelines

Forestry Commission: Edinburgh

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Contents

1. Introduction

Forests and Climate Change is one of a series of seven Guidelines that support the United Kingdom Forestry Standard (UKFS). The UKFS and Guidelines outline the context for forestry in the UK, set out the approach of the UK governments to sustainable forest management, define standards and requirements, and provide a basis for regulation and monitoring – including national and international reporting.

The UKFS approach is based on applying criteria agreed at international and European levels to forest management in the UK. However, because the history of forestry and the nature of the woodlands in the UK differ in fundamental ways from those of other European countries, a main purpose of the UKFS is to demonstrate that these agreements are applied in an appropriate way to the management of UK forests and woodlands.

The UKFS Guidelines on *Forests and Climate Change* is a new edition to the existing series of Guidelines published by the Forestry Commission. Together with the 2011 editions of the UKFS and the rest of the Guidelines, it has been produced to:

- provide an explicit statement of UKFS Requirements for sustainable forest management in line with statements for other land uses supported by EU rural development measures;
- ensure that the UKFS and its supporting Guidelines form an integrated whole by linking the UKFS Requirements through to the different elements of sustainable forest management;
- clarify the status of the UKFS, and the assurances provided by meeting the Requirements through the regulatory process;
- strengthen the role of forest planning;
- incorporate recent developments in legislation, international agreements, and the way forestry activity is monitored and reported;
- incorporate recent advances in the scientific understanding of forestry;
- include national and international initiatives on climate change and the role forests can play in mitigation and adaptation.

The new editions of the Guidelines have also replaced the 'Standard Notes', which gave detailed guidance on forestry practice in the first and second editions of the UKFS.

The UKFS and Guidelines have been developed by the Forestry Commission in Great Britain and the Forest Service, an agency within the Department of Agriculture and Rural Development in Northern Ireland, through an open and consensual process in accordance with government guidance. This has involved many interested parties and the general public in a formal consultation.

The UKFS and Guidelines have been endorsed by the UK and country governments and apply to all UK forests and woodlands. Together with the national forestry policies and strategies of England, Scotland, Wales and Northern Ireland, the UKFS provides a framework for the delivery of international agreements on sustainable forest management, alongside policies on implementation.

The standards for the planning, design and sustainable management of forests and woodlands in the UK use an approach based on internationally recognised science and best practice. The UKFS is the basis of forestry practice for the independent UK Woodland Assurance Standard (UKWAS), which is used for voluntary independent certification. It can also be used for assessing compliance as part of an environmental management system such as ISO 14001.

By meeting the Requirements of the UKFS, forest and woodland owners, managers and practitioners can demonstrate that forestry operations and activities are both legal and sustainable. The main bodies responsible for the regulation and monitoring of the UKFS and Guidelines are the Forestry Commission in Great Britain and the Forest Service in Northern Ireland.

The UKFS Guidelines on *Forests and Climate Change* is relevant to all those with an interest in UK forests and woodlands, particularly owners, managers and practitioners, and all organisations with responsibilities for forests and woodlands – including government agencies, local authorities, non-governmental organisations (NGOs), charities and trusts.

An increased frequency and severity of summer drought is likely to represent the greatest threat to woodlands from climate change in the UK

2. Overview of Forests and Climate Change

Forests and Climate Change is structured in the same way as the other Guidelines that support the UK Forestry Standard (UKFS). This section sets out the purpose of the UKFS Requirements, explains the role of the Guidelines and how they relate to the UKFS, defines the scope of the series and provides explanations of terminology.

UKFS Requirements

The UKFS Requirements for Climate Change are set out in Section 5. There are two levels of compliance: **Legal** and **Good forestry practice**. Guidelines for managers on complying with the Requirements for Climate Change are set out in Section 6.

In addition to climate change, there are UKFS Requirements for six other elements of sustainable forest management, each set out in an individual Guidelines publication, categorised as follows:

- Biodiversity
- Historic Environment
- Landscape
- People
- Soil
- Water

General Forestry Practice is a further element of sustainable forest management that is covered by the UKFS itself, as it is common to climate change and the other elements of sustainable forest management. Requirements for General Forestry Practice apply in most forestry situations, for example planning and operations.

For completeness, and so that these publications stand alone, the UKFS Requirements and Guidelines for General Forestry Practice are set out in Appendix 3 of each of the Guidelines publications.

Legal requirements

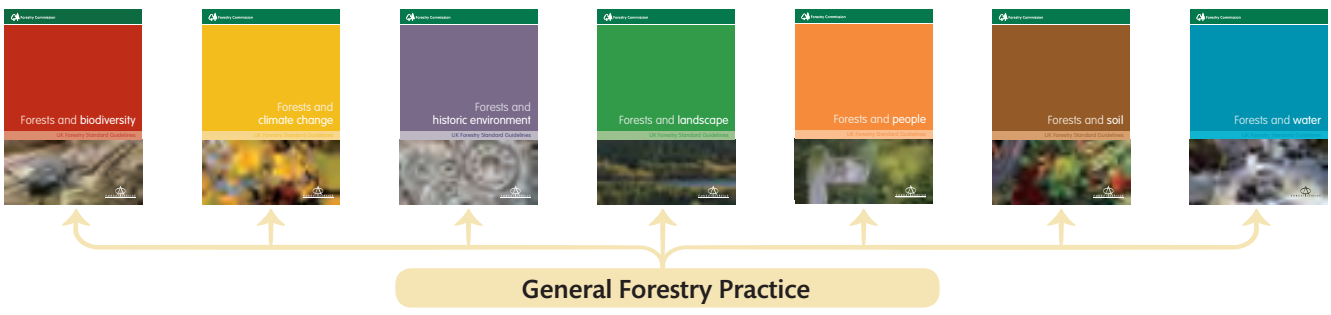
Statutory requirements of EU and UK legislation, including legislation applicable in Scotland, Wales and Northern Ireland, that has the most direct bearing on the management of forests and woodlands. Contravention of these requirements could lead directly to prosecution.

Good forestry practice requirements

Further requirements of sustainable forest management, linked to internationally agreed criteria and commitments, to meet UK and country policy. They complete the framework for the exercise of the regulatory powers of the forestry authorities in the UK and for the payment of grants.

Guidelines

Guidelines provide more detailed information for forest and woodland owners, managers and practitioners on how to comply with the UKFS Requirements. Some guidelines apply to more than one situation and to more than one element of sustainable forest management. These guidelines are cross-referenced.



Purpose of the UKFS Guidelines

The series of UKFS Guidelines explains the principles of the various elements of sustainable forest management in further detail, sets out how the UKFS Requirements can be met, and points to sources of practical guidance. Each of the UKFS Guidelines covers a different element of sustainable forest management and is based on current, relevant research and experience.

The purpose of the UKFS Guidelines is to provide:

- a statement of the UKFS Requirements relevant to that particular element of sustainable forest management;
- guidance and advice for those managing forests and woodlands on how to meet these Requirements;
- the basis for assessing proposals, management operations and activities to ensure the sustainability of UK forests and woodlands.

Scope and application

The UKFS and supporting series of Guidelines have been developed specifically for forestry in the UK and apply to all UK forests. The UKFS and Guidelines are applicable to the wide range of activities, scales of operation and situations that characterise forestry in the UK. The relevance of the Requirements and Guidelines will therefore vary according to the circumstances of the site, particularly the size of the forest or woodland, the scale of operation, and the objectives of the forest or woodland owner.

The UKFS and Guidelines encompass the entire forest environment, which may include open areas, water bodies such as rivers, lakes and ponds, and shrub species in addition to the trees themselves. They apply to the planning and management of forests within the wider landscape and land-use context, and to all UK forest types and management systems, including the collective tree and woodland cover in urban areas. The scope of the UKFS and Guidelines does not extend to the management of individual trees (arboriculture), orchards, ornamental trees and garden trees, tree nurseries, and the management of Christmas trees.

Some aspects of forest management lend themselves to 'yes or no' compliance, but most do not, and the UKFS and Guidelines have not attempted to condense all the complexities of forest management into an over-simplistic format. The UKFS and Guidelines have therefore been written to be interpreted with a degree of flexibility and applied with an appropriate level of professional expertise.

It is also recognised that forest and woodland management is a long-term business and, while management opportunities should be taken to effect improvements, it may take more than one rotation to achieve some of the Requirements. In assessing whether the Requirements have reasonably been met, the overall balance of benefits or ecosystem services will be taken into account.

Definitions and terms

The UKFS and Guidelines apply to all UK forests. The term **forest** is used to describe land predominately covered in trees (defined as land 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). The alternative term **woodland** has local nuances of meaning so it is used in the text where it is more appropriate, but for the purposes of the UKFS and Guidelines the meaning is synonymous with forest. **Forestry** is the science and art of planting, managing and caring for forests.

Short rotation coppice (SRC) and **short rotation forestry** (SRF) are both included within the scope of the UKFS and Guidelines, whether managed as part of a forest or as an agricultural or stand-alone regime. Although requirements for site selection and environmental protection for SRC and SRF will be the same as for other types of forestry, there will be differences in how other requirements can be met, particularly in the case of SRC, but the principles given in the UKFS will be applied.

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 FMU is the area subject to a forest management plan or proposal. This area is selected by the owner and/or manager and will be determined by the nature of the forest, the proposed operations and management objectives. Extensive FMUs have the advantage of allowing a strategic approach to be taken in

achieving UKFS Requirements, both in terms of the area covered and the timescale.

For the UKFS Requirements the term **must** is used to reflect a **legal requirement**, whereas the term **should** is employed for a **good forestry practice requirement**, which recognises that there may, in exceptional cases, be reasons for divergence.

UKFS **guidelines** are concerned with greater detail and therefore use a range of imperative terms appropriate to context. For unacceptable practice or management, the term **avoid** is used, meaning 'keep away', 'refrain from' or 'prevent from happening'. Where specific maximum and minimum values or proportions are defined, they refer to the forest management unit and serve as a starting point for assessing compliance with the Requirements. However, because UK forestry encompasses a variety of activity, the relevance of guidelines will vary and, as with good forest practice requirements, there will be exceptional situations where a reasonable case for divergence can be made.

Detailed definitions of terminology specific to the UKFS Guidelines on *Forests and Climate Change* can be found in the Glossary.

Box 2.1 Guidance on good practice and reports of research to support the UK Forestry Standard can be found in the Forestry Commission technical publications series.

Woodlands sequester carbon and provide a sustainable source of energy that can be used as an alternative to fossil fuel.

3. Introduction to forests and climate change

Climate change presents one of the greatest long-term challenges facing the world today. Over the past 150 years, the atmospheric concentration of carbon dioxide has increased significantly. This is as a direct result of human activities, mainly through the use of fossil fuels and changing land use. There is mounting evidence that climate change could create impacts on our environment that may be substantial, abrupt and irreversible.

The agricultural and forestry systems on which humans depend have developed in a climate that has undergone fluctuations but remained relatively stable since the end of the last Ice Age (around 10 000 years ago). However, the average global temperature is now rising. The 20th century was probably the warmest century in the past 1000 years and, globally, the ten warmest years since instrumental records began (1861) have all occurred since 1997[1]. There is evidence that rainfall patterns are changing and there is likely to be an increase in the incidence of extreme weather. An increased frequency and severity of summer drought is likely to represent the greatest threat to woodlands from climate change in the UK.

Guidance on adapting to climate change is inevitably provisional because of the uncertainty associated with climate change projections. However, there are actions that can be taken now to mitigate the impacts of climate change and to adapt to its effects. These UKFS Guidelines on *Forests and Climate Change* are focused on the actions that forest managers can take to protect forests and woodlands in the UK, and to ensure that we can adapt to the new threats and opportunities that climate change will bring while still maintaining and expanding a sustainable forest and woodland resource.

Forests and the carbon cycle

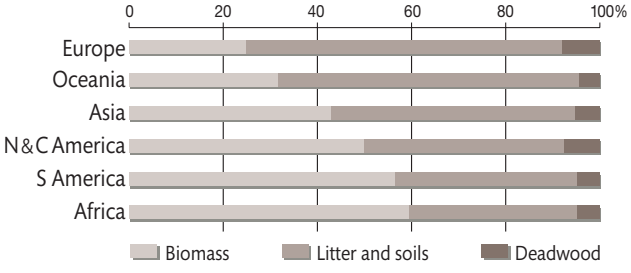
Forests play an important role in the global carbon cycle (Figure 3.1). They account for almost three-quarters of the annual exchange of carbon between the land and the atmosphere (Figure 3.2). Land-use change, primarily the clearing of forests for agricultural expansion, particularly in the tropics, has contributed approximately a quarter of the increase in carbon dioxide in the atmosphere since the industrial revolution[2]. Forestry (including deforestation) continues to account for 17.4%[3] of the global annual greenhouse gas emissions attributed to human activity.

However, providing forests are managed in a sustainable way, they perform a vital role as carbon stocks and sinks, representing an important means of removing carbon dioxide from the atmosphere (Box 3.1). Globally, forests store 289 GtC (1060 $GtCO_2e$) in biomass alone; forest biomass and forest soils and litter combined contain more carbon than the atmosphere[4] (Box 3.2).

If these natural and managed 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. Carbon in forest soils is particularly important (Figure 3.1), as a greater proportion is often stored in the soil than the biomass, especially on peat-based soils.

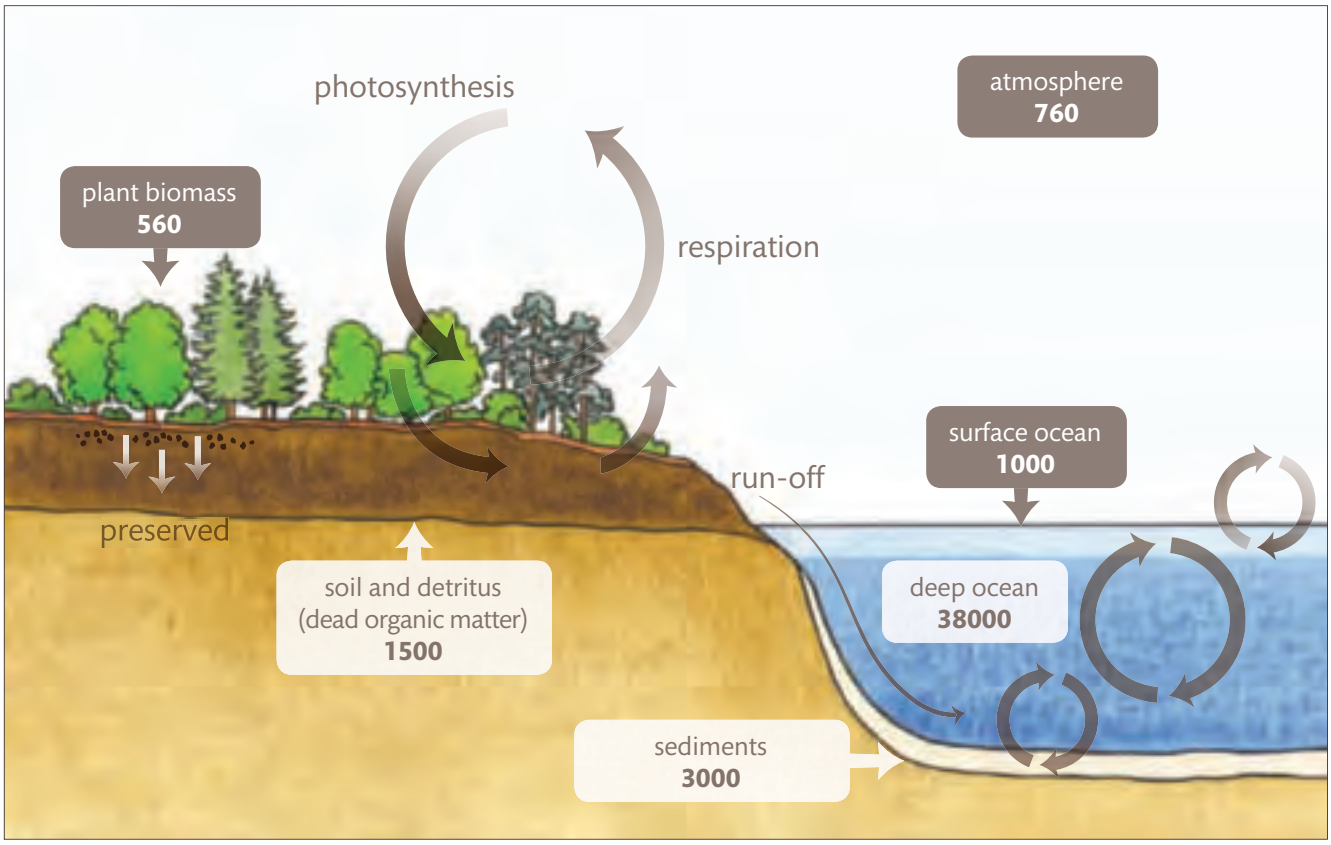
In addition to carbon sequestration, forests contribute to climate change mitigation as a source of renewable energy and sustainable wood products. It has been estimated that, in 2030, the total mitigation potential of global forests amounts to nearly 13 800 $MtCO_2$ per year (3800 MtC per year), as shown in Table 3.1.

