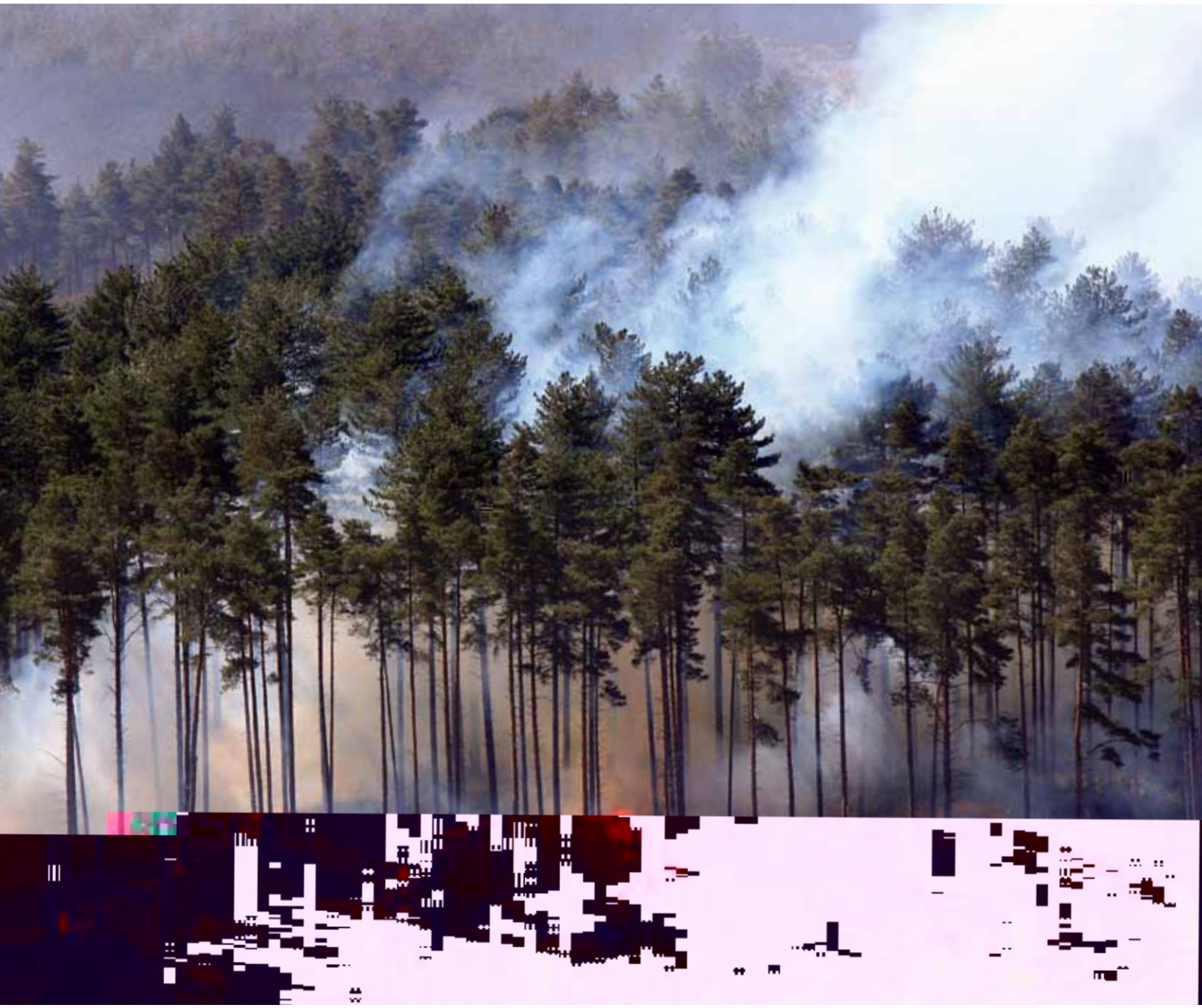
Forestry Commission



Practice Guide

Building wildfire resilience into forest management planning

FOREST SERVICE

Forestry Commission

Practice Guide

Building wildfire resilience into forest management planning

Forestry Commission: Edinburgh

This publication is also available on our website at: www.forestry.gov.uk/publications.

First published by the Forestry Commission in 2014.

ISBN: 978-0-85538-886-7

Forestry Commission (2014).
Building wildfire resilience into forest management planning
Forestry Commission Practice Guide
Forestry Commission, Edinburgh.

Keywords: contingency planning; environment; forest management planning; forestry; resilience sustainable forest management; wildfire.

FCPG022/FC-GB(ECD/AH)/JTCP-1.5K/APR14

Enquiries relating to this publication should be addressed to:

Forestry Commission
Silvan House
231 Corstorphine Road
Edinburgh EH12 7AT
0131 334 0303
publications@forestry.gsi.gov.uk

In Northern Ireland, to:

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

The Forestry Commission will consider all requests to make the content of publications available in alternative formats. Please send any such requests to the Diversity Team at diversity@forestry.gsi.gov.uk or call 0131 314 6575.

Contents

Acknowledgements

A number of organisations and individuals have contributed to the development of this Practice Guide: in particular we would like to thank the Department of Sustainability and Environment, State of Victoria, Australia; the National Rural Fire Authority and SCION, New Zealand; the USA National Fire Protection Association; the UK Chief Fire Officers Association, UK Fire Brigades Union, England and Wales Wildfire Forum, Dorset and Northumberland Fire and Rescue Services, Confederation of Forest Industries (CONFOR), the Institute of Chartered Foresters, the Cabinet Office Civil Contingencies Secretariat, and Natural England. Figures 2, 3 and 6 were adapted from material supplied by the EuroFire project (funded by Leonardo da Vinci – European Training for the UK).


Forestry Commission
Forests and climate change
UK Forestry Standard Guidelines

Reducing the incidence and impact of wildfires in forests and woodlands through good management planning is important for sustainable forest management and to protect the provision of forest ecosystem goods and services. It can help to prevent small wildfire incidents escalating into large-scale, out-of-control events, reduce the costs of fire suppression, and reduce the impact on the fire and rescue services – allowing them to respond to other more immediate life-threatening incidents.

Defining 'wildfire'

Wildfires, including forest fires, are defined as 'any uncontrolled vegetation fire that requires a decision, or action, regarding suppression'. Vegetation fires also include operations such as prescribed burning and suppression fires (defined below), which are not covered by this Practice Guide. Vegetation fires affect a wide range of land uses and habitat types in the UK.

Prescribed burning operations
Prescribed burning (controlled fire) is a method of managing vegetation in a variety of habitats. This may be to encourage new growth and diversify the structure of heather moors, or to reduce fuel loading in a forest or woodland. Prescribed burning is only appropriate in a limited number of situations and should only be undertaken by trained staff.

Suppression fires
Suppression fires are used to burn off the vegetation that could provide the fuel ahead of an established wildfire. Suppression fires are not appropriate for all situations and should only be undertaken by skilled fire fighters.

Aim and scope

This Practice Guide sets out good practice for building wildfire resilience into forest management planning. The guidance aims to help reduce the likelihood and severity of wildfires in forests and woodlands in the UK and promote appropriate fire prevention regimes. It is primarily focused on the planning measures that can be used and only covers operational issues, such as fire suppression activities, where they benefit from some element of forest management planning.

The Guide supports the UK Forestry Standard, and applies to both new and existing forests and woodlands on the public and private estate across England, Scotland, Wales and Northern Ireland. It is aimed at forest and woodland owners and managers, forestry practitioners, planning teams and all those involved in adaptive management aimed at building resilient forests. The guidance is not intended to be prescriptive, and it should be applied proportionately to the level of risk of a wildfire occurring in a particular forest or woodland.

Wildfires in the UK

Most of the wildfires that affect forests and woodlands in the UK are 'surface fires', which are fuelled by leaves and needles in the litter layer, scrub and other low-level vegetation. Some are 'ground fires' that burn into peat. Only a small minority of wildfires will result in a 'crown fire', an extreme and highly hazardous fire event. Wildfires, once established, can be categorised as 'wind driven', 'fuel driven' or 'topographically driven', depending on the way that they spread.

How do wildfires start?

While wildfires can occasionally start naturally, for example by lightning strikes, the vast majority are caused by people – either accidentally or deliberately. The risk of a fire starting is increased by the combination of a number of factors (see below), including periods of hot, dry weather and a build-up of dry or dead vegetation, which acts as a fuel. After a fire has established, low relative humidity and high winds provide ideal conditions for the fire to spread rapidly.

When do wildfires occur?

Most wildfires in the UK occur in spring and summer (known as the 'fire season'). This is because a large volume of ground vegetation (a significant proportion of which may be dry), combined with extended periods of hot or dry weather, increases fire risk. Wildfires are particularly destructive during a drought because the twigs and branches of trees also dry out, providing further fuel for a fire. Climate projections indicate that spring and summer droughts are likely to become more frequent in some parts of the UK and wildfire risk is therefore likely to increase (Box 1).

What factors increase wildfire risk?

A number of factors can contribute to an increased risk of a wildfire starting or spreading, and extreme fire events may occur when several of these factors combine. Key factors include:

- Site location and climate
- Site topography
- Land use and vegetation type
- Weather
- Forest and tree health.

Site location and climate

The location of a forest or woodland will influence the risk of a wildfire occurring in two key ways. The first is climate, as set out in Box 1, and the second is remoteness. The proximity of forests and woodlands to urban areas and increased public access increase the risk of wildfires, as most are started by people. However, while there are more fires in woodlands close to urban areas, these are likely to be smaller and less serious due to faster detection, reporting and response. Conversely, while there are generally fewer wildfires in forests in remote locations, these are often more serious when they do occur. This is due to delays in detection, difficulty in reporting if there is a poor mobile phone signal, and the response time if the fire is difficult to locate.

Box 1 Impacts of climate change on wildfire risk in the UK

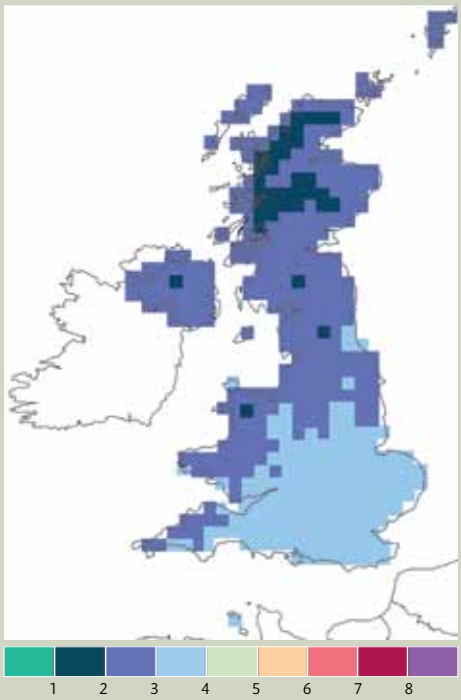
The climate projections published by the Met Office in 2009 show that there are a number of factors that could have an impact on wildfire risk in the UK. By the 2080s, summer mean temperature is projected to increase across the whole of the UK – by around 4.2 °C in the south of Britain and by just over 2.5 °C in the north of Britain. Summer rainfall declines across most of England and Wales, by around 40% in parts of the far south of England, but changes are minimal over northern Scotland. Relative humidity decreases by around 9% in summer in southern England and by less elsewhere.

For more information see: **http://ukclimateprojections.metoffice.gov.uk**

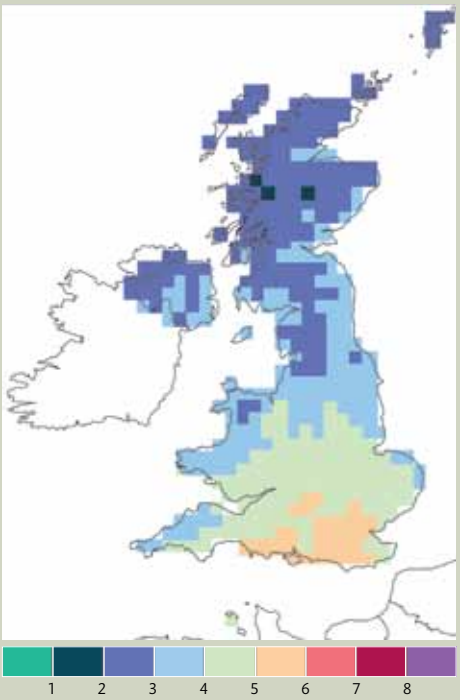
Wildfire risk

A preliminary assessment of the potential implications of climate change for wildfire risk was carried out as part of the *UK climate change risk assessment*. This was done by applying the 'McArthur Forest Fire Danger Index' (FFDI) to the output of a regional climate model. The FFDI was developed in Australia and incorporates a number of variables, including daily maximum temperature, daily mean wind speed and the number of days since it last rained. The results of the preliminary assessment for the UK are illustrated in the maps below, which show the simulated 30-year mean FFDI for 1970–2000 (left) and 2070–2100 (right).

Forest fire danger index 1970–2000



Forest fire danger index 2070–2100



A value of 1 means that fire will not burn, while a value of 5–12 is considered a 'moderate' risk. The index is exponential, extending to 50 (serious), 75 (extreme) and 100 (catastrophic). The simulations project the wildfire risk to rise across the whole of the UK by the 2080s, with the largest increase occurring in southern England, extending into south Wales. The smallest projected increase in risk is in northern Scotland. It should be noted that this is a preliminary assessment for illustrative purposes only, and is not intended for use in decision-making.

For more information on the *UK climate change risk assessment* and to download the Evidence report, visit: **www.gov.uk**.

Site topography

Wildfire intensity and the speed of spread is influenced by landscape characteristics such as site topography; valleys and gullies affect fire behaviour and can, in addition, alter the direction or channel prevailing winds generating a 'chimney effect' and extreme fire events (Figure 2).

Changes in slope can increase the size of the area where vegetation could become pre-heated as well as cause uphill convection clouds. Fires tend to burn uphill at greater speed and intensity than they burn downhill (Figure 3). Compared with level ground, slopes greater than 10% double the speed of fire spread; slopes greater than 20% quadruple the speed.

Figure 2 The effect of valleys and gullies on fire behaviour.