Figure 3.1 Breakdown of carbon storage by carbon pool and region (from UNEP Vital Forest Graphics).



[1]The Met Office (www.metoffice.gov.uk/hadobs).
[2]Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.
[3]Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.
[4]Global Forest Resources Assessment. (FAO, 2010).

Figure 3.2 The carbon cycle. The diagram shows the six main global reservoirs of carbon. The boxed numbers are the sizes of the reservoirs in 10^{12} kg.



Box 3.1 Carbon in forests

The accumulation of carbon in forests is often referred to as 'carbon sequestration'. In a legal context, sequester means to seize temporary possession of something. This gives a good analogy with the pattern of carbon dynamics, highlighting four important features:

- Individual atoms of carbon are continually being exchanged between the atmosphere and forests and woodlands; in other words, an individual atom is only captured from the atmosphere temporarily.
- Over the lifetime of a forest more carbon atoms are captured than are released so there is net accumulation of carbon in the forest.
- Carbon is only accumulated by a stand of trees up until the point when equilibrium is reached, so that the quantity of carbon accumulated is finite.
- The accumulation of carbon by a forest is reversible, as carbon being sequestered can be returned to the atmosphere through dieback, decay, the burning of wood or disturbance of the soil.

The carbon balance of a forest needs to take into account the exchanges or fluxes of carbon between the atmosphere and the different components of a forest ecosystem, including the forest soil. The sum of all the carbon in the forest ecosystem is known as the 'carbon stock' of the forest. A particular carbon balance may be described as representing a 'sink' (resulting in carbon sequestration) if there is a net transfer of carbon from the atmospheric carbon dioxide to the forest.

Box 3.2 Facts and figures

- The six greenhouse gases as defined by the Intergovernmental Panel on Climate Change (IPCC) for reporting purposes are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). Apart from carbon dioxide, those relevant to forestry are methane and nitrous oxide.
- The 'global warming potential' (GWP) of methane and nitrous oxide, over a 100-year time horizon is, respectively, 25 times and 298 times that of carbon dioxide[a]. Therefore, total greenhouse gas amounts are sometimes expressed as CO_2e (carbon dioxide equivalents) by using these conversions where more than one greenhouse gas is being considered.
- In 2009 annual UK greenhouse gas emissions were 566 megatonnes (Mt) of CO_2e per year (of which about 474 Mt were CO_2)[b].
- 1 megatonne (Mt) is 1 000 000 tonnes. 1 gigatonne (Gt) is 1000 megatonnes or 1 000 000 000 tonnes.
- To convert carbon (C) to carbon dioxide (CO_2), multiply by 44/12 (approximately 3.7).
- The annual average rate of carbon dioxide removal from the atmosphere, over a typical 40-year rotation of Sitka spruce, is around 13.5 tCO_2 (3.7 tC) per hectare per year – taking into account initial losses from soil respiration stimulated by site preparation. Established mixed oak–ash forest in southern England removes carbon dioxide from the atmosphere at around 15 tCO_2 (4.1 tC) per hectare per year[c].
- In 2009 woodlands in the UK removed 12.7 $MtCO_2$ (3.5 MtC) per year[b]. The sequestration rate is predicted to fall to 10.6 $MtCO_2$ (2.9 MtC) per year by 2011[d].
- One tonne of (oven-dried) wood contains approximately half a tonne of carbon (1.8 t of carbon dioxide)[e].
- Woodlands in the UK can accumulate up to 218 tC (800 tCO_2) per hectare in biomass[c].
- The estimated carbon stock of UK woodlands (including their soils) is approximately 790 MtC (2900 $MtCO_2e$). Of this, 150 MtC is contained in biomass and 640 MtC in soil[c].
- The estimated carbon stock in harvested timber and wood products is around 80 MtC (290 $MtCO_2e$)[c].
- One tonne (or 4 m^3) of woodchip has a calorific value of 3500 kWh, equivalent to about 0.3 tonnes (or 350 litres) of heating oil[f].

[a] Contribution of Working Group I to the Fourth Assessment Report of the IPCC.
[b] DECC (2008). UK Greenhouse Gas Emissions.
[c] Read, D.J. *et al.* (2009). Combating climate change – A role for UK forests. TSO, Edinburgh.
[d] CEH (2009). Inventory and projections of UK emissions by sources and removals by sinks due to land use, land use change and forestry.
[e] Forestry Commission. (2003). Forests, carbon and climate change: the UK contribution. Forestry Commission Information Note.
[f] The Biomass Energy Centre Reference Library (www.biomassenergycentre.org.uk).

Table 3.1 Global mitigation potential of forestry activities in 2030.

	Mitigation potential in 2030 ($MtCO_2$ per year)			
	Afforestation	Reduced deforestation	Forest management	Total
North America	445	10	1 590	2 045
Europe	660	95	1 225	1 980
Central and South America	750	1 845	550	3 145
Asia and Pacific	1 465	810	2 270	4 545
Africa and Middle East	725	1 190	145	2 060
Global	**4 045**	**3 950**	**5 780**	**13 775**

Note: global model results indicate annual amount sequestered or emissions avoided, above business as usual (the assumption that trends in forestry activities continue as at present) in 2030 for carbon prices 100 US$/$tCO_2$ and less. These figures refer to biomass only and do not take account of soil carbon. Adapted from the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (Working Group III, Chapter 9, Table 9.3).

Forestry and climate change

Over the coming decades UK forestry needs to respond to climate change in two principal ways: through mitigation and adaptation.

Climate change mitigation

Climate change mitigation was defined by the IPCC in its Fourth Assessment Report as 'a human intervention to reduce the sources or enhance the sinks of greenhouse gases'. In the context of forestry, it means establishing new woodlands and managing existing woodlands and wood products sustainably to enhance their potential as a sink of greenhouse gases (see Figure 3.4).

Forests and carbon capture

Forests capture carbon and store it as a component of wood itself. Over time, forests can enrich the soil carbon content through the addition of organic matter from leaf litter, branch fall 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. Carbon flux measurements have shown that productive conifer forests can sequester around 13.5 tCO_2 (3.7 tC) per hectare per year over a typical 40-year rotation, taking into account initial losses from soil respiration stimulated by site preparation[5].

The stock of carbon in the biomass of the 3 million hectares of UK woodland is 150 MtC (550 $MtCO_2$) and the net carbon uptake is predicted to be 10.6 $MtCO_2$ per year in 2011 (see Box 3.2). The annual uptake of carbon by UK woodlands is currently declining from a maximum of 15 $MtCO_2$ per year in 2004. This decline can be explained by the age structure of UK forests; many of the 40-year-old (and older) conifer plantations established during the 1950s to 1980s, which have a high uptake, have been felled and replanted since 2004.

Much of the woodland in the UK is not managed for timber harvesting and gradually accumulates carbon in woody biomass and in the soil. Long-established woods with old trees can represent a large carbon store but, in the long term (many hundreds of years), the ecosystem approaches equilibrium when carbon gained through growth may be balanced by carbon lost to the atmosphere through decomposition. Sustainable forest management, including the transfer of carbon stored in the forest to wood products, will maintain woodlands as a net carbon sink.

Around 640 MtC (2350 $MtCO_2$) is stored in forest and woodland soils in the UK[5]. In general, woodland soils have low and infrequent levels of disturbance, particularly under continuous cover management systems, and, for a given soil type, the total carbon content per unit area of woodland is higher than that for agricultural soils.

Some forest operations, such as ground preparation to establish trees, may result in a short-term loss of carbon from the soil until this is replaced as forests grow. The aim of these UKFS Guidelines on *Forests and Climate Change* is to minimise short-term losses, while recognising that some level of disturbance is necessary for successful woodland establishment and management. This will deliver the benefits of carbon capture over the longer term (see also the UKFS Guidelines on *Forests and Soil)*.

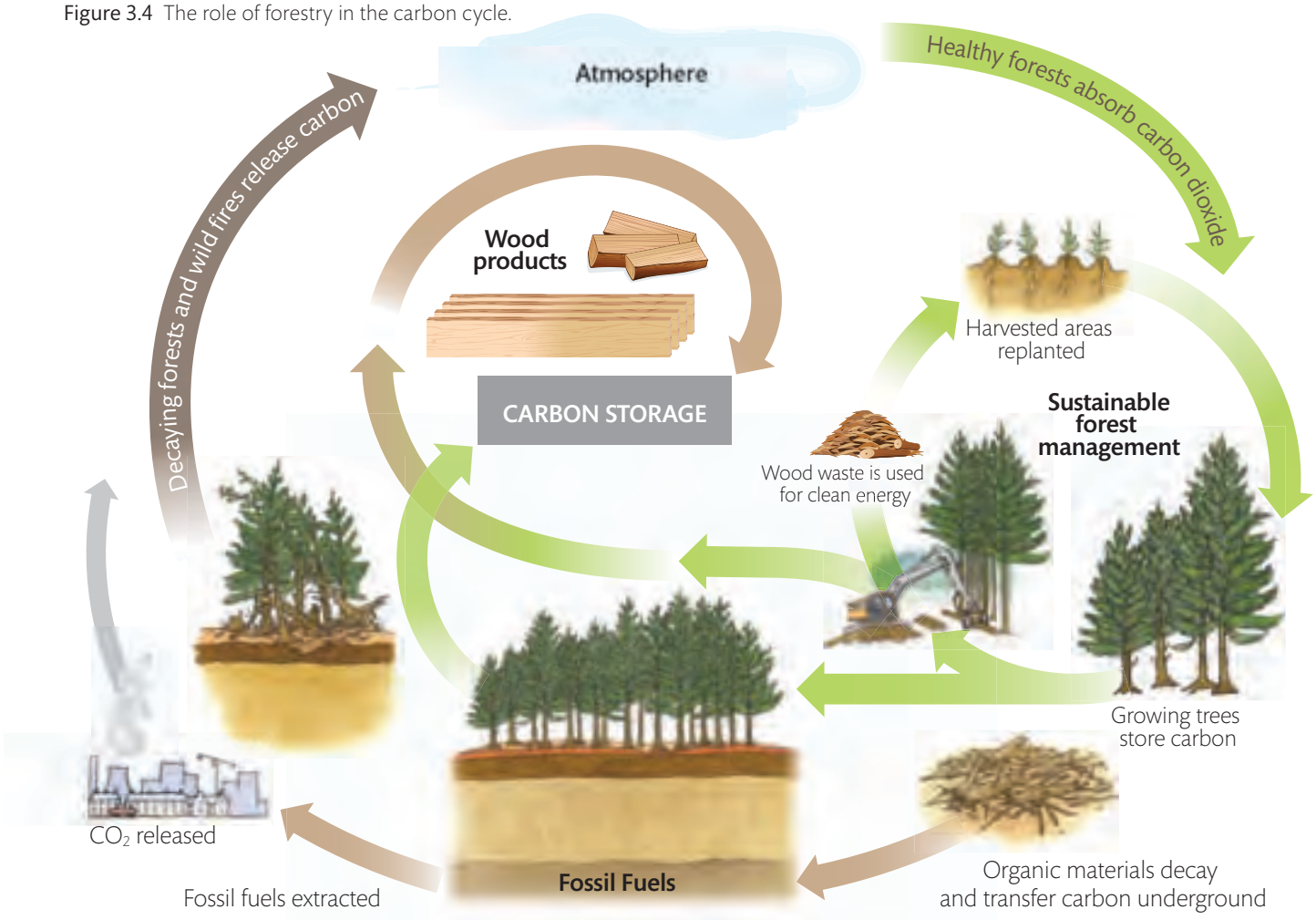
Carbon in timber and wood products

Carbon comprises about 50% of the dry weight of wood. Timber and wood products can be used for a variety of purposes (Figure 3.3), and the longer they remain in use, the longer the carbon is stored. Subsequent recycling can extend carbon storage in wood even further and, at the end of its life, it may be burned to generate heat or energy and substitute for fossil fuels. Even if wood is sent to landfill, it continues to store carbon until it eventually decomposes.

Figure 3.3 Wood can be used as a sustainable building material, as shown here at a new Forestry Commisson visitor centre.

[5]Combating climate change – A role for UK forests (TSO, 2009).

Figure 3.4 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. Older forests release carbon at the same rate that they absorb it, which has a neutral effect on the carbon cycle.

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.

Wood can be used as a sustainable building material in many situations as a substitute for energy-intensive materials such as concrete and steel. In addition to its inherent renewability, timber requires less processing energy than many other materials. For example, a tonne of brick requires four times the amount of energy to produce than sawn softwood; concrete five times; glass six times; steel 24 times; and aluminium 126 times[6]. If the timber and wood products sector continues to increase as it has done in recent years, there is potential to store an estimated additional 10 MtC (37 $MtCO_2e$) in new and refurbished homes in the UK between 2010 and 2020[7].

Woodfuel

Substitution benefits also arise when wood is used as fuel to replace fossil fuels such as coal, gas or oil. For example, in a full life cycle analysis for electricity generation, woodchip (Figure 3.5) generates 58 kg carbon dioxide emissions per megawatt hour (MWh) whereas that produced via the national grid generates 530 kg carbon dioxide per MWh. For direct heating, woodchip generates only 25 kg carbon

[6]Wood for Good – Facts and Figures.
[7]Combating climate change – A role for UK forests (TSO, 2009).

Figure 3.5 Woodchips can be used to generate heat and power in both large and small-scale installations.

dioxide per MWh whereas coal generates 484 kg carbon dioxide per MWh and natural gas 270 kg CO_2 per MWh[8].

Although burning wood generates carbon dioxide, an equivalent amount of carbon dioxide was relatively recently sequestered from the atmosphere as the trees grew. In this way, woodfuel can be seen as being close to carbon neutral, and a valuable sustainable substitute for fossil fuel. It is not completely carbon neutral, as carbon dioxide is emitted during harvesting, transport and processing. It is estimated that the total greenhouse gas emission in the UK associated with forest machine operations is 0.26 $MtCO_2e$ per year – or around 2% of the carbon sequestered by UK woodlands in 2009[9].

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 woodland, but may not provide as wide a range of other benefits, such as for biodiversity and recreation. Harvesting forest residues such as brash and stumps also represents a potential source of woodfuel. However, the harvest of these materials is only suitable under certain conditions. The Guidelines in Section 6 provide more detail.

All types of forest and woodland can sequester and store carbon and this is likely to become an increasingly important consideration when setting management objectives. In addition, sustainable forest management and woodland expansion could have an important part in the transition to a society less reliant on fossil fuel, while simultaneously generating a range of environmental, social and economic benefits.

Climate change adaptation

Adaptation was defined by the IPCC in its Fourth Assessment Report as initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects. In the context of forestry, it means reducing the vulnerability of forests – as well as using forests to reduce the vulnerability of society to climate change.

Climate change projections

Annual average temperatures in central England have risen by about 1°C since 1970 and there has been a change in seasonal rainfall patterns, with winter rainfall increasing and summer rainfall declining. Warming has been greater in winter than in summer, particularly in the south and east of the UK[10]. The most visible effects of these changes have been to the timing of natural events: for example, bud break of oak in southeast England has advanced by three weeks since the 1950s[9].

Climate projections show the likely future climate of the UK[10]. The projections quantify the likelihood of future changes under three greenhouse gas emissions scenarios (high, medium and low). The projections of climate change take into account uncertainty due to natural variability and modelling by giving the probabilities of a range of outcomes. These projections allow for the development of risk-based approaches to climate change adaptation.

Climate projections for the UK indicate increases in mean summer temperature of 3–4°C by the 2080s under the medium emissions scenario[10]. Increases are greater to the south and east. The projections also suggest that, although there will be little change to total annual rainfall, summer rainfall will decrease while winter rainfall will increase. As a result, summer droughts may become more frequent and severe. A larger proportion of rainfall is likely to occur during extreme events, in summer and winter, extending the duration of winter waterlogging and increasing the severity of summer flooding – as well as increasing soil erosion and the frequency of landslips. Projections also indicate that cloud cover, particularly in summer, will decline.

[8]The Biomass Energy Centre Reference Library (www.biomassenergycentre.org.uk).
[9]UK Combating climate change – A role for UK forests. (TSO, 2009).
[10]UK Climate Projections. (Defra, 2009).

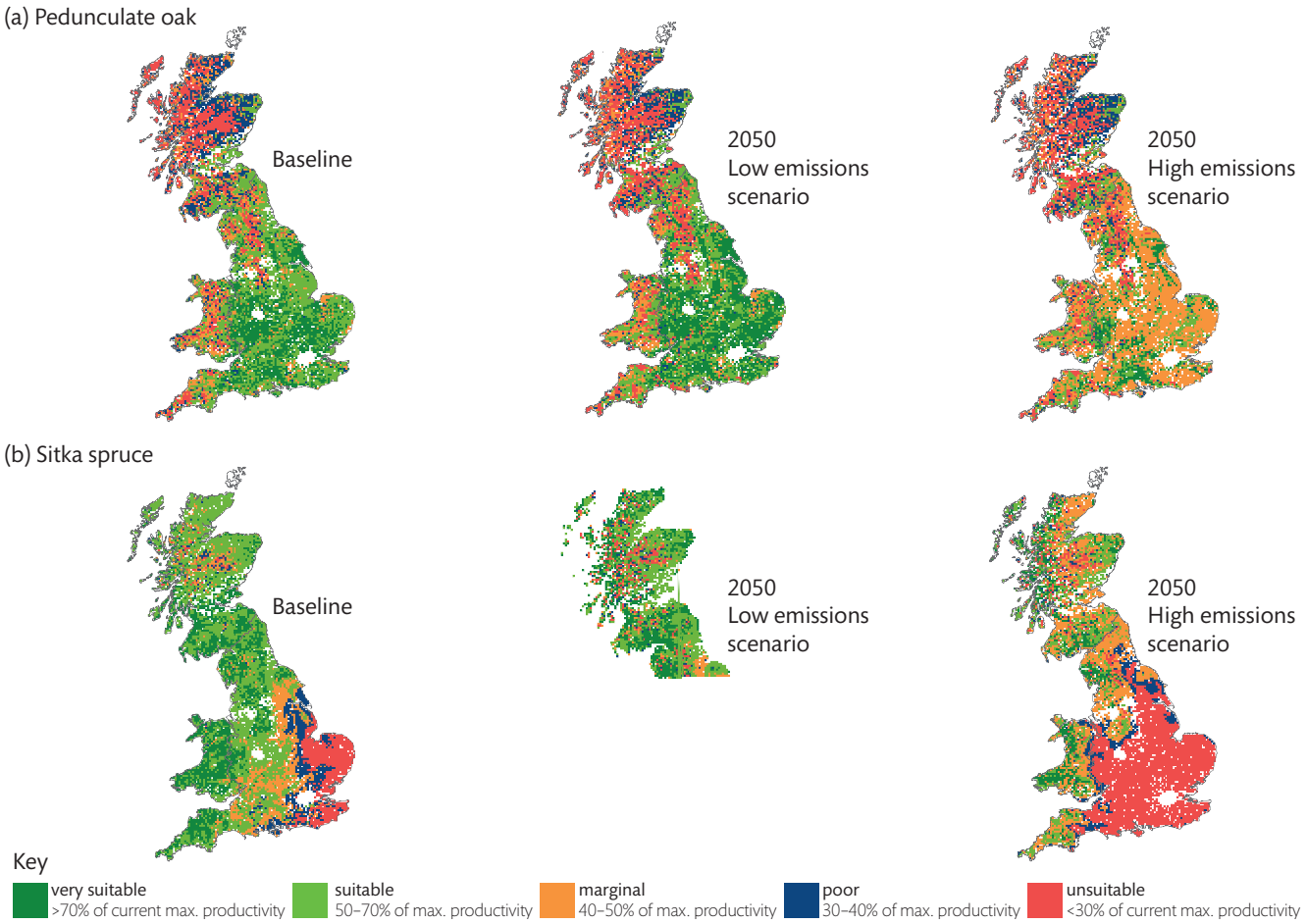
Impacts on tree growth and forest productivity

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[9]. Other changes in the atmospheric environment may also have impacts, including changes in nitrogen and sulphur deposition and increased levels of ozone pollution. There are also likely to be a number of new and indirect effects on woodlands 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.

However, it is still uncertain exactly how trees will respond to the likely changes in climatic variables or how woodland ecosystems as a whole will be affected. Irrespective of future success in reducing emissions, the global climate is already locked into a level of change that will require adaptation responses. 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 and woodlands from climate change. There is a very high likelihood that there will be serious impacts on drought-sensitive tree species on shallow, freely draining soils, particularly in the southern and eastern areas of Britain. These impacts will be widespread in established stands and they will mean that the suitability of species for use in commercial forestry in all regions will need to be re-assessed (Figure 3.6).

Figure 3.6 The 'suitability' (productivity relative to maximum productivity achievable by that species under current climatic conditions) for (a) pedunculate oak, and (b) Sitka spruce under Baseline (1961–90, left) and UKCIP02 Low emissions (centre) and High emissions (right) climate change scenarios for 2050.



Approaches to adaptation

The IPCC describes adaptation measures under three categories:

- Autonomous adaptation: occurs automatically as a response to climate change, rather than as a conscious response to anticipated change. It is triggered by ecological changes in natural systems, and by market or welfare changes in human systems.

- Planned adaptation: is the result of a deliberate policy, based on an awareness that conditions are in the process of change and that action is required to maintain, or regain, the desired state.

- Anticipatory (or proactive) adaptation: takes place before impacts of climate change are observed.

For the long timescales of forestry, anticipatory adaptation involves risks because climatic change projections are uncertain. However, it offers the highest potential gains for ensuring forests, and the benefits they provide, are maintained in the future.

Climate change uncertainties, coupled with the long timescales of forestry, suggest that resilience to climate change will be a key attribute for most types of forests and woodlands. However, in developing resilience, a balance is required to ensure that, as far as possible, the integrity of existing ecosystems is maintained. Appropriate choice of species and origin, diversity in species and structure, and effective stand management may all help to build resilience. These measures will also develop the management flexibility required for forests to thrive in a changing environment.

Forests and woodlands can help people and society adapt to climate change by providing a range of benefits such as:

- provision of habitats that provide ecological connectivity;
- natural flood management;
- diffuse pollution control;
- slope stability and control of soil erosion;
- a source of renewable energy;
- temperature control;
- shade and shelter.

Woodlands will contribute these benefits in varying amounts dependent on their location, woodland type and the soil type. In particular:

- Urban and peri-urban woodlands: provide shade and reduce temperature, so ameliorating the 'heat island' effect in towns, and reduce wind speed (Figure 3.7).
- Trees on farms: provide shade and shelter for animals, habitats that contribute to ecological connectivity, and a source of renewable energy.
- Protection forests: contribute to natural flood management (Figure 3.8), slope stability, and the control of soil erosion.

The various benefits of forests can be described as 'ecosystem services' and they contribute to wider sustainable development objectives (see Section 3 of *The UK Forestry Standard*). Ecosystem services provide a rationale for balancing the benefits of forestry in the local context to serve the wider needs of society.

Figure 3.7 Trees, such as these in Cardiff city centre, can help to moderate the climate in urban areas.

Figure 3.8 Woodlands planted on floodplains can alleviate floodwaters.

4. Policy and context

At the Earth Summit in 1992 most countries joined an international treaty – the United Nations Framework Convention on Climate Change – to begin to consider what can be done to reduce global warming and to cope with whatever changes to our climate are inevitable. More recently, a number of nations approved an addition to the treaty, the Kyoto Protocol, which has more powerful, and legally binding, measures.

This section provides further background, gives an overview of the developments relevant to forests and climate change, and summarises the main statutes. Further details of legislation and conventions are provided in Appendix 1, UK and country-level strategies and delivery mechanisms are summarised in Appendix 2.

International context

The United Nations Framework Convention on Climate Change (UNFCCC) is an international environmental treaty established at the UN Conference on Environment and Development (the 'Earth Summit'), in 1992. The treaty is aimed at reducing emissions of greenhouse gases in order to combat global warming.

The UNFCCC came into force in March 1994 and has been ratified by the UK and over 180 other countries. The stated objective of the convention is: 'to achieve stabilization of greenhouse gas concentrations in the atmosphere at a low enough level to prevent dangerous anthropogenic interference with the climate system'.

Kyoto Protocol

The Kyoto Protocol is an international agreement linked to the UNFCCC. Industrialised (Annex 1) countries that ratified this protocol, including the UK, are committed to reduce their emissions of carbon dioxide and five other greenhouse gases, or engage in emissions trading if they maintain or increase emissions.

The important distinction between the Protocol and the Convention is that the Convention *encouraged* industrialised countries to stabilise greenhouse gas emissions, while the Protocol *commits* them to do so. The major feature of the Protocol is that it sets binding targets for 37 industrialised countries and the European community for reducing greenhouse gas emissions. These amount to an average of 5% against 1990 levels over the five-year period 2008–12.

Forestry and climate change in the EU

A number of commitments have been made by the EU Member States and the European Commission in the Ministerial Conferences on the Protection of Forests in Europe (MCPFE), which reflect the need for action on European forests, including addressing climate change. These commitments were developed in successive Resolutions on Forests and Climate Change at the Conferences in Helsinki (1993), Vienna (2003) and the 2007 Warsaw Declaration. The declarations commit signatory countries to play an active role in addressing climate change through the role that forestry can play in both mitigation and adaptation.

The *EU forestry strategy* and the *EU forest action plan* (outlined in the UKFS) contain an action directly relevant to climate change adaptation:

> Key Action 6: Facilitate EU compliance with the obligations on climate change mitigation of the UNFCCC and its Kyoto Protocol and encourage adaptation to the effects of climate change. The Commission will continue to support research, training and studies on the impact of and adaptation to climate change. The Member States are invited to work on assessing the impacts of climate change, to raise awareness and to exchange experience, as well as to promote activities for mitigation and adaptation.

In April 2009 the European Commission initiated moves towards a European framework for tackling climate change and its implications. The role of forests and forest

protection is included and this is likely to lead to co-ordinated action at EU level.

UK climate change programmes

The UK's contribution to the reduction of greenhouse gas emissions is led by the Department of Energy and Climate Change. The Climate Change Act 2008 includes significant powers in relation to mitigation, reporting and adaptation. These are outlined below. The Committee on Climate Change was established under the Act as an independent, expert committee to advise Government on carbon budgets and to scrutinise progress on an annual basis.

The Act contains provisions that set a legally binding target for reducing total greenhouse gas emissions in the UK and introduced a framework of consecutive five-year carbon budgets, which set the trajectory towards the 2050 target. The Act commits the UK to a reduction of at least 80% by 2050 against the 1990 baseline. In 2009 the first three carbon budgets were set covering 2008–22 and require greenhouse gas emissions to be reduced by at least 34% by 2020. The level of the fourth carbon budget (2023–27) was announced in 2011 and policies and measures to deliver it will be published in the UK *Carbon plan*.

Under the terms of the Act and the UK's reporting requirements under the Kyoto Protocol, the UK greenhouse gas emissions inventory will include greenhouse gas emissions and the uptake associated with afforestation, deforestation and forest management. While the Act does not regulate specific sites or forestry activities, it may be used to establish an economic rationale for forestry activities and the development of trading schemes for the purpose of limiting greenhouse gas emissions.

The *Adapting to climate change programme* drives and co-ordinates work on domestic adaptation across Government. The programme aims to deliver the adaptation-related requirements of the Climate Change Act. This includes undertaking the UK's first climate change risk assessment by 2012, which includes forestry as one of eleven sectors and developing a statutory national adaptation programme responding to the risks identified by the assessment.

In Scotland, the Climate Change (Scotland) Act 2009 sets a legally binding greenhouse gas emissions reduction target of 80% by 2050 compared with 1990 levels, together with an interim target of 42% by 2020 and a requirement to set annual targets. As required by the Act, the Scottish Government has set out its proposals and policies for meeting these targets in *Low carbon Scotland: meeting emissions reduction targets 2010–2022*.

The carbon benefits of wood biomass used to fire or co-fire power generation is recognised by the *UK renewables obligation*, which is designed to promote the generation of electricity from renewable sources in the UK. In 2011 the UK government also announced the introduction of a *Renewable heat incentive*.

The UK renewable energy strategy, published in 2009, sets a target for renewables to produce 15% of the UK's energy requirements by 2020. In turn, biomass has been identified as having the potential to meet 33% of the renewables target with woodfuel and forestry activity making a significant contribution. *The UK low carbon transition plan* plots how the UK will meet the commitments of The *UK renewable energy strategy*. The *2020 routemap for renewable energy in Scotland* has a target of an equivalent of 100% demand for electricity from renewable energy, as well as 11% of heat to come from renewable sources by 2020.

Forests and climate change in the UK

Managing forests and woodlands in the UK sustainably means balancing their contribution to a widening range of objectives, including environmental, economic and social benefits. Felling trees is part of a sustainable cycle, provided that young trees are re-established or allowed to regenerate to ensure woodland continuity. Forests have been managed for timber and other products for hundreds of years while maintaining their biodiversity and value to society. The capacity of woodlands to mitigate and adapt to climate change has added a further critical objective to forest policy and a new dimension in sustainable forest management.

The UK approach to forestry and climate change is defined in terms of the following six key actions:

- protecting the forests that we already have;
- reducing deforestation;

- restoring forest cover;
- using wood for energy;
- replacing other materials with wood;
- planning to adapt to our changing climate.

The creation of new woodlands to sequester carbon, protect carbon in the soil and further integrate land uses are key policy themes across the UK. The UK Government has signalled its support for woodland creation in the UK Low Carbon Transition Plan and announced that it would support a new drive to encourage private funding of woodland creation. The governments in each country have expressed aspirational targets for creating new woodlands (Table 4.1).

Country forestry policies and strategies

In England, the Natural Environment White Paper *The natural choice: securing the value of nature* (2011) identifies the need to protect and improve England's forests and woodlands and increase woodland area to mitigate and adapt to climate change. The UK *Carbon plan* (2011) also outlines incentives aimed at woodland expansion and increasing the area of woodland that is managed. The Forestry Commission published a *Woodfuel implementation plan* in 2011.

In Scotland, the *Scottish forestry strategy* (2006) highlights climate change as a major theme, with a key role for forestry in adaptation, mitigation, carbon capture and storage, and raising public awareness. The delivery of these functions is set out in subsequent implementation plans. Forestry Commission Scotland also published a *Climate change action plan* in 2009.

In Wales, the Welsh Assembly Government strategy *Woodlands for Wales* identifies 'responding to climate change' as one of five strategic themes. Adapting Welsh woodlands to ensure their resilience to a changing climate is identified as an overarching priority. A prominent role is given to woodlands and trees in helping society deal with the effects of climate change, as well as other environmental pressures. The Strategy also identifies the role of woodlands and timber in helping to mitigate climate change through carbon storage and both direct and indirect fossil fuel substitution. In this context, a particular emphasis is placed on sustainable forest management as the main delivery method for these ambitions.

In Northern Ireland, reference to the role of forestry and climate change appears in *Northern Ireland forestry: a strategy for sustainability and growth* as part of a joint approach by Northern Ireland government departments. The Strategy states that:

> Forestry practices can make a significant contribution to reducing greenhouse gas emissions through increasing the amount of carbon removed from the atmosphere by the national forest estate, by burning wood for fuel, and by using wood as a substitute for energy-intensive materials such as concrete and steel.

The Department of Agriculture and Rural Development has a long-standing programme to increase the level of forest cover in Northern Ireland by expanding the publicly owned estate and supporting private landowners.