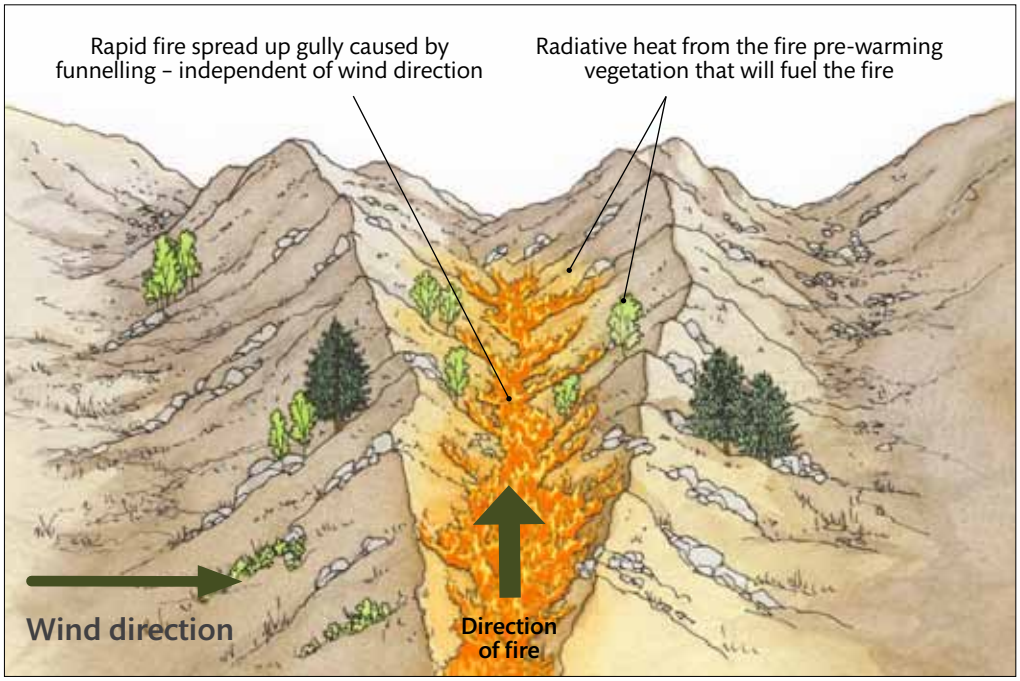
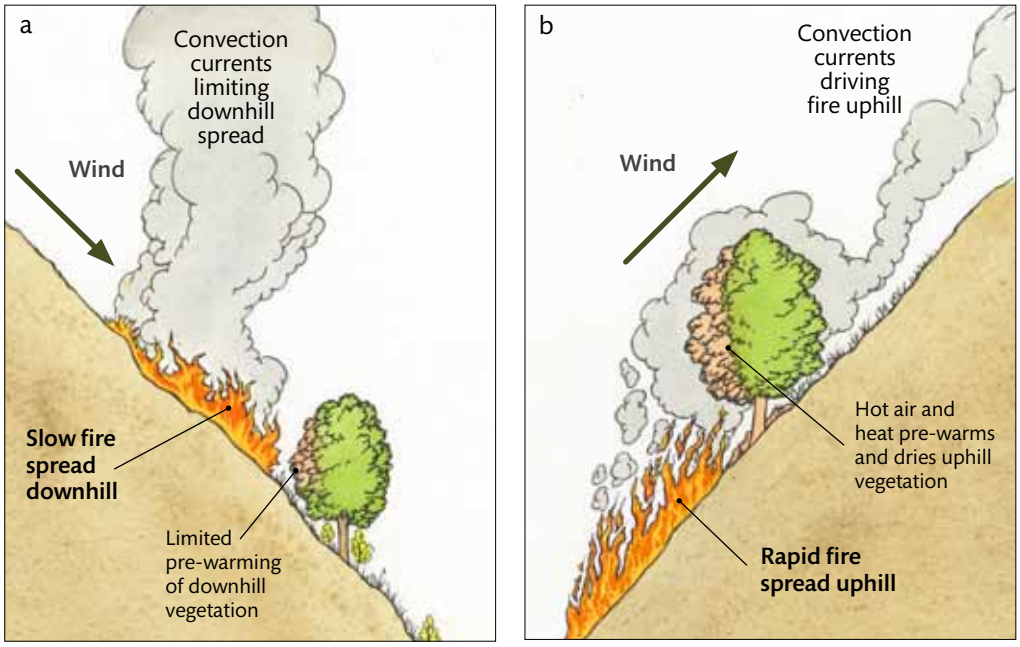


Figure 3 The effect of slope on fire behaviour: (a) a low-risk 'creeping fire' burning slowly downhill, and (b) a dangerous 'running fire' burning rapidly uphill.



Slope type influences the rate at which fire will spread:

- Fires on **straight slopes** have a predictable rate of spread.
- Fires on **concave slopes** will be faster and burn more intensely at the summit.
- Fires on **convex slopes** will be faster and burn more intensely at the base of the slope.

Slope type also influences visibility; fires on straight and concave slopes can be more easily seen from viewpoints and high ground than those on convex slopes.

Slope aspect influences the risk of a wildfire occurring and the severity of a wildfire incident if it does occur. Sites with predominately south-facing slopes will be warmer than those facing north and will be hottest in the afternoon; wildfires on these sites are therefore more likely to exhibit extreme fire behaviour.

Land use and vegetation type

Land use and vegetation type will influence the likelihood of a wildfire starting or spreading. Table 1 sets out the susceptibility of different habitat types found in the UK by land-use type.

Table 1 Susceptibility of different land-use types by habitat type (based on the Joint Nature Conservation Committee (JNCC) Broad Habitat classification).

Land-use type	High-risk habitats	Low-risk habitats
Forests and woodlands	Young coniferous woodland of pine, spruce or fir. Plantations of eucalyptus/cypress.	Broadleaves, mixed and yew woodlands.
Heathland, moorland and semi-natural grassland	Dwarf shrub heath, gorse, bracken, grasses.	Bogs (unless in drought conditions).
Agriculture and horticulture	Arable crops nearing and immediately after harvest. Grasslands nearing harvest.	Grasslands after harvest.
Agroforestry	Christmas tree plantations.	Short rotation coppice (excluding eucalyptus).
Urban greenspace	Roadside and railway side vegetation (dependent upon season and species).	Gardens in built-up areas.

For forest and woodland land uses, forest type will affect wildfire risk. Tree species such as eucalyptus, pine, spruce and fir can be high risk and coniferous woodland is at a higher risk than broadleaved woodland – particularly if the trees are young and even-aged (thicket-stage conifers are at a particularly high risk). Wildfire risk is also increased for certain silvicultural systems: uniform silvicultural systems pose a higher risk than irregular shelterwood systems.

Woodland structure (i.e. the density and arrangement of trees and other vegetation) affects the availability of ground, surface and crown fuels in the event of a wildfire, as does a build-up of standing, fallen and stump deadwood, post-harvesting residues and log stacks.

The density of vegetation can also affect the speed at which a fire will burn by influencing air movement and the supply of oxygen. For example, the high density of litter and organic matter in surface forest fires and peat fires results in much slower fires than those in thicket-stage conifers.

Weather

Dry conditions and high winds are significant factors affecting the chances of a fire starting, the intensity with which it will burn and the rate at which it can spread. Wind can cause 'fire spotting' (i.e. burning leaves and bark being blown ahead of the main fire causing smaller fires to start), and also increases the risk of extreme fire behaviour (Figure 4). However, wind speed and direction may change during a wildfire incident and will often not be predictable.

Figure 4 Extreme fire behaviour caused by a combination of fuel loading and a sudden increase in wind speed at Swinley Forest, Berkshire, in 2011.

Forest and tree health

Pest and disease outbreaks can reduce the resilience of forests and woodlands to wildfire by increasing fuel loading associated with both standing trees and surface litter. The thinner crowns associated with stands in poor health also promote the growth of ground vegetation, further increasing fuel loading. Fallen and leaning trees can create 'ladder fuels', which allow surface fires to move to the crowns of trees, thus promoting extreme fire behaviour. This risk is particularly acute in areas subject to significant windthrow. Wind damage may also limit access within the forest, impairing the ability to respond effectively to wildfire events.

What can be done to prevent wildfires?

It may not be possible to prevent wildfires completely, but wildfire resilience can be improved through good forest management planning. This should focus on reducing the likelihood of wildfires occurring, reducing the severity of damage and impacts on people and the environment if they do occur, and assisting with fire suppression activities. These are the subjects of the next two sections of this Guide.

The importance of planning

Forest and woodland owners and managers should ensure that wildfire resilience is considered at the start of the forest management planning process and, where relevant, that a wildfire management plan is produced and integrated with the final forest management plan.