Table 4.1 Aspirations for woodland creation across the UK.

Country	Aspiration	Expressed in
England	Increase woodland cover from 10% to 13% by 2060 (an average of 8000 hectares per year)	Natural Environment White Paper (2011)
Scotland	Increase forest area from 17% in 2006 to 25% by mid 21st century (approximately 10 000 hectares per year)	Low carbon Scotland: meeting the emissions reduction targets 2010–2022
Wales	Create 100 000 hectares of new woodland between 2010 and 2030 (or 5000 hectares per year)	Ministerial announcement (2010)
Northern Ireland	Double the area of forest from 6% to 12% from 2006 to 2056 (approximately 1700 hectares per year)	Northern Ireland forestry: a strategy for sustainability and growth (2006)

Standards for carbon sequestration

The practice of planting trees and forests to sequester carbon from the atmosphere to compensate for greenhouse gas emissions has become increasing popular. Many individuals and businesses have invested in tree planting schemes, which have sometimes been of variable quality. The Forestry Commission, in collaboration with other partners, has developed a new code designed to bring robust standards to the forest carbon market. The Woodland Carbon Code sets voluntary standards for woodland projects in the UK that make claims about the carbon they sequester. It clarifies good carbon management in addition to sustainable forest management practice set out in the UKFS and supporting Guidelines (www.forestry.gov.uk/carboncode).

In 2009, the UK Government produced guidance on how organisations should measure and report their greenhouse gas emissions. Woodland creation has not previously been eligible as an activity to be included in the calculation of an organisation's net greenhouse gas emissions, even if the organisation is directly responsible for the planting of the new woodland. However, a newly published annex to the UK Guidance (Annex L) now recognises the carbon benefits of woodland creation and allows organisations that invest in or are directly associated with projects certified to the Woodland Carbon Code, to report those carbon savings as part of their net greenhouse gas emissions. For more information see: www.defra.gov.uk/environment/economy/business-efficiency/reporting.

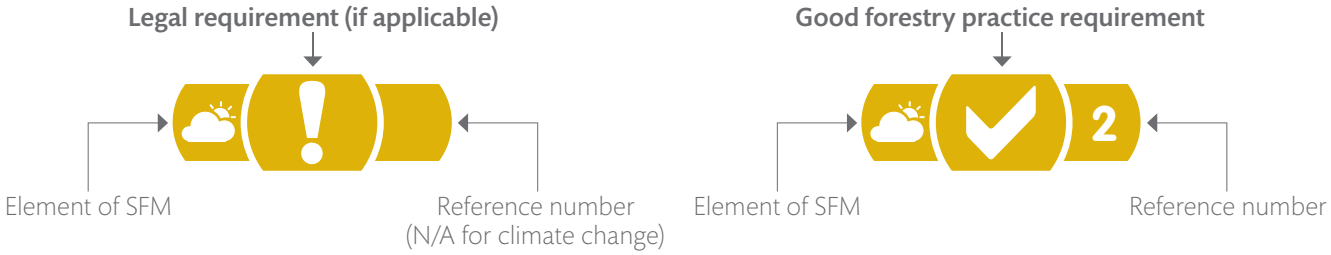
Carbon sequestration resulting from projects certified to the Woodland Carbon Code will, in common with other woodland creation, contribute directly to the UK's national targets for reducing emissions of greenhouse gases. The Woodland Carbon Code does not provide a route to conformance with regulatory carbon 'offsetting' schemes (e.g. the Carbon Reduction Scheme or EU Emissions Trading System) or the generation of internationally tradable carbon credits linked to either the compliance or voluntary markets.

5. UKFS Requirements: Climate Change

The UKFS Requirements for Climate Change are set out in this section (see Section 2 for further information). The UKFS Requirements for General Forestry Practice are given in the UKFS itself and in Appendix 3 of this publication.

Key to symbols

Requirements



Cross-references

Cross-references may be made to the other elements of sustainable forest management (SFM), where the Requirement is common to more than one subject.

- General Forestry Practice
- Forests and Biodiversity
- Forests and Climate Change
- Forests and Historic Environment
- Forests and Landscape
- Forests and People
- Forests and Soil
- Forests and Water

The UKFS Requirements outline the main legislation and are intended as a source of advice. You are advised to consult the relevant statutes for more information and the definitive legal text.

Climate change mitigation

The climate change programmes of the UK and of England, Scotland, Wales and Northern Ireland 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 – for example beyond the first rotation where trees are being grown for timber – of the forest carbon stock 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.

Forest management should contribute to climate change mitigation over the long term through the net capture and storage of carbon in the forest ecosystem and in wood products.

Climate change adaptation and protection

Climate change will have an impact on forest ecosystems in the UK and this will present both risks and opportunities for forestry and the achievement of management objectives. These must therefore be taken into account in forest management plans. Risks include tree mortality, fire, extreme weather events, and pest and disease outbreaks. Opportunities include potential increases in productivity and the range of species that can be grown. The understanding of climate change impacts and the risks to forests is likely to change over time. It is therefore recognised that forest owners and managers will need to base decisions on the current available evidence and advice on good practice.

Forest management should maintain or enhance the resilience of forests and forest ecosystems in order to reduce the risks posed by climate change to their sustainability.

Forest management should enhance the potential of forests to protect society and the environment from the various effects of climate change.

6. UKFS Guidelines: Climate Change

Guidelines on meeting the UKFS Requirements for Climate Change are set out in this section. Guidelines on meeting the UKFS Requirements for General Forestry Practice are given in the UKFS itself and in Appendix 3 of this publication.

Key to symbols

Guidelines

Cross-references

Cross-references may be made to the other elements of sustainable forest management (SFM), where the Guideline is common to more than one subject.

- General Forestry Practice
- Forests and Biodiversity
- Forests and Climate Change
- Forests and Historic Environment
- Forests and Landscape
- Forests and People
- Forests and Soil
- Forests and Water

The table below introduces factors important for forests and climate change. The Guidelines that follow provide more information on how to comply with the UKFS Requirements, grouped by the factor headings.

Factor	Importance for climate change
Mitigation	
Carbon in forest products	Forest products can substitute for more energy-intensive materials and can be used as a source of renewable heat and electricity.
Carbon in soils	Soils contain the major proportion of carbon in the forest ecosystem. It takes decades or centuries to accumulate but can be rapidly lost through disturbance.
Carbon in forest ecosystems	Forestry can contribute to climate change mitigation by protecting and increasing forest carbon stocks.
Operational carbon footprint	Reducing fossil fuel usage in management activities can enhance the role of forestry in climate change mitigation.
Adaptation	
Forest planning	Forest design, structure and composition needs to be resilient to the effects of a changing climate and extreme weather events.
Adaptive management	Approaches to management that are flexible, reactive and anticipatory will help forests and woodlands adapt to the changing climate.
Tree and shrub species selection	Introducing diversity in tree species and origins will ensure some thrive should others decline.
Landscape ecology	Woodland and trees can be used to develop ecological connectivity between habitats to enhance the ability of woodland ecological communities to adapt to climate change.
Environmental protection	Woodland and trees that are appropriately located can help to alleviate the impacts of climate change on society and the environment.

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 through:

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

Given a sufficient forest area, it is generally possible to increase forest carbon stocks over the long term, i.e. at least one forest rotation. However, woodland delivers a range of public benefits and there may be times when the balance favours other management priorities. An example is ancient woodlands, where limited intervention to meet biodiversity objectives may be appropriate and maximising carbon capture would be a secondary objective.

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 energy-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 woodland 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 a number of 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 likely to be limited due to the energy expended in their extraction and transport, and also from the release of carbon from soil disturbance (see Carbon in soils below). 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 and that there will be a net carbon gain as a result of the activity over the forest cycle (see the UKFS Guidelines on *Forests and Soil*).

Where woodlands are managed for timber production, maximise carbon sequestration through efficient management, consistent with the output of durable products.

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

3 Avoid removing stumps unless for tree health reasons or where a risk-based assessment has shown that adverse impacts can be reduced to acceptable levels. 15

Carbon in soils

In general, forest soils have high levels of carbon and maintaining the forest area will help ensure these stocks of carbon are protected. Soil organic matter can decompose to release carbon dioxide when soils become aerated as a result of disturbance or drainage. This effect is most marked in the deeper organic or peat soils, although it is important to consider fluxes of all the greenhouse gases – especially methane. On most soils, long-term carbon gains through new woodland establishment are likely to outweigh initial carbon losses due to soil disturbance. Forest management that minimises intervention and results in reduced soil exposure or cultivation, such as continuous cover silviculture systems, will help preserve soil carbon stocks. The continual input of organic materials from leaf litter and decomposing roots will gradually increase the soil carbon content (see the UKFS Guidelines on *Forests and Soil*).

The carbon benefits associated with woodland creation are generally greatest on soils with a low content of organic matter, such as mineral soils. On some peat soils the magnitude of soil carbon losses due to disturbance and oxidation can be greater than carbon uptake by tree growth over the long term. For this reason, and for reasons of habitat and biodiversity value, there is a general presumption against forest establishment on deep peat soils, whether found in raised bogs or in blanket bogs. More detailed policies in relation to peat soils are determined at county level. Oxidation and habitat degradation can also result from changes to the local hydrology by planting adjacent to these sites.

4 Minimise the soil disturbance necessary to secure management objectives, particularly on organic soils. 13 17

5 Avoid establishing new forests on soils with peat exceeding 50 cm depth and on sites that would compromise the hydrology of adjacent bog habitats. 5 24

6 Consider the potential impacts of soil disturbance when planning operations involving cultivation, harvesting, drainage and road construction. 14 18

7 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. 7 20

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 woodland ecosystem carbon are found in ancient woodlands, mature woods managed for conservation, and continuous cover silviculture systems. 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.

Since the formation of the Forestry Commission in 1919, there has been an increase in forest cover in the UK and a general presumption against the removal of forests and woodlands. Net deforestation would reduce the capacity to sequester carbon and is counter to a number of international commitments on retaining forest cover. In recent years, rates of woodland creation have declined and there have been increasing pressures for woodland removal – both for development and for the restoration of priority open habitats. Where deforestation is proposed, an Environmental Impact Assessment (EIA) is likely to be required, and each case will have to be determined individually. All the various implications, including the practicality of habitat restoration, will need to be considered in the context of country-level policies on woodland removal. This assessment will include the effects on climate including the potential emissions of greenhouse gases (see the UKFS Guidelines on *Forests and Biodiversity*).

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

9 Retain or expand the forest area and consider compensatory planting where forest area is lost through land-use change. 4

10 Leave a proportion of standing and fallen deadwood: concentrate it 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. 10 23

11 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. 35 25

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 woodlands in 2008[11]). 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

[11]Combating climate change – A role for UK forests (TSO, 2009).

emissions is timber haulage, so shorter haulage distances to local markets and 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 woodfuel instead of fossil fuels, will all contribute towards minimising 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.

12 Plan forest operations, civil engineering and timber transport to minimise energy use; consider using sustainable biofuels. 28

13 Minimise the use of pesticides and fertilisers in accordance with Forestry Commission and Forest Service guidance. 23 5 57

14 Consider the use of timber for the construction of forest buildings and recreation infrastructure and the use of woodfuel for heating.

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

Adaptation

Forest planning

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 (see UKFS Requirements and Guidelines for General Forestry Practice – Appendix 3). Ensuring a forest is diverse in terms of age, structure, species and origin, genetic diversity and choice of silvicultural system is likely to endow forests with greater resilience to the changing climate. This should also keep a wide range of forest management options open.

Continuous cover forest management encourages structural and species diversity and evolutionary adaptation through the promotion of natural regeneration. Such management systems can also make woodlands more resilient to wind damage as, for example, there are always areas of established young trees should windthrow affect the canopy. Regular monitoring of woodlands will provide an early warning of potential problems in relation to climate change.

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, which take into account climate change projections, is available to assist with forest planning (see Further reading and useful sources of information). Changing rainfall patterns[12] will be relevant to operational planning, including the design and specifications for forest roads, culverts and bridges. Forest drainage which follows the

[12]UK Climate Projections (Defra, 2009).

advice in the UKFS Guidelines on *Forests and Water* will help ensure water is released slowly following heavy rainfall.

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

16 Plan for forest resilience using a variety of ages, species and stand structure; consider the risks to the forest from wind, fire, and pest and disease outbreaks. 6

17 Consider alternatives to clearfell systems, such as continuous cover forestry, where suitable sites and species combinations allow and management objectives are compatible. 13 18

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

19 Consider projections of changes to rainfall patterns when specifying designs for culverts, drainage systems and roads. 31

Adaptive management

Climate change adaptation will require a flexible, reactive and anticipatory approach to management. Detecting change through vigilance and effective monitoring is necessary to inform such an approach. For small, individual woodlands, published trends and associated guidance may suffice, but for larger forests some form of monitoring could help inform management decisions.

New threats may demand a change in silvicultural practice (e.g. to manage pests and diseases that may prosper in the future climate). This may necessitate changes to species selection or management practice: an example is red-band needle blight, which has meant that the planting of pine species has been severely curtailed in the UK, thus removing an important timber-producing species used in British forestry.

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

- rotation length – to reflect changing wind risk and growth rates;
- planting season – in response to changes in dormancy and water availability;
- mammal control – of deer, grey squirrels and other invasive species that threaten regeneration and growth;
- species choice – in relation to the changing climate and impacts of pest and disease outbreaks;

- the timing of operations – to avoid interfering with important breeding animals such as protected birds.

Review forest rotation lengths in response to changing productivity and wind risks, and review planting seasons in response to changing conditions and establishment success.

Review species suitability and diversity over time as forest management plans are renewed.

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

The plant and animal communities that colonised the British Isles following the last Ice Age around 10 000 years ago have developed in response to the prevailing climatic conditions. Species have adapted by moving to occupy suitable environments within the natural range of climatic fluctuation. However, the recent changes to the climate occurring as a result of human activities will potentially lead to more rapid change, shifting climatic regimes and more frequent extreme weather events. This will present both risks and opportunities for most natural and semi-natural populations – both for the trees themselves and to the pests and diseases that attack them.

The challenges of climate change now require thought to be given to ensuring that forests have the resilience to deal with future changes, and reflect the uncertainty associated with climate projections. The resilience of forests and woodlands can be improved by increasing diversity, which includes both species diversity and genetic diversity. Achieving species diversity in forests is a Requirement of the UKFS, and forest management plans will need to address tree species composition of the forest management unit (FMU) as a whole. In addition, there are more 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. Planting a variety of species, either in mixtures or in pure stands, can enhance the resilience of forests and woodlands to projected climate change. For productive forests, a broader range of timber species than have typically been planted in the past may therefore warrant consideration. For native woodlands, 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 new woodlands are 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, better matched to a drier site, or planting material of a more southerly origin that may be better adapted to the future climate. For example, in southern England, a proportion of species from warmer areas of continental Europe may offer advantages as climate change progresses.

Genetic diversity, in addition to species diversity, is important in the context of climate change. Genetic diversity – both within and between populations – varies at local and regional scales and may include distinctive genetic patterns or sub-species. The genetic diversity present in a population reflects its evolutionary history and determines its ability to respond to a changing environment: for example by developing resistance to pests and diseases, and adapting to climatic change. This applies to the trees and shrubs themselves and to the many other woodland species dependent upon them that may have co-adapted with tree populations over thousands of years. The comparatively long generation time for trees makes it particularly important that populations contain sufficient genetic diversity to be able to adapt to change.

Evidence suggests that most populations of trees in semi-natural woodlands contain high levels of genetic diversity, even in smaller and more isolated woods. Linking and expanding native woods using natural regeneration as part of a habitat network, or planting with well-adapted stock, will increase gene flows and strengthen the capacity of tree populations to adapt. Changes in the nature and composition of the woodland through natural selection and evolutionary adaptation will take place over time.

For all new woodlands it is vital that material is drawn from a broad genetic base. When planting native species and native woodlands 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 other origins from areas with conditions that are well matched to the predicted future climate at the planting site, in situations where climate change projections indicate that it may be necessary to do so. Advice on suitable origins for planting of native species can be obtained from country-specific policies and guidance.

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, developed by the Forestry Commission, 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.

23 Diversify forest composition so that no more than 75% of the forest management unit is allocated to a single species and a minimum of the following are incorporated:

- 10% open space;
- 10% of other species or ground managed for environmental objectives;
- 5% native broadleaved trees or shrubs.