Forest management plans

The details required for a forest or woodland grant scheme or felling application can provide the basis for the forest management plan at its most simple. 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.

In forests and woodlands where wildfire has been identified as a risk, it is recommended that a representative from the fire and rescue services or other wildfire advisor is included as part of the planning team. Their skills can be used to help define fire hazards and risks as well as advise on appropriate prevention measures that can be incorporated into the forest management plan.

Contingency plans

Contingency plans cover what happens in the event of an unexpected or unplanned event and are produced as part of the forest management planning process. They can be used to address threats such as accidents, spillages, pest and disease outbreaks, extreme weather events and fire. The UK Forestry Standard requires that appropriate contingency plans are put in place to deal with such risks to the forest.

Wildfire management planning

Although wildfire management planning is part of contingency planning, consideration of wildfire resilience should be embedded within the forest management planning process. Good planning and the design of appropriate resilience measures will help prevent wildfires occurring and reduce the impact of those that do occur. Wildfire management planning should be proportionate to the level of risk – it should also be considered at the landscape scale, and so it will include the risk the surrounding land poses in addition to the forest or woodland itself.

In areas that are at high risk of wildfire, a specific wildfire management plan should be produced that will provide details of all issues relating to wildfire prevention and management and the evidence upon which it is based. In some instances, the wildfire management plan will be an integral component of the forest management plan, but in more complex, high-risk situations, it will be a separate document. The plan should contain details of the following:

- Wildfire risk assessment
- Wildfire prevention measures
- Wildfire response plan.

Wildfire risk assessment

A wildfire risk assessment can be a useful tool for identifying fire hazards and evaluating fire risk. It can be used as a framework for planning decisions on wildfire prevention measures, and form the evidence base for the wildfire management plan, by providing details of specific site hazards and how wildfire risks will be mitigated and managed.

Further information on using wildfire risk assessments in planning is provided on page 11. An example wildfire risk assessment template with a worked example is provided in Appendix 1.

Wildfire prevention measures

Wildfire prevention measures are planned forest management techniques used to increase the resilience of the forest to wildfire and reduce the severity and spread of a wildfire event.

Wildfire management zones are a way of zoning sites around particular assets or infrastructure to determine the nature and extent of any wildfire prevention measures required, for example where operations such as prescribed burning should be avoided or can be carried out. Further details on wildfire management zones are provided in Appendix 2.

Wildfire response plan

Wildfire response plans (also known as 'fire plans' and 'fire maps') provide vital information to the fire and rescue services in the event of a wildfire. Although they are prepared in advance for the response phase of an incident, the information gathered can be used to help refine forest planning decisions in areas of high wildfire risk by consideration of factors such as access points and water supplies. It is critical that the wildfire response plan accurately reflects what exists on the ground; plans may only be valid for short periods if forest operations change the structure or fuel loading of the site (e.g. through thinning and clearfelling).

The information required to develop a wildfire response plan is considered at various stages of the forest management planning process. Further details on the information required for a response plan and an example fire map with standard symbols are provided in Appendix 3.

Wildfire response plans should include:

- Forest/woodland name and location
- Contact details
- Access and communications
- Signage and orientation features
- Assembly/rendezvous points
- Site hazards
- Fuel hazards
- Priority protection areas
- Water supplies

The planning process

Building wildfire resilience can be considered under each of the seven stages of the forest management planning process defined in the guidelines in the UK Forestry Standard on General forestry practice (Table 6.1, page 52).

1. Scoping
2. Survey
3. Analysis
4. Synthesis
5. Implementation
6. Monitoring
7. Review

These stages are discussed in more detail in the following sub-sections, which focus on the wildfire aspects of forest and woodland resilience that are relevant to each stage.

1. Scoping

At the Scoping stage, management objectives are defined and stakeholders identified. Wildfire resilience should always be considered at this stage even if it is later decided that it is not relevant for a particular forest or woodland.

Setting objectives

Management objectives for forests and woodlands will be set out within the framework of national, regional and local strategies and policies. For sites where there is a high risk of wildfire, wildfire resilience should be stated as an objective of the forest management plan.

It is useful to consider 'critical success factors' at this stage. These should be developed so that the effectiveness of any wildfire resilience measures can be assessed during monitoring and to determine whether objectives have been met. Example critical success factors could include:

- a reduction in the number of wildfire incidents over the period of the management plan;
- a reduction in the area burnt or damaged during wildfire incidents;
- reduced disruption and damage to critical infrastructure over a 10-year period.

Identifying stakeholders

Key stakeholders might include the local wildfire group, fire and rescue services, police and relevant landowners. For larger sites, consider the local resilience forum – a multi-agency partnership made up of representatives from local public services, including the emergency services, local authorities, the NHS, the Environment Agency and others. Consulting stakeholders early in the planning process will help to:

- identify hazards;
- quantify risks;
- understand the impact of forest management plan proposals;
- generate a combined, collaborative solution;
- contribute resources (information, skills, staff, money).

2. Survey

The Survey stage is a comprehensive exercise to collect and map all the information about a site and its location, including any statutory constraints that might apply. If wildfire resilience has been identified as relevant at the Scoping stage, then the most important information to gather will be that needed to produce a wildfire management plan – which will include the information needed to carry out a risk assessment (see page 11), prioritise areas for wildfire management (see page 14), and develop a wildfire response plan (see page 15).

This information will include, for example, details of site location and topography, existing land use and vegetation type, site designations (e.g. for natural or cultural heritage), prevailing climate, impact of past weather events, and forest and tree health. Information may come from a range of sources, such as records and reports of previous wildfire incidents from your own files (or those from other landowners), or through consultation with stakeholders and residents, or from personal and professional experience.

Historical weather records, including information on wind speed and wind direction from past wildfire incidents, can be useful but must be used with caution in planning as all wildfires are unique events.

Carrying out a risk assessment

It can be helpful to use a risk assessment framework to identify fire hazards and calculate fire risk (Box 2). This will aid decision making and provide the evidence base for the wildfire management plan. Fire risk is the probability of a wildfire occurring and its potential impact at a particular location. It can be quantified using the formula: 'Fire risk = likelihood x severity'.

The level of detail required for a wildfire risk assessment should be proportionate to wildfire risk. It can be presented in map or matrix form, depending on the scale and nature of the forest or woodland being assessed. Appendix 1 provides more information on calculating fire risk and an example risk assessment template, based on the HSE (Health and Safety Executive) framework.

When carrying out a risk assessment, remember:

A **hazard** is anything that may cause harm, for example extreme fire behaviour. The **risk** is the chance, high or low, that someone or something could be harmed by this or any other hazard, together with an indication of how serious the harm could be.

Box 2 Carrying out a wildfire risk assessment

Step 1 Identify the hazards
Step 2 Decide who/what might be harmed and how
Step 3 Evaluate the risks and decide on precautions
Step 4 Record your findings and implement them
Step 5 Review your assessment and update if necessary

Identifying hazards

Details on land use and vegetation type should be collected as it can have an impact on the likelihood and severity of a wildfire incident in a particular forest or woodland. It is important to consider information on land use at the landscape scale and not just at site level, as surrounding land may also present hazards to the forest or woodland. Examples include:

- Habitats with a high wildfire risk – such as young, even-aged conifers or areas of dry heath within, or adjacent to, forests and woodlands.
- Residential/commercial/industrial developments – where the assessment of risk should include any potentially hazardous materials or equipment.
- Utilities/transport – such as sub-stations, power lines or steam train railway lines.
- Recreation facilities and areas of public access – where fires may be started accidentally or deliberately.

Figure 5 Fires may be started accidentally, for example by the careless use or disposal of a barbeque.