Note: (i) Where more than one species is suited to the site and matches the management objectives, opportunities must be taken to further diversify the above species composition: this is important in the context of climate change. (ii) In woodlands of less than 10 hectares and in native woods the above proportions may be relaxed providing the adjacent land uses provide landscape and habitat diversity. 8 11

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

25 When selecting trees and shrubs for new woodlands, consider the risks and opportunities of climate change for particular species and regions to decide if alternative species or increased species diversity are merited. 13

26 Where timber production is an important objective, consider a wider range of tree species than has been typical of past planting, and consider the use of planting material from more southerly origins.

27 Choose trees or shrubs which are well adapted to the site and are drawn from a sufficiently wide genetic base of parent trees to promote future adaptation. 14

28 Encourage natural regeneration of native tree and shrub species to promote natural selection and climate change adaptation, and conserve distinctive genetic patterns – especially in and around semi-natural woodlands. 15

Landscape ecology

Woodlands 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 (see the UKFS Guidelines on *Forests and Biodiversity* for more information).

The location and composition of woodlands and appropriate design of woodland margins can facilitate the migration of species. Extensive woodlands comprising a diverse range of habitats and sites will help enhance the ability of individual species to endure as climate change progresses. Larger woodland areas contain more varied gene pools, facilitating evolutionary adaptation processes.

29 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. 8

Environmental protection

Woodland can help society and the environment adapt to the impacts of climate change through the alleviation of flooding, the control of soil erosion and by moderating temperatures in towns and cities. It is important that these aspects of adaptation are considered in the location of new woodlands and individual trees.

Trees generally use and intercept more water than other types of land use, increasing infiltration rates and reducing water run-off. Variations exist between conifer and broadleaved species, and upland and lowland areas, as well as between woodlands and energy crops such as short rotation coppice. Climate change could increase the effect of

forestry on water yields and low 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.

Forestry can have a range of effects on flood flows, which can differ from those on water yield, depending on the type and scale of forest operation. There may be opportunities to enhance floodwater storage through restoring forest wetlands and creating ponds and other storage features. The restoration of floodplain forests and riparian woodland could have an important role in reducing flood peaks, as well as providing many other environmental benefits.

Woodland has an important role in helping to reduce landslips and in minimising soil erosion that may become more prevalent with climate change. This is because:

- tree canopies reduce rainfall intensity on the soil;
- windbreaks reduce erosion of agricultural soils;
- riparian woodland stabilises river banks and reduces soil erosion;
- buffer areas alongside watercourses reduce diffuse pollution arising from agricultural activity.

Conversely, care is required to ensure that the type of woodland and choice of management regime do not increase the potential for landslips on vulnerable sites (see the UKFS Guidelines on *Forests and Water*).

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

- providing recreational opportunities close to where people live and work;
- providing cooling through evaporation from leaf surfaces and reflecting solar radiation;
- providing shade for comfort and reducing the incidence of UV-related health problems;
- 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.

In urban areas, the risk of new pests or diseases becoming established is high because a wide range of planting material is used – much of it is imported – and a range of exotic tree and shrub species is present in parks and gardens. Urban trees are frequently found in a more stressed environment (e.g. with air pollution, soil compaction and water availability issues), and warmer city climates may favour the establishment of some imported pathogens.

30 When siting new woodland, consider the potential benefits in relation to flood alleviation, improvement of water quality and other ecosystem services. 79

31 On steep slopes where there is a risk of slope failure or serious erosion, consider alternatives to clearfelling. 18 35

32 In urban situations, consider the potential benefits of woodland and trees in reducing the impacts of climate change.

33 Be vigilant for pests and diseases in forests and woodlands, particularly in urban areas where the risks of new problems are high. 22

7. Implementation and monitoring

The revised edition of the UK Forestry Standard and its supporting series of Guidelines have not changed the legal framework for forestry or introduced new regulations. The aim is to provide greater clarity by outlining the scope of relevant existing regulations, and using these, together with the principles of sustainable forestry, to define forest management requirements in a more explicit way.

This section explains the mechanisms for regulating forestry in the UK and ensuring that forests are managed sustainably according to UKFS Requirements.

The regulatory framework

The Forestry Commission has a range of powers under the Forestry Act 1967 (as amended) through which the primary regulatory powers over forestry in Great Britain can be exercised. In Northern Ireland, the equivalent role in respect of the Forestry Act (Northern Ireland) 2010 is performed by the Forest Service, an agency within the Department of Agriculture and Rural Development. Some legislation is specific to forestry, but much legislation of relevance to forest and woodland owners and managers has wider application to any land management activity. The implications for forest managers of the main statutes of relevance are set out in the UKFS Requirements (Section 5).

Forestry policy in England, Scotland, Wales and Northern Ireland is the responsibility of the respective governments. Their forestry policies and strategies set out the priorities and programmes agreed in each country. For the public forest estate, policy is applied directly by the Forestry Commission and the Forest Service. For other forests, policy is implemented through a range of regulatory instruments and incentives. The forestry authorities also fund research and provide advice and guidance to support policy development. Increasingly, forestry policy is delivered through or in partnership with a range of other departments of government, agencies and organisations.

Felling

Under the Forestry Act, it is illegal to fell trees in Great Britain without prior approval, although there are exceptions for trees below a specified size, dangerous trees, and very small-scale felling operations. Cases of illegal felling are rare, but suspected cases are investigated, and prosecution may ensue. Where trees are subject to designations, for example on Sites of Special Scientific Interest, the consent of the relevant statutory authorities is required for management activity. In addition, deforestation for the purposes of conversion to another type of land use may be subject to the Environmental Impact Assessment Regulations (see below).

In Northern Ireland, the Forestry Act (Northern Ireland) 2010, with its provisions for felling licences and felling management plans, now aligns more closely with Great Britain.

Restocking

There is a presumption against the removal of woodland and the loss of forest cover in the UK, and it is normally the case that felling approval is granted subject to restocking. Restocking is required as a policy priority linked to a number of national and international commitments to prevent forest losses worldwide and to mitigate the effects of climate change. In Great Britain, the Forestry Commission may serve a Restocking Notice, which requires restocking and establishment to take place.

In Northern Ireland, granting of a felling licence will be subject to conditions set out in a felling management plan, which may refer to the restocking of the land with trees. In addition, a restocking notice may be served following unauthorised felling. This provision of the Forestry Act will come into operation when subordinate legislation is made. There are some special cases in the UK where trees can be established elsewhere (usually referred to as compensatory planting) or permanently removed.

The permanent removal of trees may be sanctioned if there are overriding environmental considerations, for example to allow the restoration of important habitats;

such projects have to be individually assessed, taking into account the practicality of restoration, together with the implications for future management.

The removal of trees may also take place to enable development, authorised under the planning regulations, to proceed. Such developments may include alternative sustainable land uses such as windfarms or hydroelectric schemes. In such cases, all the arguments, including impacts on climate change through loss of forest cover, will need to be addressed within the framework of woodland removal policies at country level and the planning legislation. As deforestation is involved, an Environmental Impact Assessment is likely to be required.

Environmental impacts of forestry

Proposals for new planting (including short rotation coppice and Christmas trees), deforestation, and the construction of forest roads and quarries come under the forestry provisions of the EU Environmental Impact Assessment (EIA) Regulations. The Forestry Commission and the Department of Agriculture and Rural Development in Northern Ireland are responsible for the implementation of the Regulations, and will advise applicants about their scope and whether there is likely to be a need for an EIA. Forestry proposals that may have significant environmental impacts will require an EIA before approval is granted.

If an EIA is required, the applicant must prepare a comprehensive forest management plan, together with an exploration of the potential environmental impacts – this process will involve appropriate specialists. The applicant must submit an Environmental Statement to the forestry authority, and this and the EIA will be made available to the public and to the various statutory environmental authorities. The Forestry Commission or Department of Agriculture and Rural Development will take account of any comments received before making their decision.

The Environmental Liability Directive (2004/35/EC) establishes a common framework for liability with a view to preventing and remedying damage affecting the land, including damage to animals, plants, natural habitats and water resources. The Directive is the first EC legislation whose main objectives include the application of the 'polluter pays' principle. It requires those responsible for the most significant cases of environmental damage to take immediate action to prevent the damage occurring and to put right damage where it does occur.

Consultation on forestry proposals

The forestry authorities make provision for anybody to comment on forestry proposals before a decision is reached. The mechanisms for doing this vary across England, Scotland, Wales and Northern Ireland, and with the significance and extent of the proposal. Consultation is extensive where an Environmental Impact Assessment is involved. The minimum consultation requirement in Great Britain is that clearfelling applications, forest management plans (for the public forest estate and for other woodlands) and grant applications are entered on the Public Register of New Planting and Felling. The arrangements for viewing the Register are on the Forestry Commission website at: www.forestry.gov.uk/publicregister.

In addition to the Public Register, local authorities and other statutory bodies are sent details of proposals under formal consultation and notification procedures. This process ensures a wide range of views is taken into account. The majority of applications, often with amendments, are approved through this process. If objections are lodged and sustained, the Forestry Commission may ask for advice from an advisory committee, and/or refer to the appropriate forestry minister before arriving at a decision. The above procedures do not negate the requirements for forest and woodland owners to consult other statutory agencies with regard to particular woodlands, for example the conservation agencies in the case of Sites of Special Scientific Interest.

Plant health and forest reproductive material

The Forestry Commission and the Forest Service also exercise legal powers to prevent the entry and spread of non-endemic pests and diseases of trees, under the 1967 Plant Health Acts. Trade in forest reproductive materials (seed, plants or cuttings) is also controlled under the 2002 Forest Reproductive Material Regulations (as amended), which implement the EU Directive 1999/105/EC on the marketing of forest reproductive material.

Meeting UKFS Requirements

The UKFS Requirements in Section 5 provide the basis for assessing whether the UK Forestry Standard has been implemented. Guidelines for forest and woodland managers on meeting the Requirements are given in Section 6 of this publication for Climate Change, and in the rest of the Guidelines series for the other elements of sustainable forest management. The numbered Guideline points will enable an assessment to be made as to whether the relevant Requirements of the UKFS have been achieved.

The current regulatory mechanisms for forestry allow two options for the approval of forest and woodland management proposals:

- Felling licences
- Forest management plans

The forestry authorities also provide incentives to encourage the creation of new woodlands and the management of existing woodlands. The payment of grants is conditional on meeting UKFS Requirements.

Felling licences

The felling licence is a straightforward statutory instrument that gives permission to fell trees and is separate from the offer of incentives. There are many situations where a felling licence will be the most appropriate way to get approval for forestry proposals. Felling licences offer proportionate and expedient regulation to suit many UK situations, particularly where management activities are of limited scope, modest impact or infrequent occurrence.

In Northern Ireland, a felling management plan will be an integral part of a felling licence under the Forestry Act (Northern Ireland) 2010.

A felling licence gives the owner the legal authority to proceed on the basis of the discrete operational area and activity involved. The licence requires the applicant to submit a range of information and to exercise good forestry practice. However, the licence does not extend to the wider context and area covered by a forest management plan – as a result, there will be UKFS Requirements and Guidelines that are not relevant or applicable to the individual licence area.

While the Requirements and Guidelines that are relevant or applicable to the licence area must be complied with, the limited scope of a felling licence necessarily restricts the levels of assurance that can be provided in relation to sustainable forest management. Accordingly, the minimum levels of UKFS assurance provided by a felling licence will be confined to the discrete operational area and defined as:

- Legality.
- Environmental suitability to the site.
- Conservation of high-value habitats and protected sites.
- Protection of society values and the provision of opportunities for public comment.
- Protection of the forest area through a replanting condition.

Forest management plans

The forest management plan provides a more comprehensive basis for assessment that extends beyond the discrete operational area. This area is defined as the forest management unit (FMU). Forest management plans set proposals in a broader context, both in the area covered and over time. They also provide a clear statement of intention and allow proposals to be communicated to others. Forest management plans will be assessed for approval, monitored and periodically updated and their approval renewed. All publicly owned forests are managed using forest management plans which are available for public comment. The level of assurance provided by a forest management plan will therefore extend to all the UKFS elements of sustainable forest management applicable to the FMU.

Incentives

The Forestry Commission and the Forest Service offer a range of incentives for woodland creation, woodland management and related activities. Each country in the UK has grant programmes aimed at supporting the delivery of their forestry policies and strategies. For forests and woodlands that are not part of the public forest estate, most planting, natural regeneration and some management operations take place with the assistance of grants and through the approval of a forest management plan. However, the approval required by the Forestry Commission or the Forest Service to proceed with proposals may be separate from the offer of a grant.

In Great Britain, the offer of incentives for forestry will be conditional on meeting the UKFS Requirements. This will have to be demonstrated through the submission and approval of a forest management plan. In Northern Ireland, there is no general requirement for forest management plans at the current time. However, essential planning information including maps, a statement of objectives and establishment prescriptions is required for forest and woodland grant applications.

Monitoring

Monitoring is carried out at a strategic level, which is used for international and national level reporting, and at the level of individual forests and woodlands, to check that agreed proposals are being implemented.

Strategic reporting

The UK is committed to international agreements on sustainable forest management and these require countries to report at intervals of about five years on indicators developed by the Global Forest Resources Assessment (GFRA) and Forest Europe (formerly the Ministerial Conference on the Protection of Forests in Europe). These indicators show the extent and condition of forests and woodlands, together with environmental, social and economic aspects of sustainable forest management.

The range of reportable indicators was greatly increased for the GFRA in 2005 and 2010 and for the Ministerial Conference on the Protection of Forests in Europe in 2007. These, together with indicators at country level, now form the main basis for strategic monitoring that has superseded the earlier UK Indicators of Sustainable Forestry. Forestry also features in other international indicator sets on which the UK reports, such as those for the UN Convention on Biological Diversity (UNCBD) and the UN Framework Convention on Climate Change (UNFCCC).

A range of mechanisms provides data for this monitoring and reporting. For indicators concerned with UK forests, the national forest inventories, where the total forest and woodland resource is comprehensively assessed, have been the main source of data. Additional data are provided by a range of research plots across the UK that are used for environmental monitoring, and which form part of international co-operative programmes. Aspects covered include biodiversity, forest health, air pollution and climate change.

In the UK, each of the country forestry programmes or strategies has developed a set of performance indicators linked to strategic priorities. Where regional strategies exist within countries, indicators can also be linked to their strategic aims. These country indicators also draw upon existing statistics and surveys (for example, the current National Forest Inventory), and projects such as the Native Woodland Survey of Scotland will improve the scope of data collection and future reporting.

In Great Britain, the Forestry Commission has prepared a digital base map for all woodlands over 0.5 hectares, as part of the National Forest Inventory. This will ensure that monitoring will take place against definitive woodland areas. A sample survey, based on the digital map, will be undertaken for all these woodlands and data collected on species, structure, timber potential, and a range of environmental attributes. (A separate survey has been proposed for woodlands less than 0.5 hectares.) New technologies, including remote sensing, will enable the forestry authorities to carry out further checks on forest management and ensure the woodland map and associated survey data are regularly updated. In Northern Ireland, the Forest Service is in the process of completing an analysis of data on woodland area and type and will, in the future, provide and maintain a register of woodland.

Monitoring of individual forests and woodlands

Within the framework of the UKFS, the Forestry Commission in England, Scotland and Wales and the Forest Service in Northern Ireland will develop their own approaches to assessing forestry proposals for approval and verifying their implementation. These approaches will be informed by the nature of forests and woodlands in each country and risk factors associated with non-compliance.

The UKFS Requirements and Guidelines provide explicit statements against which proposals can be checked and their implementation monitored. The approval and monitoring regime will extend to individual forests and woodlands, but, as with all aspects of compliance, a risk-based approach appropriate to the context will be

taken. This will reflect the relevance and importance of the various elements of sustainable forest management, and individual Guidelines.

The implementation of forest management plans will be checked by the forestry authorities for grant payment purposes and again periodically as plans are amended or revised. At intervals, active forest management plans will be updated and formally re-submitted for an assessment of implementation to date and approval. Inspections will be based on a proportion of approved plans, selected at random, and the remainder based on the perceived risk profile of non-compliance.