Mapping fuel hazards

The different types of trees and other vegetation found in forests and woodlands have different fuel characteristics (Table 2), which will be affected by the time of year and prevailing weather. Defining and mapping the locations of generic vegetation types (e.g. type and age of woodland) and open ground at a broad scale is an important part of the survey and the resulting map should form a component of the wildfire management plan (see Appendix 3).

Fine fuels are the first stage in fire development. They are easy to ignite and burn very rapidly, but at low temperatures. Light, medium and coarse fuels become progressively more difficult to ignite due to better moisture retention. They burn more slowly than fine fuels but at higher temperatures and for longer periods.

Table 2 The fuel characteristics of different vegetation types.

Vegetation type	Size (diameter)	Moisture gain/loss	Fuel type
Grass, heather, leaves/needles, moss, surface litter	5 mm or less	Very rapid	Fine fuel
Living and dead twigs and stems	5 mm to 25 mm	Rapid	Light fuels
Small trees, sticks, branchwood, shrubs and low-level vegetation	25 mm to 75 mm	Slow	Medium fuels
Mature trees, standing and fallen deadwood, logs, deep humus and litter layers, peat	75 mm or greater	Very slow	Coarse and heavily compacted fuels

The quantity and density of vegetation should also be surveyed as part of information gathering. Figure 6 shows how woodland can be considered in a vertical and horizontal framework across a site. In all vegetation types, and especially trees, fire can move between vertical fuel types creating a 'fuel ladder' (Figure 7), which can promote extreme fire behaviour such as crown fires.

Figure 6 The vertical and horizontal distribution of vegetation fuels. Horizontal arrangement is the distribution of fuels across a compartment; vertical arrangement is the layers of fuel from ground level up to the canopy.

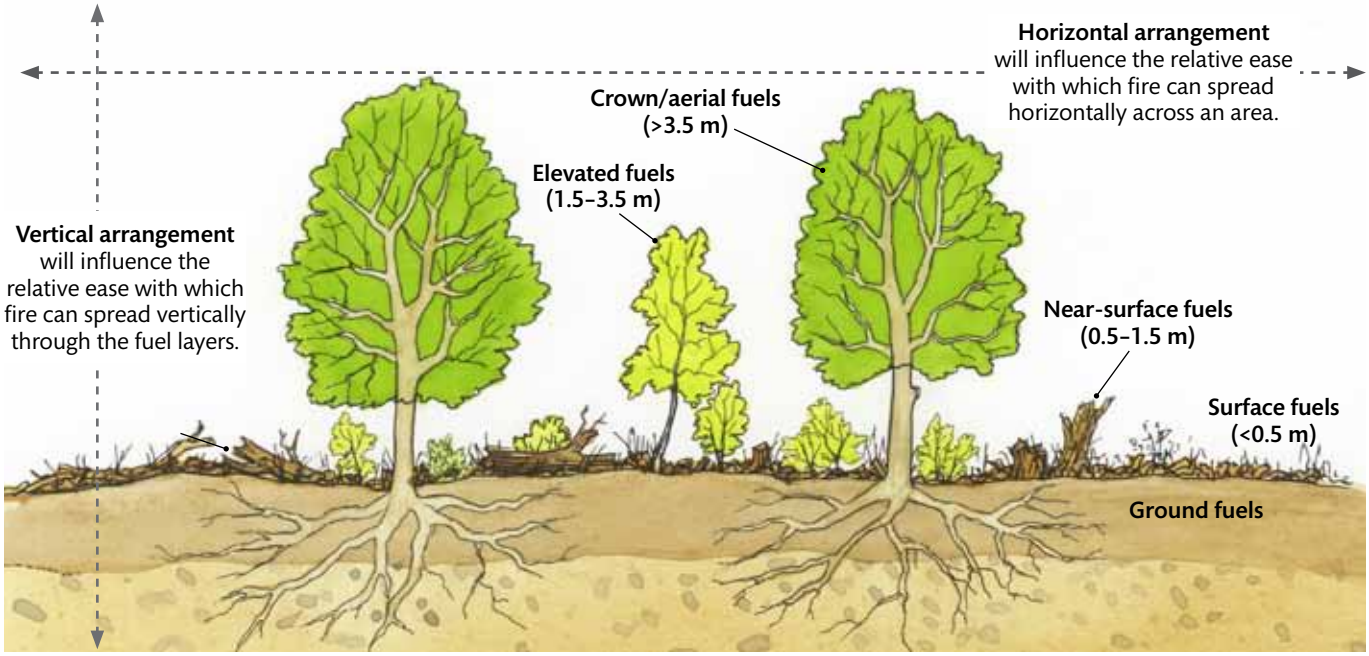


Figure 7 Ladder fuels demonstrating torching behaviour within Corsican and Scots pine at Swinley Forest, Berkshire, during 2011.

Identifying who or what might be harmed

After identifying hazards, identify buildings and other facilities used by forest workers or the public; the protection of human life is always the first consideration and it will be the priority of the fire and rescue services in the event of a wildfire. Also identify any assets and infrastructure that could be damaged or destroyed (or where disruption and damage could have a significant, costly impact). Examples are given in Box 3, but these will vary with location and site type.

Box 3 Assets and infrastructure

Environmental assets
Include designated sites such as Sites of Special Scientific Interest and National Nature Reserves. Cultural heritage includes ancient monuments, listed buildings and valued landscapes.

Social assets
Include commercial and residential properties (especially thatched properties) and leisure and recreational facilities such as path networks, mountain bike trails and visitor centres.

Economic assets
Include farmland, other food and fibre production, woodfuel, sporting and tourism, and wind farms.

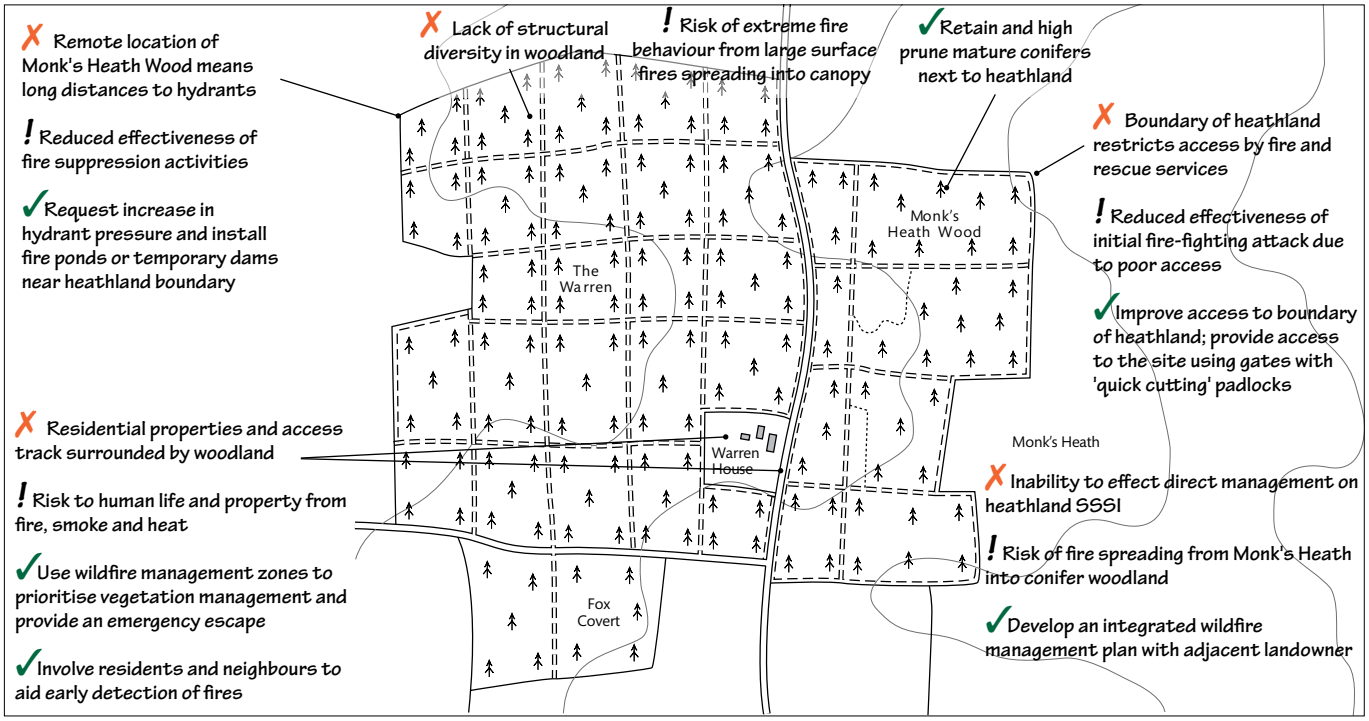
Infrastructure
Includes transport infrastructure such as motorways or other important roads and railways, and utilities such as power lines, underground pipelines and sub-stations.