Inspectors will offer advice on meeting the UKFS Requirements and allow the opportunity for remedial work to be carried out. However, where there are serious or persistent departures from UKFS Requirements, and these are not remedied, approved plans may be suspended and grants may be reclaimed. Where there is failure to meet the legal requirements, legal action may ensue.

Operational plans are a requirement of good forestry practice (see General Forestry Practice – Appendix 3), and the forestry authorities may ask to see these on site visits and more formally when forest management plans are due for renewal. Other UK regulatory authorities and organisations responsible for environmental standards, water quality, health and safety and employment may carry out checks to provide assurance of operational and legal compliance. As with other aspects of forest monitoring, the authorities will take a risk-based approach.

In addition, a new representative sampling survey will be introduced as a general audit on the implementation of UKFS Requirements and the systems in place. Taken together, these various measures will give assurance that the UKFS is being applied for the forest resource as a whole and, on the basis of a risk-based sample programme, will give assurance for individual woodlands.

Monitoring and forest certification

The processes of government regulation and independent forest and woodland certification will remain distinct. However, the forestry authorities will take account of certification in adopting a risk-based approach to monitoring. The UK Woodland Assurance Standard (UKWAS), which is used as the basis of independent certification in the UK, draws on the UKFS and is compatible with the UKFS Requirements. UKFS monitoring will therefore be done with a lighter touch where additional assurance is provided by independent certification. All the forests and woodlands managed by the Forestry Commission and the Forest Service are independently certified and this will similarly be taken into account in the monitoring regime.

Evidence of legality and sustainability

For the majority of timber production in the UK, certification can be used to provide evidence that timber and wood products are legal and sustainable. For forests and woodlands that are not certified, the UKFS may be used to provide a risk-based approach to demonstrating legal and sustainable forest management. All active forest management plans will be regularly assessed and renewed against the UKFS Requirements, but checks on the detailed implementation of plans will be undertaken on a sample basis. As with certification, evidence will also be needed that links products to the forest covered by the management plan (see Section 4 of the UKFS). Where a felling licence is issued but a forest management plan is not in place, the levels of assurance will be lower and extend to legality and the aspects of sustainability outlined under Felling licences (see above).

Further reading and useful sources of information

Detailed information and resources for the UK Forestry Standard and each of its supporting series of Guidelines can be found at:

www.forestry.gov.uk/ukfs
www.forestry.gov.uk/ukfs/biodiversity
www.forestry.gov.uk/ukfs/climatechange
www.forestry.gov.uk/ukfs/historicenvironment
www.forestry.gov.uk/ukfs/landscape
www.forestry.gov.uk/ukfs/people
www.forestry.gov.uk/ukfs/soil
www.forestry.gov.uk/ukfs/water

Forestry Commission and Forest Service publications

Forestry Commission publications can be viewed and downloaded from: www.forestry.gov.uk/publications

Forest Service publications can be viewed and downloaded from: www.dardni.gov.uk/forestservice/publications

Other publications

Combating climate change – a role for UK forests. An assessment of the potential of the UK's trees and woodlands to mitigate and adapt to climate change. TSO, Edinburgh. (2009).

Forestry Commission and Forest Service websites

Climate change

For information on forests and **climate change**: www.forestry.gov.uk/climatechange

For information on the **Woodland Carbon Code**: www.forestry.gov.uk/carboncode

For information on forestry-related **climate change research**: www.forestry.gov.uk/fr/climatechange

For information on **decision support systems**: www.forestry.gov.uk/fr/decisionsupport

General

For information on **forestry statistics,** including forestry facts and figures: www.forestry.gov.uk/statistics

For information about the **National Forest Inventory**: www.forestry.gov.uk/inventory

For information about **forest research**: www.forestry.gov.uk/forestresearch

For information on **plant health** and biosecurity issues: www.forestry.gov.uk/planthealth

For information on **forest reproductive materials**: www.forestry.gov.uk/frm

For information and guidance on **Environmental Impact Assessments**: www.forestry.gov.uk/eia
www.dardni.gov.uk/forestservice/environment

For information and guidance on **felling**: www.forestry.gov.uk/felling
www.dardni.gov.uk/forestservice

For information and guidance on **grant schemes**: www.forestry.gov.uk/grants
www.dardni.gov.uk/forestservice

To view the **public registers** on grants and felling applications, and Environmental Impact Assessments: www.forestry.gov.uk/publicregister

Other useful websites

www.decc.gov.uk
The Department of Energy and Climate Change is responsible for all aspects of UK energy policy, and for tackling global climate change on behalf of the UK.

http://ukclimateprojections.defra.gov.uk
UK Climate Projections

www.theccc.org.uk
The Committee on Climate Change is an independent body established under the UK Climate Change Act 2008. It advises the UK Government on setting and meeting carbon budgets and on preparing for the impacts of climate change.

www.ukcip.org.uk
The UK Climate Impacts Programme

www.naei.org.uk
UK Greenhouse Gas Emissions Inventory

www.decc.gov.uk
UK Greenhouse Gas Emissions Projections

www.biomassenergycentre.org.uk
The Biomass Energy Centre Reference Library

www.legislation.gov.uk
All enacted legislation and revisions for the United Kingdom, Scotland, Wales and Northern Ireland.

www.metoffice.gov.uk
The Meterological Office

www.woodforgood.com
Wood for Good provides facts and figures on wood, carbon and energy.

International context

www.fao.org/forestry/fra/en/
Global Forest Resources Assessment

www.ipcc.ch
The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the assessment of climate change. It provides a clear scientific view on the current state of knowledge on climate.

www.un.org/esa/forests
United Nations Forum on Forests

Contact addresses

Forestry authorities

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E: enquiries@forestry.gsi.gov.uk
www.forestry.gov.uk

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E: fcengland@forestry.gsi.gov.uk
www.forestry.gov.uk/england

Forestry Commission Scotland
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E: fcscotland@forestry.gsi.gov.uk
www.forestry.gov.uk/scotland

Forestry Commission Wales
Welsh Assembly Government
Rhodfa Padarn
Llanbadarn Fawr
Aberystwyth SY23 3UR
T: 0300 068 0300
E: fcwenquiries@forestry.gsi.gov.uk
www.forestry.gov.uk/wales

Forest Service
Department of Agriculture and Rural Development
Dundonald House
Upper Newtownards Road
Ballymiscaw
Belfast BT4 3SB
T: 02890 524480
E: customer.forestservice@dardni.gov.uk
www.dardni.gov.uk/forestservice

Climate change authorities

Defra
Nobel House
17 Smith Square
London SW1P 3JR
T: 08459 33 55 77
E: defra.helpline@defra.gsi.gov.uk
www.defra.gov.uk

The Scottish Government
Rural & Environment Directorate
Victoria Quay
Edinburgh EH6 6QQ
T: 08457 741 741
E: ceu@scotland.gsi.gov.uk
www.scotland.gov.uk

Welsh Government
Department for Environment, Sustainability and Housing
Cathays Park
Cardiff CF10 3NQ
T: 0845 010 3300
E: wag-en@mailuk.custhelp.com
www.wales.gov.uk

Department of the Environment Northern Ireland
Clarence Court
10–18 Adelaide Street
Belfast BT2 8GB
T: 028 9054 0540
E: enquiries@doeni.gov.uk
www.doeni.gov.uk

Forest Research

Forest Research is the agency of the Forestry Commission and the UK leader in forestry and tree-related research.

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www.forestry.gov.uk/forestresearch

Appendix 1 – Legislation and conventions

United Nations Framework Convention on Climate Change

www.unfccc.int

The United Nations Framework Convention on Climate Change (UNFCCC) forms the basis of international law in respect of climate change. The Convention does not itself contain legally binding targets for the reduction of greenhouse gases or enforcement mechanisms but it does provide for updates or Protocols which can contain emissions limits. The best known of these so far is the Kyoto Protocol.

The EU is a party to the UNFCCC (and subsequent Protocols) and has passed legislation, based on its Kyoto commitments, that sets climate change obligations for Member States including the UK.

Kyoto Protocol

www.unfccc.int

The Kyoto Protocol is an international agreement linked to the UNFCCC. The major feature of the Kyoto Protocol is that it sets binding targets for 37 industrialised countries and the European community for reducing greenhouse gas emissions.

Directive 2003/87/EC

www.europa.eu

Directive 2003/87/EC on establishing a scheme for greenhouse gas emission allowance trading within the Community is the principal piece of EU legislation stemming from the Kyoto Protocol that established the EU Emissions Trading System (ETS).

Climate Change Act 2008

www.legislation.gov.uk

This Act provides a framework to assists the UK's attempts to become a low carbon economy. It includes a legally binding target of at least an 80% cut in greenhouse gas emissions by 2050, to be achieved through action in the UK and abroad, and also a reduction in emissions of at least 34% by 2020. Both these targets are against a 1990 baseline. The principal provisions of the Act are:

- setting ambitious, legally binding targets;
- taking powers to help meet those targets;
- strengthening the institutional framework;
- enhancing the UK's ability to adapt to the impact of climate change;
- establishing clear and regular accountability to the UK Parliament and to the devolved legislatures.

Climate Change (Scotland) Act 2009

www.legislation.gov.uk

The central objective of the Scottish Act, like the UK Act, is to reduce greenhouse gas emissions by 80% by 2050. There is also an interim target, currently set at 42% by 2020. The new legislation enshrines in law for the first time targets, duties and mechanisms to tackle the causes of climate change.

Appendix 2 – Strategies and delivery mechanisms

Strategies

Climate change – general

Climate change policies and programmes for each country are also available:

England
www.defra.gov.uk
www.decc.gov.uk

Scotland
www.scotland.gov.uk

Wales
www.wales.gov.uk

Northern Ireland
www.doeni.gov.uk

The natural choice: securing the value of nature (2011). HM Government.

Carbon plan (2011). HM Government.

Climate change: the UK programme 2006. Department of Energy and Climate Change, London – sets out policies and priorities for action in the UK and internationally.

UK renewable energy strategy 2009. Department of Energy and Climate Change, London – sets detailed targets for reducing emissions, increasing renewables and creation of jobs in the renewables sector.

Low carbon Scotland: meeting the emissions reduction targets 2010–2022 (2011). Scottish Government, Edinburgh.

Natural environment framework – a living Wales. Welsh Assembly Government, Cardiff.

Climate change – forestry related

European Union forestry strategy, council resolution 1999/C 56/01 (1998). European Commission.

European Union forest action plan 2007–2011 (2006). European Union.

Climate change plan 2010. Defra, London.

The Scottish forestry strategy (2006). Forestry Commission Scotland, Edinburgh.

Climate change action plan 2009–2011. Forestry Commission Scotland, Edinburgh.

Woodlands for Wales: the Welsh Assembly Government's strategy for woodlands and trees (2009). Welsh Assembly Government, Cardiff.

Northern Ireland forestry. A strategy for sustainability and growth (2006). Northern Ireland Forest Service, Belfast.

First steps towards sustainability. A sustainable development strategy for Northern Ireland (2006). Office of the First Minister and Deputy First Minister Northern Ireland, Belfast.

Delivery mechanisms

EU Emissions Trading System

www.ec.europa.eu

The EU Emissions Trading System (ETS), which is currently in its second phase (2008–12, i.e. the same period as the Kyoto Protocol), requires Member States to create a National Allocation Plan within which emissions allowances are allocated to various sectors that emit greenhouse gases (e.g. large electricity producers, refineries, chemicals, food and drink). However, this national basis for allocation of emissions allowances will cease when Phase II ends on 31 December 2012. During Phase III (2013–21), emissions allowances for each Member State will be set by the Commission.

Adapting to Climate Change Programme

www.ukcip.org.uk

The UK Government's Adapting to Climate Change Programme is a cross-government programme, co-ordinated by the Department for Environment, Food and Rural Affairs (Defra). The Programme's key objectives are to:

- develop a more robust and comprehensive evidence base about the impacts and consequences of climate change;
- raise awareness of the need to take action now and to help others to take action;
- work across government at the national, regional and local level to make sure the need to adapt to climate change is embedded into government policies, programmes and systems.

UK Low Carbon Transition Plan

www.decc.gov.uk

The UK Low Carbon Transition Plan plots how the UK will meet the 34% cut in emissions on 1990 levels by 2020. The Plan shows how reductions in the power sector and heavy industry; transport; homes and communities; workplaces and jobs; and farming, land and waste sectors could enable carbon budgets to 2022 to be met.

UK Renewables Obligation

www.decc.gov.uk

The Renewables Obligation (RO) is the main mechanism for supporting the generation of renewable electricity. Since its introduction, the RO has been subject to various reforms and improvements. The most significant change to date was in April 2009, with the introduction of banding. This provides for different technologies to receive different levels of support, providing a greater incentive for less-developed technologies, including dedicated biomass burning, which have the potential to generate significant amounts of electricity.

Renewable Heat Incentive

www.decc.gov.uk

In 2010 heat generated from renewable energy met less than 2% of the UK's total heat demand. The Renewable Heat Incentive (RHI) is expected to come into force in 2011 and will assist towards the adoption of forms of heating such as biomass boilers and stoves which use forest products, together with air-source and ground-source heat pumps, sustainable biogas, biomethane and bioliquids, and solar thermal water heaters. This will help the UK to reach the 2020 renewable heat energy target of 12%.

Woodland Carbon Code

www.forestry.gov.uk/carboncode

The Woodland Carbon Code sets out the standards for voluntary carbon sequestration projects that incorporate core principles of good carbon management as part of modern sustainable forest management.

2020 routemap for renewable energy in Scotland

www.scotland.gov.uk

The *2020 routemap for renewable energy in Scotland* is an update and extension to the Scottish Renewables Action Plan 2009. This updated and expanded routemap reflects the challenge of a new target to meet an equivalent of 100% demand for electricity from renewable energy by 2020, as well as 11% of heat from renewable sources. Within the routemap, sectors such as wind, hydro and biomass have their own plans and programmes. The targets and actions for biomass are particularly significant for forestry.

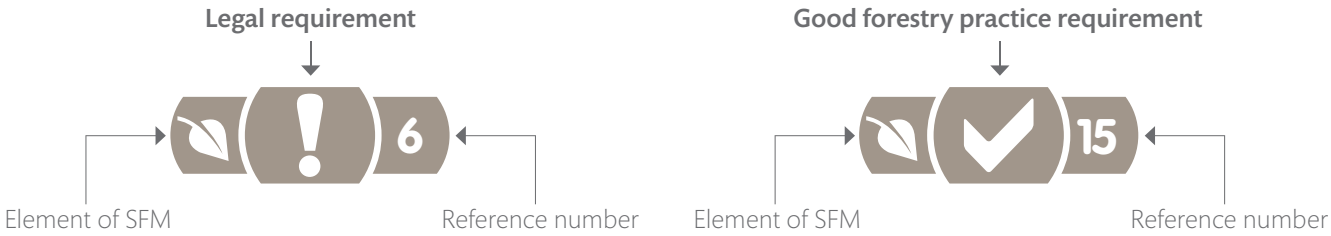
Appendix 3 – General Forestry Practice

General Forestry Practice Requirements

This section replicates the Requirements for General Forestry Practice set out in the UKFS (see Section 2 for more information). General Forestry Practice is covered by the UKFS itself and not by an individual Guidelines publication because the Requirements and supporting Guidelines describe aspects of management that apply to most forest and woodland situations and that are common to the other elements of sustainable forest management (SFM).

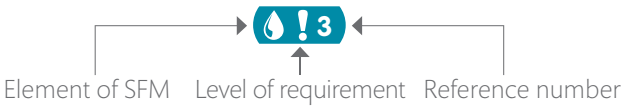
Key to symbols

Requirements



Cross-references

Cross-references may be made to the other elements of sustainable forest management, where the Requirement is common to more than one subject.



- General Forestry Practice
- Forests and Biodiversity
- Forests and Climate Change
- Forests and Historic Environment
- Forests and Landscape
- Forests and People
- Forests and Soil
- Forests and Water

The UKFS Requirements outline the main legislation and are intended as a source of advice. You are advised to consult the relevant statutes for more information and the definitive legal text.

General compliance

All occupiers of land and parties engaged in commercial activities are subject to a range of laws and regulations. Some are of special relevance to land-based activities in general and others are more specific to forestry. Compliance with the law is fundamental to the UKFS, and the main legislation of most general relevance to forestry is outlined in this section. More specific legislation is outlined under the relevant elements of sustainable forest management and in the supporting series of Guidelines.