Smoke, sparks and embers from fires can carry for many hundreds of metres and affect a wide area. Sparks and embers can cause separate 'spot fires' well beyond the main fire. Smoke from wildfires may also affect flight paths.

Identifying areas for wildfire management

Identifying areas for wildfire management can be achieved by using 'wildfire management zones' – a method of zoning sites according to the level of wildfire resilience required (Table 3). Zones are designed to ensure the proportionate use of wildfire prevention measures and are determined by the location of assets, priority protection areas and other factors identified during

Figure 9 An example map-based analysis of wildfire factors highlighting constraints (✗), opportunities (✓) and threats (!) for Monk's Heath Wood (see also Table 4).



4. Synthesis

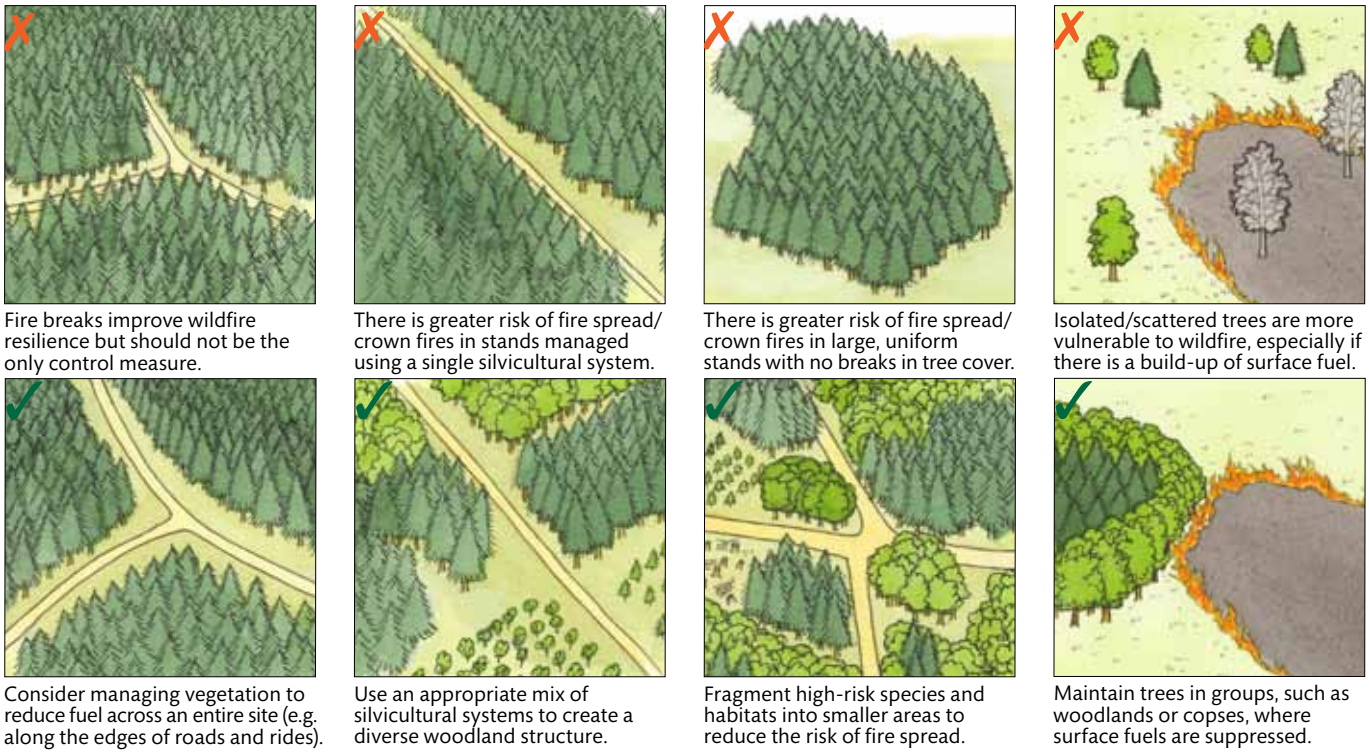
At the Synthesis stage, the design concept is developed and the draft management plan drawn up. This is an iterative process that uses management objectives and the analysis to refine the forest management plan before it is finalised and submitted for approval. The aim at this stage should be to ensure wildfire resilience is balanced with other objectives and to ensure that prevention measures are financially sustainable. The wildfire prevention measures developed at this stage should be integrated with the design proposals for the forest management plan.

The aim of wildfire prevention measures in planning wildfire resilience is to reduce the risk of wildfires occurring and to minimise the impact of any wildfires that do occur. Planning should start at the largest scale and work down to the smallest scale (e.g. landscape, forest management unit, compartment) to be fully effective. Some key design concepts to achieve this are given in Figure 10. The proposals should now also clearly define specific fire prevention measures such as wildfire management zones and other control measures, where applicable, and these should be detailed in the wildfire management plan.

A number of forest management techniques can be used to build wildfire resilience into forests and woodlands. The following are described in the next section of this Guide:

- Managing vegetation and fuels (page 19)
- Creating fire breaks and fire belts (page 20)
- Improving forest design (page 23)
- Building silvicultural resilience (page 26)
- Planning for people (page 29)
- Planning for an incident response (page 31).

Figure 10 Principles of good planning for building wildfire resilience into forest design.



Fire breaks improve wildfire resilience but should not be the only control measure.

There is greater risk of fire spread/ crown fires in stands managed using a single silvicultural system.

There is greater risk of fire spread/ crown fires in large, uniform stands with no breaks in tree cover.

Isolated/scattered trees are more vulnerable to wildfire, especially if there is a build-up of surface fuel.

Consider managing vegetation to reduce fuel across an entire site (e.g. along the edges of roads and rides).

Use an appropriate mix of silvicultural systems to create a diverse woodland structure.

Fragment high-risk species and habitats into smaller areas to reduce the risk of fire spread.

Maintain trees in groups, such as woodlands or copses, where surface fuels are suppressed.

5. Implementation

At the Implementation stage, operational plans are developed from the forest management plan and work programmes are prepared. For areas at high risk of wildfire, and where a specific wildfire management plan has been drawn up, wildfire prevention measures should now be implemented. Priorities will be determined by the requirements of wildfire management zones, where these have been used to protect assets and infrastructure.

Active management to reduce fuel loadings and ongoing maintenance in wildfire management zones A and B (see Managing vegetation and fuels – page 19 and Appendix 2) will increase effectiveness of wildfire prevention measures.

Plan documentation

Wildfire management may be fully integrated with the overall forest management plan, in which case the risk assessment documentation and other relevant information should be recorded in the overall plan. Where a specific wildfire management plan has been produced, the response plan component should be sent to the fire and rescue services (where it will be used to develop a fire suppression plan), local wildfire groups and neighbouring landowners.

Where possible, the wildfire response plan should be in a format that can be most easily used by the fire and rescue services, so it is important to check and find out their preference. If a geographic information system (GIS) or similar software system has been used in the forest management planning process, it may be possible for forest managers and planners to supply a digital version of the fire map to the fire and rescue services, which could then be uploaded to a mobile data terminal so that it is accessible from a fire appliance during an incident.

6. Monitoring

Monitoring the effectiveness of wildfire resilience measures should be part of the forest management plan review cycle. Indicators of progress should be checked at regular intervals and data collected and recorded to evaluate delivery. In wildfire management planning, the critical success factors set at the beginning of the planning process (see Stage 1 – Scoping) should be regularly monitored to assess whether the objectives have been met during plan development and delivery. These factors should be re-evaluated if necessary.

For effective monitoring, it is important that forest managers can refer to their own accurate wildfire incident records, as well as data from their local fire and rescue services.

7. Review

At the Review stage, work on the forest management plan is recorded and at regular intervals (usually 5 or 10 years) the plan is updated. Reviewing the wildfire management plan as part of this cycle will allow changes to be incorporated and provide an opportunity for new staff to familiarise themselves with wildfire management issues and any wildfire prevention measures that have been implemented.

Changes in land use

Over the period of the forest management plan it is likely that either forest operations will have altered the structure of the forest or woodland, or land use and vegetation type will have changed in other ways. The age profile of conifer-dominated woodland should be assessed, focusing on the development of thicket-stage stands. The creation/restoration of open ground habitat, either within or adjacent to the forest, may have enhanced wildfire risk. In contrast, restructuring and the planting of broadleaved trees may have reduced wildfire risk. Any changes in infrastructure associated with the woodland (e.g. new power or pipelines) should be considered in the review, as should changes in the condition or classification of forest roads. New buildings (or changes in use or demolition of existing buildings) and changes in recreational use of the forest should also be reflected during the review process.

Learning from past incidents

If a wildfire incident has occurred since the last update, there will be opportunities to learn from what has happened. Opportunities to re-establish a more resilient forest for the future should be discussed with the local wildfire advisor, if available. Specific aspects to consider might include: the availability of water during the wildfire incident and whether there is a need for additional fire ponds or access points to natural water supplies; issues associated with access to and within the forest that could be addressed by improving/upgrading the forest road network; lack of fire belts/breaks that impaired the wildfire response; and whether the structure of the forest promoted the rate of spread or intensity of the wildfire incident.

Wildfire response plan

The wildfire response plan (see Appendix 3) should also be updated as part of the review cycle to take account of wildfire prevention measures that have been put in place during the plan period. These elements will have become physical features that the fire and rescue services can use, rather than the conceptual proposals illustrated in the forest management plan.

Forest management techniques

Wildfire resilience can be achieved through a number of forest management techniques, which should be considered during the forest management planning process:

- Managing vegetation and fuels
- Creating fire breaks and fire belts
- Improving forest design
- Building silvicultural resilience
- Planning for people
- Planning for an incident response.

Managing vegetation and fuels

Managing vegetation in forests and woodlands with the aim of preventing a build-up of fuel should be considered across a whole site or, if not financially possible, in strategic locations that are identified during the forest management planning process. The aim should be to create a mosaic of managed vegetation that reduces wildfire risk and provides opportunities to extinguish a fire rather than relying on linear features such as fire breaks.

For existing forests and woodlands, wildfire resilience can be improved through vegetation treatments such as thinning and felling, cutting back ride-side vegetation, and linking naturally resilient features such as rivers and wetlands to fragment high-hazard areas. For new forests and woodlands, or when re-structuring existing forests, resilience can be achieved by choosing fire-resilient species, selecting appropriate silvicultural systems, and creating fire breaks or fire belts.

Management approaches

As described on page 14, wildfire management zones are a useful way of zoning sites to determine the level of vegetation management required at a particular location. Four zones (A–D) are defined (see Appendix 2) and Table 5 sets out examples of suitable vegetation management practices that can be used in each. Managing vegetation will be the principal method of reducing the risk of wildfire incidents in Zones A and B.

Table 5 Suitability of forest management practices for managing vegetation in wildfire management zones.

Management practice	Zone A	Zone B	Zone C	Zone D
Vegetation management	Vegetation and other combustible materials should be minimised	Fuel loading and deadwood should be reduced	Conventional vegetation management practices	Conventional vegetation management practices
Prescribed burning	Not suitable close to buildings and other assets/infrastructure	• Use a prescribed burning plan • Use manual/mechanised cutting to reduce vegetation around the edge of the coupe to be burnt • Ensure that a wildfire response plan is in place in the event of a fire going out of control		Not suitable
Grazing	Intensive grazing of grass suitable	• Use manual/mechanised cutting to reduce vegetation around the edge of the grazing site • Fragment the grazing site using fire/fuel breaks	Conventional grazing management practices	• Use manual/mechanised cutting to reduce vegetation around the edge of the grazing site • Fragment the grazing site using fire/fuel breaks

Creating fire breaks and fire belts

Fire breaks and fire belts are linear features that act as barriers to slow or stop the progress of a wildfire. Fire (and fuel) breaks are gaps in vegetation or other combustible material that aim to prevent the spread of surface fires (Figures 11a,b and 12a,b). Fire belts are strips of woodland composed of fire-resistant (usually broadleaved) species, which help maintain a 'clean' forest floor and prevent or reduce the spread of surface and crown fires (Figure 12c). These features should form part of a robust fire prevention mosaic that is considered during planning and not as a replacement for a holistic site approach. Table 6 summarises key fire break and fire belt features.

Figure 11a A fire break of mown grass at Windsor Great Park, Berkshire. In addition to their usefulness for timber extraction, fire breaks can be used as control lines during a wildfire incident and they provide good locations from which to start fire suppression activities.

Figure 11b A fuel break being cut by fire fighters as a control line through moorland adjacent to woodland in Northumberland. Breaks such as this will not stop fires on their own – as a fire approaches, they will require additional suppression measures to prevent it from crossing them.

Figure 12 Examples of (a) a fire break created by cutting back the heather, (b) a fuel break created by cutting back the heather and exposing the mineral soil, and (c) a fire break and fire belts in an established woodland.

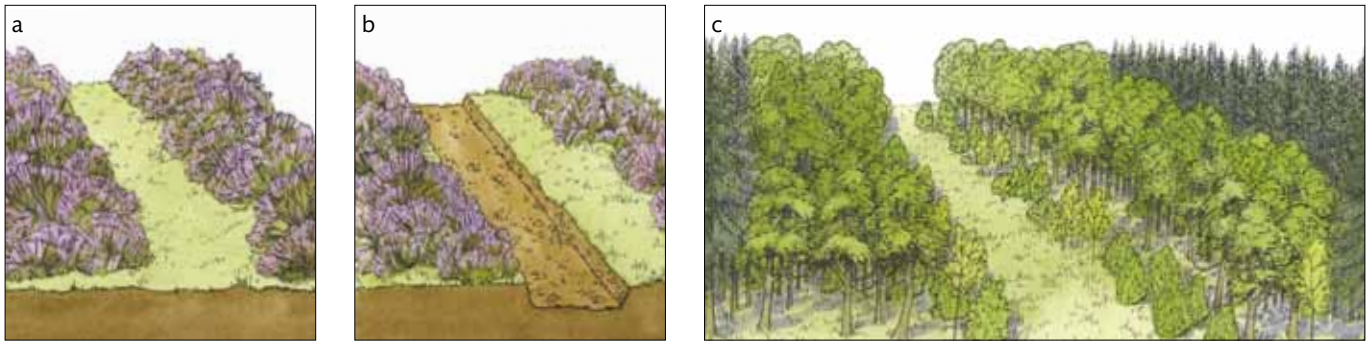


Table 6 Features of fire and fuel breaks and fire belts.