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

Operations must be authorised by the legal owner.

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

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

Forest protection

The Forestry Act 1967 conveys wide powers to control felling and provide assistance to promote the interests of forestry, the development of afforestation, and the production and supply of timber in Great Britain. The Forestry Act was amended by the Wildlife and Countryside (Amendment) Act 1985 and, in Scotland, by the Nature Conservation (Scotland) Act 2004 to take account of wider environmental considerations and to incorporate the concept of 'a reasonable balance' between the interests of forestry and the environment. In Northern Ireland, the Forestry Act (Northern Ireland) 2010 conveys wide powers to promote afforestation and sustainable forestry, to protect the environment and to promote recreational use. There are also powers to regulate felling.

The Town and Country Planning Acts do not apply to forestry activities themselves, as they are not defined as 'development'. The exception is where development, for example housing, is proposed on a woodland site, in which case the planning procedures apply. Local authorities (in Northern Ireland, the Planning Service of the Department of the Environment) can apply Tree Preservation Orders (TPOs) and designate Conservation Areas to protect trees that are important in the landscape. Owners are notified of these designations. Local authorities may apply planning conditions to protect existing trees or plant new ones as part of the development consent. They may also enter into 'planning gain' agreements for additional woodland creation or protection. In areas with landscape designations, forest roads and quarries that do not form part of an approved afforestation scheme may be subject to planning controls. Areas of woodland are material considerations in the planning process and may be protected in local authority Area Plans. These plans pay particular attention to woods listed on the Ancient Woodland Inventory and areas identified as Sites of Local Nature Conservation Importance (SLNCIs).

Where required, proposals for felling or thinning must be submitted to the appropriate forestry authority for approval. Following felling, restocking will normally be required.

Note that:

- Submission for approval can be done as an integral part of a grant application.
- There are a number of exceptions: trees under a specified size, trees proved to be dangerous, fruit trees and small-scale felling may not require a felling licence. Priority habitat restoration proposals may not require restocking.
- Forestry authority approval is not required if trees are included in development approval under the Town and Country Planning Acts or other planning legislation.
- EC Directive 97/11 provides *inter alia* that deforestation for the purposes of conversion to another type of land use may be subject to the Environmental Impact Assessment (Forestry) Regulations.
- In Northern Ireland, the Forestry Act (Northern Ireland) 2010 regulates the felling of trees growing on land of 0.2 hectares or more, through granting of felling licences which include felling management plans to control necessary replanting.

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.

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

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.

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

Forests should be protected from the time of planting or restocking to ensure successful establishment and long-term viability.

Environmental impact

EC Directive 85/337/EEC is transposed into UK legislation by the various Environmental Impact Assessment (EIA) Regulations, which apply to afforestation – including short rotation coppice and Christmas trees, deforestation, and the construction of forest roads and quarries. The regulations require the forestry authority to determine whether a proposal may have a significant effect on the environment, and where this is the case the proposer is required to prepare an Environmental Statement.

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.

Plant health and biosecurity

The Plant Health Act 1967 identifies the Forestry Commission as the competent authority in Great Britain, as regards the protection of forest trees and timber, and empowers the Forestry Commissioners to make orders to prevent the introduction and spread of forestry pests and diseases. The Plant Health (Forestry) Order 2005 lays down a number of conditions and prohibitions to support these objectives. In Northern Ireland, under the Plant Health Act (Northern Ireland) 1967, the Department of Agriculture and Rural Development is the competent authority for these purposes, and the Plant Health (Northern Ireland) 2006 and the Plant Health (Wood and Bark) Order (Northern Ireland) 2006 supports these objectives.

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, and access must be given to Plant Health Inspectors and their instructions followed.

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

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

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

Forest reproductive material

The Forest Reproductive Material (Great Britain) Regulations 2002 implement EU Directive 1999/105/EC in Great Britain and provide a framework for controlling plant materials used in forest establishment. A voluntary scheme is also in place to cover native species and other species commonly planted for forestry purposes. In Northern Ireland, the Forest Reproductive Material Regulations (Northern Ireland) 2002 are applied through the Forest Service, an executive agency within the Department of Agriculture and Rural Development. The Forest Service maintains a National Register of Basic Material for Northern Ireland.

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

Forest planning

Forest planning takes place at a number of 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, which sometimes comprises several forest areas. Beneath this are the three levels at which the UKFS Requirements should be addressed:

- Forest planning applies to a convenient management unit, called the forest management unit (FMU). These plans will vary with the scale of the forest and the size and nature of the holding – usually called the **forest management plan**.
- Operational planning is concerned with the operational detail of how proposals will be implemented at site level – usually called the **operational plan** or site plan.
- Contingency planning ensures that procedures are in place and can be enacted should unforeseen events occur, for example, forests fires, catastrophic wind damage and accidental spillages – usually called the **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 is also used for communicating proposals and engaging with interested parties. The plan itself should be proportionate to the scale, sensitivity and complexity of the forest management unit (FMU).

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

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

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

At the time of felling and restocking, the design of existing forests should be re-assessed and any necessary changes made so that they meet UKFS Requirements.

Consultation on forest management plans and proposals should be carried out according to forestry authority procedures and, where required, the Environmental Impact Assessment Regulations.

Forests should be designed to achieve a diverse structure of habitat, and species and ages of trees, appropriate to the scale and context.

Forests characterised by a lack of diversity due to extensive areas of even-aged trees should be progressively restructured to achieve a range of age classes.

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

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

Operational and contingency plans

Operational plans can make forest practice more efficient and ensure that important site features are known about and protected in advance. Contingency plans address potential threats to the forest environment and accidental events, such as spillages, and help prevent or remedy environmental damage.

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

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

General Forestry Practice Guidelines

This section replicates the Guidelines for General Forestry Practice set out in the UKFS (see Section 2 for more information). General Forestry Practice is covered by the UKFS itself and not by an individual Guidelines publication because the Requirements and supporting Guidelines describe aspects of management that apply to most forest and woodland situations and that are common to the other elements of sustainable forest management (SFM).

Key to symbols

Guidelines

Cross-references

Cross-references may be made to the other elements of sustainable forest management, where the Guideline is common to more than one subject.

- General Forestry Practice
- Forests and Biodiversity
- Forests and Climate Change
- Forests and Historic Environment
- Forests and Landscape
- Forests and People
- Forests and Soil
- Forests and Water

The table below introduces factors important for general forestry practice. The Guidelines that follow provide more information on how to comply with the UKFS Requirements, grouped by the factor headings.

Factor	Importance for general forestry practice
Forest planning process	
Forest management plans	Forest management plans allow a manager to demonstrate that all relevant aspects of sustainable forest management have been considered. They provide a basis for monitoring and assessment.
Operational plans	Operational plans help to ensure safe and efficient working practices on a site and the protection of the forest environment.
Contingency plans	Contingency plans set out what happens in the event of accidents, unexpected or unplanned events so damage to the forest environment can be minimised.
Forest planning considerations	
Forest productivity	The UK is committed to maintaining or increasing its forest area, and to enhancing the environmental, economic and social values of forest resources.
Forest structure	Diverse forests provide a range of benefits and are more resilient to changing environmental conditions.
Silviculture	A range of silvicultural systems are available to meet management objectives and add to structural diversity.
Felling and restocking	Opportunities are presented at felling and restocking to restructure age classes and to redesign forests to meet UKFS Requirements.
Mammal damage	Wild mammals and domestic livestock can cause damage to forests and woodlands, particularly at the establishment stage. Some such as deer require co-operative action for effective control.
Pests and diseases	Forests and woodlands in the UK are experiencing unprecedented levels of threats from a range of pests and diseases; climate change is expected to exacerbate levels of damage.
Use of chemicals	Chemical pesticides and fertilisers can be an important management tool in some situations but they can cause damage to the environment if used inappropriately.
Fencing	Fencing can have major impacts on wildlife, landscape, archaeology and access.
Forest roads and quarries	Forest roads, quarries and associated works can be highly visible in the landscape and are subject to Environmental Impact Assessment.
Harvesting operations	Harvesting operations are resource intensive and can also have a significant environmental impact both on the forest and surroundings.

Forest planning process

Forest management plans

At its most simple, the details required for a forest or woodland grant or felling application can provide the basis for the forest management plan. This basic plan will be appropriate for the majority of low-key and small-scale proposals, and provides an approach that is proportionate to the risks of the operations involved.

For extensive or sensitive areas, a more comprehensive approach is required. Additional information will need to be collected to ensure that all the relevant issues have been addressed. The most significant proposals may come under the Environmental Impact Assessment (EIA) Regulations, and will require comprehensive analysis.

A thorough forest planning overview is helpful to both the regulatory authorities and landowners and managers; it has the advantage of allowing UKFS Requirements and Guidelines to be considered over a larger area and a longer, more appropriate, timescale. The forest management plan provides assurances of intent and therefore individual operations within it can be approved with a lighter touch.

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 FMU is the area subject to a forest management plan or proposal. This area is selected by the owner and/or manager and will be determined by the nature of the forest, the proposed operations and management objectives. Extensive FMUs have the advantage of allowing a strategic approach to be taken in achieving UKFS Requirements, both in terms of the area covered and over time.

The process of producing a forest management plan can be organised into seven distinct stages (Table A3.1).

Table A3.1 The process of producing a forest management plan.

Stage	Objective	Activities and/or sources of information
Scoping	Development of management objectives	Owner's objectives, the potential of the site, UKFS Requirements and Guidelines, forestry strategies, policies and plans at country, regional and local level, forestry frameworks.
	Analysis of interests or 'stakeholder analysis'	Consideration of all potential interests, including those of specialist interest groups and the local community.
Survey	Collection of information	A comprehensive exercise to collect and map all the information about the site and its location, including any statutory constraints. Meetings held at this early stage with stakeholders and those with specialist knowledge will help identify all the factors involved and alert interested parties to the proposal.
Analysis	Assessment of survey information	The survey information is evaluated in the light of project objectives, allowing the potential of the site to be assessed.
Synthesis	Development of a design concept	The broad concept for the forest design is formulated from the information that has been collected and analysed, including the visual aspects.
	Development of a draft management plan	The design concept is refined and developed into a draft management plan. The draft forms the basis of consultation with interested parties. Several drafts may be required in an iterative process.
	Finalisation of the plan and submission for approval	The draft is amended, refined and firmed up into a final forest management plan.
Implementation	Development and implementation of work programmes	Operational plans are developed from the forest management plan and work programmes are implemented.
Monitoring	Evaluation of progress	Indicators of progress are checked at regular intervals. Data are collected and recorded to evaluate management.
Review	Periodic updates of the forest management plan	Work done on the plan is recorded, and at regular intervals the plan is updated to keep it current. Periodically (usually at five-year intervals) the plan is thoroughly reviewed and updated.

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.

Operational plans

Operational or site planning helps 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 which 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 address:

- potential hazards to workers;
- potential hazards to forest users – by making them aware of operations and putting diversions in place;
- machine access, refuelling and timber stacking;
- how to safeguard sensitive or easily damaged parts of the site;
- how to ensure only the intended trees and shrubs are felled;
- how the site will be left on completion, including the disposal of waste materials;
- how to modify operations in case of bad weather.

Contingency plans

Contingency plans cover what happens in the event of an unexpected or unplanned event. For site operations this may include accidents and dealing with spillages or other problems that could pose a serious risk to water supplies and aquatic ecosystems. The Environmental Liability Directive (2004/35/EC) seeks to achieve the prevention and remedying of environmental damage and reinforces the 'polluter pays' principle, making operators financially liable for damage. Contingency plans can also be used to address other threats to the forest, for example fire, extreme weather events such as gales, or outbreaks of pests and diseases.

3 Have appropriate contingency plans in place to deal with risks to the forest, including spillages, pest and disease outbreaks, extreme weather events and fire. 18

Forest planning considerations

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

Forest productivity

The maintenance of the productive potential of forests includes both timber production, which serves the development of forest industries and economic well-being, and wider non-market benefits and values such as recreation, and other ecosystem services. 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 make sure they become

successfully established, and protecting the health of forests and woodlands, for example, by ensuring they have the necessary resilience to cope with emerging threats and changing conditions – in particular climate change. It also involves maintaining levels of fertility and site potential for future rotations.

4 Retain or expand the forest area and consider compensatory planting where forest area is lost through land-use change. 9

5 Ensure new woodland and replanting becomes established, and young trees are not overcome by competing vegetation.

6 Plan for forest resilience using a variety of ages, species and stand structure; consider the risks to the forest from wind, fire, and pest and disease outbreaks. 16

7 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. 7 20

Forest structure

Ensuring a forest has a varied structure in terms of age, species, origin or provenance and open space will provide a range of benefits. It will endow forests with the resilience necessary to cope with emerging threats and changing climatic conditions, and will provide for flexibility in management options, for example by allowing for modifications to forest practice (see the UKFS Guidelines on *Forests and Climate Change* and also *Forests and Biodiversity* for more information).

Structural diversity can be increased by incorporating open areas and through phased felling and restocking to ensure that, over time, a varied woodland develops. As part of this, some trees can be left as long-term forest cover to produce standing and fallen deadwood. For woods of less than 10 hectares, internal diversity is less important – in these situations diversity can be considered in the context of the landscape setting. There are also some woodlands that derive their particular landscape character or biodiversity value from a principal species and in these situations a case for divergence from the guidelines can be made.

Open space is a key element of diversity within woodland. It can be used to develop permanent internal edges, structural diversity, and flexibility for operational management. Wildlife habitat can be enhanced by developing non-woodland elements, such as streams, ponds, roads, utility wayleaves and rides. Open space is also important for the provision and development of access and recreation.

8 Diversify forest composition so that no more than 75% of the forest management unit is allocated to a single species and a minimum of the following are incorporated:

- 10% open space;
- 10% of other species or ground managed for environmental objectives;
- 5% native broadleaved trees or shrubs.

Note: (i) Where more than one species is suited to the site and matches the management objectives, opportunities must be taken to further diversify the above species composition: this is important in the context of climate change. (ii) In woodlands of less than 10 hectares and in native woods the above proportions may be relaxed providing the adjacent land uses provide landscape and habitat diversity. 11 23

9 Develop a long-term forest structure of linked permanent habitats, such as riparian woodland, open space and broadleaves. 19

10 Leave a proportion of standing and fallen deadwood: concentrate it 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. 23 10

11 Retain and manage existing veteran trees and select and manage suitable individuals to eventually take their place. 24 16

12 Manage a minimum of 15% of the forest management unit with conservation and the enhancement of biodiversity as a major objective. 20

Silviculture

A range of silvicultural systems are available to provide flexibility in meeting management objectives and to add to the structural diversity of the forest. Silvicultural systems with a lower environmental impact than clearfelling are recommended in semi-natural woodland. In the context of climate change, varied silviculture will increase the resilience of forests and may limit the damage caused by extreme events such as gales or pest outbreaks.

13 Consider alternatives to clearfell systems, such as continuous cover forestry, where suitable sites and species combinations allow and management objectives are compatible. 18 17

14 Maintain a range of stand structures and silvicultural approaches across the forest as a whole, including veteran trees, open-crowned trees, open space and areas of natural regeneration. 17

Felling and restocking

Many forests, particularly those established in the 20th century, were planted or felled and replanted over a short timescale and have little diversity. Other older woods may have been neglected, leading to the development of a uniform structure. In both cases, felling and restocking presents the opportunity to restructure age classes and improve diversity. In even-aged woodlands, this may involve bringing forward felling in some areas and delaying felling and restocking in others. 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 and semi-natural habitats. The various elements of sustainable forest management, detailed in the UKFS Guidelines, can be addressed and changes made where necessary to bring the forest up to current standards. These may include aspects such as the redesign of buffer areas and drainage systems, extending habitats for biodiversity and addressing forest landscape design.

15 In forests characterised by a lack of diversity due to extensive areas of even-aged trees, retain stands adjoining felled areas until the restocking 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.

16 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.

17 Take the opportunity provided by felling and restocking to redesign forests to meet UKFS Requirements and address issues such as buffer areas, drainage systems, biodiversity habitats and forest landscape design.

18 In semi-natural woodland, limit felling to 10% of the area in any five-year period unless there are overriding biodiversity or social advantages.

Mammal damage

Forests and woodlands may be subject to damage or degradation due to grazing or browsing mammals, particularly when trees are at the establishment stage. The manager's role is to monitor damage and decide whether intervention is necessary.

In areas where deer pose a threat to the forest and wider environment, deer management plans – often incorporating culling – allow a strategic approach to be taken. Keeping records of both deer culled and levels of damage will help inform plans so 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, Scottish Natural Heritage advises on the sustainable management of wild deer (formerly performed by the Deer Commission), while the Deer Initiative performs similar functions in England and Wales.

Responsibility for wild deer in Northern Ireland lies with the Northern Ireland Environment Agency of the Department of the Environment for Northern Ireland.

19 Monitor forest damage, and intervene to protect vulnerable trees from browsing and grazing mammals, including voles, deer, rabbits, hares, grey squirrels and livestock.

20 In areas where deer are a threat, develop deer management plans – ideally in co-operation with local deer management groups. 43

Pests and diseases

There has been a significant increase in the incidence of pest and disease outbreaks in forests and woodlands in recent years. 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 monitoring damage, keeping abreast of emerging threats and deciding when intervention is necessary.

21 Consider the susceptibility of forests and woodlands to pests and diseases; take specialist advice and develop strategies for protection.

22 Be vigilant for pests and diseases in forests and woodlands, particularly in urban areas where the risks of new problems are high. 33

Use of chemicals

The use of artificial pesticides and fertilisers is generally a last resort in practising sustainable forestry, although they can have more of a role in energy crops, such as short rotation coppice. Pesticides and fertilisers are expensive, and only deployed in a reactive way to protect trees when a problem has been identified or is highly likely. Their use on special sites such as ancient woodland is particularly discouraged.

23 Minimise the use of pesticides and fertilisers in accordance with Forestry Commission and Forest Service guidance. 13 5 57

Fencing

The alignment and design of forest fences can have major impacts on wildlife, access, landscape and archaeology. Fence lines themselves are not usually prominent but they can generate striking textural changes in the landscape through differences in grazing or land use.

A particular problem of fences in upland areas is that they can be invisible to birds such as black grouse. Techniques to mark fences to improve their visibility and to align them so that they avoid obvious flight paths will help minimise collisions. Fencing also needs to be considered in relation to public access: it is illegal to obstruct rights of way and in other areas access can be an important consideration in fence alignment. When fences are replaced or become redundant, removal is a better option than leaving them as they can be a nuisance to livestock, wildlife and people.

24 Consider the impacts of fencing on biodiversity, landscape, archaeology and access, and minimise adverse effects. 45

25 Consider removing old and redundant fencing rather than leaving it in place.

Forest roads and quarries

Forest roads, quarries and associated infrastructure works can be highly visible in the landscape and therefore come within the scope of the Environmental Impact Assessment

(EIA) Regulations. In areas with landscape designations, roads and quarries that do not form part of an approved afforestation scheme may be subject to planning controls. Considering important viewpoints, and allowing road alignments to respond to the landform – rather than taking the most direct route – can both ameliorate visual impacts and sometimes reduce the amount of cut-and-fill during construction. The construction of forest roads and the extraction of material accounts for a high proportion of the total energy expended in the forest life cycle, and so has a bearing on the sustainability of the timber grown (see the UKFS Guidelines on *Forests and Climate Change*).

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 and functions independently from the main forest drainage network. Where minor public roads and bridges are weak, consideration can 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 rail or sea alternatives to road transport.

26 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.

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

28 Plan forest operations, civil engineering and timber transport to minimise energy use; consider using sustainable biofuels. 12

29 Consider how forest road networks can be exploited to minimise damage to public roads, and take advice from timber transport groups.

Harvesting operations

Harvesting and extraction operations are resource intensive and can have a significant environmental impact on both the forest and its surroundings. With careful operational planning it is possible to combine good silviculture and cost-efficiency with care for people and the environment. Soil compaction, leading to rutting and erosion, can be minimised by the planning and good management of forest operations, such as protecting extraction routes by using layers of fresh brash to spread the machine load. Machine choice and working method affect the ground pressure and the risk of damage. The potential of damage to soils and the water environment is usually greatest in wet weather and consideration needs to be given to how changes in weather will affect operations.

Burning of forest residues such as brash is generally discouraged and is not acceptable on ancient woodland sites. Other management options are less environmentally damaging, but if burning is the only practical alternative, a written application to the environment agencies will be required under the Waste Management Regulations (as amended). The maximum allowed is 10 tonnes in any 24-hour period. The environmental risks, safety and

potential nuisance of burning should all be taken into account as part of the application. Where felling might have an impact on road users, either from trees coming down or from vehicles emerging onto the highway, safety will need to be considered and liaison with the highway authority is advisable.

30 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 degradation starts to occur. 9 36

31 Maintain adequate brash mats throughout extraction operations. 11

32 On sites vulnerable to compaction and erosion, consider the weather and aim to carry out operations during dry periods; plan ahead for changes in the weather that could affect site conditions. 10 37

33 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. 39

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

35 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. 11 25

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

Glossary

Adaptation Initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects (IPCC Assessment Report 4). In this context 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.

Ancient woodland Woodland which 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.

Arboriculture The management of individual trees, but sometimes used to include the management of trees and woodlands in urban situations.

Autonomous adaptation Adaptation that occurs automatically as a response to climate change, rather than as a conscious response to anticipated change. It is triggered by ecological changes in natural systems, and by market or welfare changes in human systems.

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 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.

Buffer (area/zone) An area of land which protects the watercourse 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 the adjacent land.

Carbon capture *see* **Carbon sequestration**

Carbon dioxide equivalent (CO_2e) Greenhouse gases can be referred to as an equivalent carbon dioxide emission by multiplying their mass by their Global Warming Potential. This allows comparison of the relative radiative forcing effect of different greenhouse gases.

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 sink and source The carbon balance of a forest is often described as a sink if there is a net transfer of carbon from the atmosphere to one or more of the carbon pools in the forest (resulting in carbon sequestration). When a forest is described at a carbon source then there is a net transfer of carbon to the atmosphere.

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.

Carbon uptake *see* **Carbon sequestration**

Certification scheme A voluntary scheme 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 forest practice. They offer product labels to demonstrate that wood or wood products emanate from well-managed forests.

Clearfelling Cutting down of an area of woodland (if it is within a larger area of woodland it is typically a felling greater than 0.25 ha). Sometimes a scatter or small clumps of trees may be left standing within the felled area.

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.

Compensatory planting Creating new woodland on previously unwooded land should an area of woodland be lost due to change in land use.

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 UK Forestry Standard.

Conservation agencies The statutory nature conservation agencies: Natural England, Scottish Natural Heritage, the Countryside Council for Wales and the Northern Ireland Environmental Agency.

Contingency plan A plan of action to address potential threats to the forest such as spillages, pollution, pest attack or wind damage.

Continuous cover forestry A silvicultural system whereby the forest canopy is maintained at one or more levels without clearfelling.

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.

Cultivation Any method of soil disturbance to aid the establishment of trees.

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.

Development Change of land use authorised by the planning authorities, usually for building and urbanisation.

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.

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.

Emissions scenarios A plausible representation of the future development of emissions of substances that are potentially radiatively active (e.g. greenhouse gases, aerosols), based on assumptions of demographic and socio-economic development as well as technological change.

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 the statutory requirement under the EU Environmental Impact Assessment Directive 85/337/EEC as amended by 97/11/EC and 2003/35/EC. This introduced a Europe-wide procedure to ensure that environmental consequences of projects are evaluated and public opinion is taken into account before authorisation is given.

Environmental Statement A statement of environmental effects that is required where an Environmental Impact Assessment is called for.

Erosion The wearing away of the land surface by rain, wind, ice, or other natural or anthropogenic agents that abrade, detach and remove geologic parent material or soil from one point on the Earth's surface and deposit it elsewhere.

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.

Fertility The availability and balance of nutrients required for plant growth.

Forest Land predominately covered in trees (defined as land 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 scheme**

Forest Europe Until 2010 known as MCPFE (Ministerial Conference on the Protection of Forests in Europe), Forest Europe is the pan-European policy process for the sustainable management of the continent's forests. Forest Europe develops common strategies for its 46 member countries and the European Union on how to protect and sustainably manage forests.

Forest management plan (woodland management plan) A plan which 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) The area subject to a forest management plan or proposal. A convenient management area determined by the nature of the woodland, the management objectives and proposed operations. Extensive FMUs allow a strategic approach to be taken to meeting UKFS Requirements and Guidelines.

Forest Service An agency within the Department of Agriculture and Rural Development in Northern Ireland responsible for the regulation of forestry and the management of state forests in Northern Ireland.

Forestry The science and art of planting, managing and caring for forests.

Forestry authorities The Forestry Commission and Forest Service are the principal forestry authorities in the UK. Other bodies also have roles in regulating forestry in particular circumstances.

Forestry Commission The government department responsible for the regulation of forestry, implementing forestry policy and management of state forests in Great Britain. Forestry policy is devolved, with the exception of some reserved issues, such as international forestry, plant health and forestry standards, and a range of common issues addressed on a Great Britain basis. The abbreviations FCE, FCS and FCW refer to the respective parts of the Forestry Commission in England, Scotland and Wales.

Forestry operations Work or procedures carried out within a forest such as felling, extraction, cultivation and planting.

Global Warming Potential (GWP) An index measuring the radiative forcing of greenhouse gases in the atmosphere integrated over a given timescale (normally 100 years) relative to that of carbon dioxide. It represents the combined effect of the different timescales that gases remain in the atmosphere as well as their effectiveness in absorbing outgoing thermal infrared radiation. This allows other greenhouse gases to be referred to as an equivalent carbon dioxide emission (CO_2e).

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 in the Earth's atmosphere are water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3). Forests exchange all of these GHGs with the atmosphere to a larger or smaller extent. There are also a number of man-made greenhouse gases. The Kyoto Protocol deals with six of these: CO_2, N_2O and CH_4 as well as sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs). Others are dealt with under the Montreal Protocol on Substances that Deplete the Ozone Layer.

Groundwater All water which 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.

Infiltration The entry of water into the soil.

Interception The evaporation of rainwater from the wetted surfaces of leaves, branches and tree trunks, resulting in less water reaching the ground.

Interested parties People directly affected by, or who have a financial or other interest in, the woodland being managed; also sometimes called stakeholders.

Invasive species Animal or plant species which spread rapidly to the exclusion of other species. Many invasive species are not native or locally native.

Ironpan A soil with a hardened impervious layer, in which iron oxides are the chief cementing agents, that impairs drainage and plant growth.

ISO 14001 An international standard for environmental management systems (EMS) developed by the International Organization for Standardization (ISO). It can be applied to any industry sector. ISO 14001 requires a company to undertake a review of its environmental impact, and, based on this, to develop a policy, objectives and targets and a programme to ensure they are implemented. ISO 14001 does not set specific performance targets, other than legal compliance, and therefore sector-specific performance targets can be linked with the standard.

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 (Article 1, European Landscape Convention Council of Europe, 2002).

Margins The borders or edges of a forest; divided into the external margins between forest and other land uses and the internal margins or boundaries between species, felled areas, open ground etc.

MCPFE Ministerial Conference on the Protection of Forests in Europe. *see* **Forest Europe**

Mitigation (climate change) A human intervention to reduce the sources or enhance the sinks of greenhouse gases (IPCC Assessment Report 4). In this context, establishing and managing forests and their products to enhance their potential as a 'sink' of greenhouse gases.

Native species Species which have arrived and inhabited an area naturally, without deliberate assistance by humans. For trees and shrubs in the UK, 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(lands) Woods mainly or entirely composed of native species.

Natural regeneration Plants growing on a site as a result of natural seed fall or suckering. The term is also used to describe the silvicultural practices used to encourage natural seeding and establishment.

Notification The process of informing someone (about something). The forestry authorities have various arrangements for notifying interested parties of forestry proposals.

Open space Areas within a forest without trees, such as glades, stream sides, grass or heath land, 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. Also called a site plan.

Organic matter The organic fraction of the soil exclusive of undecayed plant and animal residues.

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 formed of partially decomposed plant material. The Forestry Commission soil classification defines peat as soil having an predominantly organic (peat) layer of depth greater than 45 cm.

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.

Phenology The study of natural phenomena in biological systems that recur periodically (e.g. development stages, migration) and their relation to climate and seasonal changes.

Planned adaptation Adaptation that is the result of a deliberate policy, based on an awareness that conditions are in the process of change and that action is required to maintain, or regain, the desired state.

Plantations Forests that have been planted or sown and are characterised by intensive silviculture treatment to meet a

specific objective or limited range of objectives. Plantations lack most of the characteristics of natural forests.

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**

Productivity (of woodland) The capacity to produce forest goods and ecosystem services.

Protection forest A forest that has a primary function of protecting the environment.

Provenance Location of trees from which seeds or cuttings are collected. Designation of Regions of Provenance under the Forest Reproductive Materials 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.

Public Register Public listing by the Forestry Commission of grant schemes, felling proposals and Environmental Impact Assessments to allow public comment.

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 absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change.

Restocking Replacing felled areas by sowing seed, planting, or allowing or facilitating natural regeneration.

Riparian Relating to or situated adjacent to a watercourse or water body.

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, but for conifers in the UK this is usually about 35 years and for broadleaves at least 60 years.

Semi-natural woodland Woodland composed of mainly locally native trees and shrubs that derive from natural seedfall or coppice rather than from planting. However, the definition varies according to the local circumstances in England, Scotland, Wales and Northern Ireland.

Sequestration *see* **Carbon sequestration**

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 primarily for the production of biomass.

Silviculture The growing and cultivation of trees, including techniques of tending and regenerating woodlands, and harvesting their physical products.

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 100 years; and an inert or passive store which takes more than a thousand years to recycle.

Spinney A small area of trees and bushes traditionally surrounded by a hedge.

Stand A discrete area of trees; characterised by homogeneity in attributes such as yield class, age, condition, distribution and thinning history.

Statutory body(ies) The authorities and bodies responsible for nature conservation (Natural England, Scottish Natural Heritage, Countryside Council for Wales and the Northern Ireland Environment Agency); environmental protection (Environment Agency (England and Wales), Scottish Environment Protection Agency and Northern Ireland Environment Agency); and the historic environment (English Heritage, Northern Ireland Environment Agency, Historic Scotland and Cadw).

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 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. (MCPFE 1993)

Thinning The removal of a proportion of trees in a forest after canopy closure, usually to promote growth and greater value in the remaining trees.

Water body The basic water management unit defined under the Water Framework Directive for which environmental objectives are set. Water bodies can be parts of rivers, lakes and estuaries, stretches of coastal water or distinct volumes of groundwater.

Watercourse Any natural or man-made channel through which water flows continuously or intermittently.

Wetlands Wetlands are transitional areas between wet and dry environments: they range from permanently or intermittently wet land to shallow water and water margins. The term can describe marshes, swamps and bogs, some shallow waters and the intertidal zone. When applied to surface waters, it is generally restricted to areas shallow enough to allow the growth of rooted plants.

Windthrow (or windblow) Uprooting of trees by the wind.

Woodfuel Wood used as a fuel. Woodfuel may be available in a number of forms such as logs, charcoal, chips, pellets or sawdust.

Notes


www.forestry.gov.uk/ukfs/biodiversity


www.forestry.gov.uk/ukfs/climatechange


www.forestry.gov.uk/ukfs/historicenvironment


www.forestry.gov.uk/ukfs/landscape


www.forestry.gov.uk/ukfs/people


www.forestry.gov.uk/ukfs/soil


www.forestry.gov.uk/ukfs/water

Practising sustainable forestry means managing our forests in a way that meets our needs at present but that does not compromise the ability of future generations to meet their needs. They will rightly expect that their forests and woodlands offer at least the same benefits and opportunities as we enjoy today. To sustain these expectations, the UK governments have set out the UK Forestry Standard and its supporting Guidelines. At the heart of this approach is the importance of balancing the environmental, economic and social benefits of forests and the recognition that our forests serve a wide range of objectives. The Guidelines publications define sustainable forest management in the UK under a series of subject areas. The UK Forestry Standard requirements have been set out in each and guidance given on how to achieve them.

www.forestry.gov.uk/ukfs/climatechange

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