	Description	Natural features	Man-made features	Advantages	Disadvantages
Fire/fuel breaks	Fire breaks are linear gaps in vegetation, which may be natural or man-made features.	Areas that are naturally fire-resistant such as suppressed or heavily grazed vegetation.	Areas of vegetation that have been cut, mown or reduced by prescribed burning.	Designed to prevent or reduce fire spread. Can aid access and the distribution of equipment during a wildfire incident. May also be used for timber extraction.	Fire and fuel breaks require regular maintenance to remain effective as control measures.
	Fuel breaks are gaps in vegetation where litter and organic materials are also removed to expose mineral soil.	Areas that have been burnt or eroded. Also includes features such as rocky outcrops, rivers, streams, lakes.	Roads, rides, paths, drainage ditches, banks, plough lines and scraped or bulldozed lines.		
Fire belts	Linear strips of woodland composed of fire-resistant tree species, generally broadleaved species.	Habitats or vegetation naturally less susceptible to fire, for example wetlands and broadleaved woodlands.	Stone walls or other linear built features.	Designed to reduce fire spread. Provide long-term fire resilience and can be retained when restructuring forests. Biodiversity benefits for a wide range of woodland species.	Fire belts require maintenance to remove understorey vegetation such as thicket-stage conifers, gorse and heather.

Designing fire breaks and belts

When planning the location of breaks and belts, the aim should be an interconnected network that surrounds the perimeter of the site or compartment at risk. The location of breaks and belts should be identified during the forest management planning process and clearly laid out on subsequent plans and maps.

When designing new or reviewing existing breaks and belts, consider:

- Locating breaks and belts at critical points where they could be used to prevent extreme fire behaviour (e.g. at the bottom or ridge line of a slope).
- Creating a network of breaks and belts in conjunction with other fire-resistant linear and area features (e.g. roads, rides, rivers and fields).
- Dividing or compartmentalising high-risk vegetation (e.g. thicket-stage conifers, heather or gorse).
- Establishing a series of breaks (e.g. where there is a significant risk of spot fires 'jumping' breaks in windy locations).

Well-planned fire and/or fuel breaks can help to control suppression fires by providing 'control lines'. You should first seek advice from the fire and rescue services or local wildfire advisor if considering this approach.

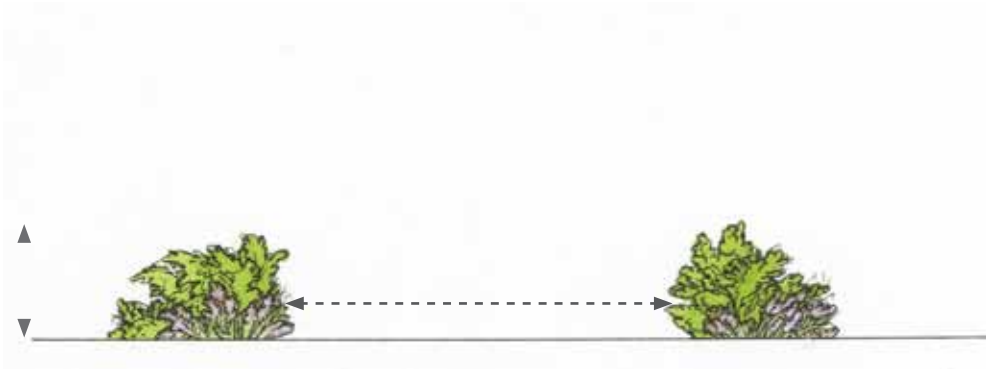
The size of fire breaks and belts will be dependent on fire risk and the intensity at which a fire is likely to burn (Figure 13). In general, the following principles should be applied:

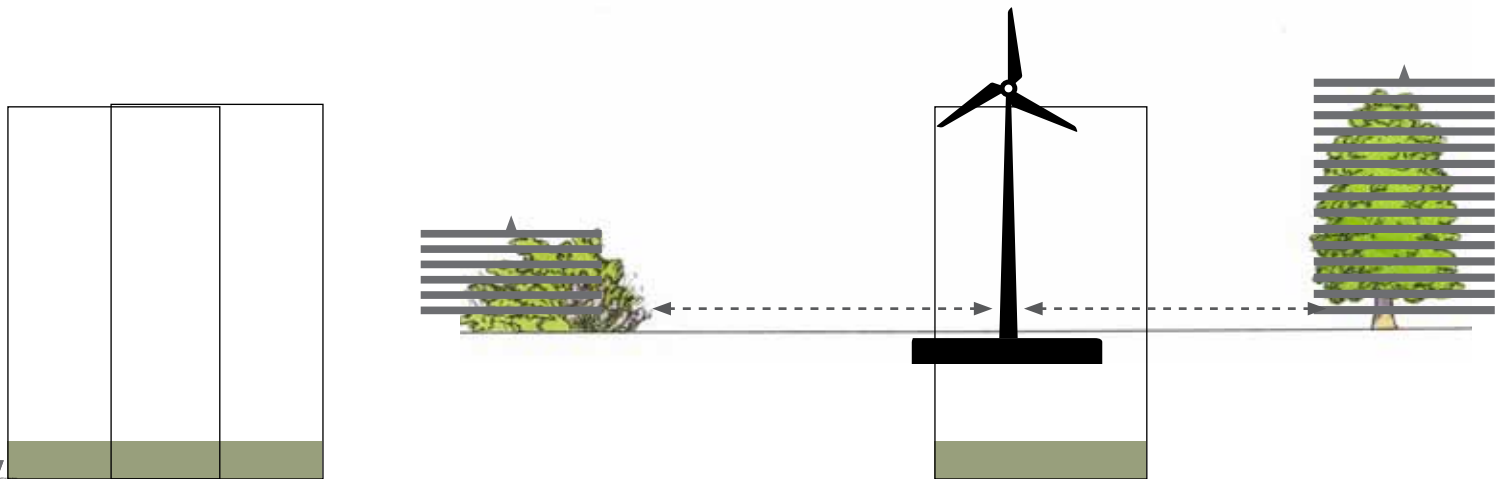
- The taller the vegetation, the wider a fire or fuel break should be.
- Fire breaks should be wider where high-risk vegetation is adjacent to, or within the vicinity of, assets and infrastructure. A ratio of 3:1 is a recommended minimum.
- Fire and fuel breaks should be accessible to a fire appliance (measuring 3 m wide by 3.5 m high) where ground conditions allow.
- Fire belts should be at least 20 m wide and wider where assets are at risk.

The wildfire resilience of fire breaks and belts can be further increased by management practices such as controlling the growth of vegetation alongside roads and rides, and brashing and high pruning trees. These practices can also provide additional amenity benefits by improving the appearance of the breaks and belts and increasing access for visitors and recreational users. However, woody residues should be reduced in areas of high wildfire risk to avoid a build-up of organic materials that could fuel surface fires.

Figure 13 Indicative fire break widths in areas of high and low-risk vegetation.

a) Fire breaks should be at least as wide as the height of the trees on either side of the break in areas of low-risk vegetation, such as these mature conifers.





Improving forest design

A proportionate approach should be adopted when considering wildfire resilience in forest design; most effort should be concentrated on forests and woodlands that are situated in high-risk areas. Wildfire resilience in forest design should be considered at the landscape scale in addition to the site scale, as neighbouring land uses will affect wildfire risk (Figure 14).

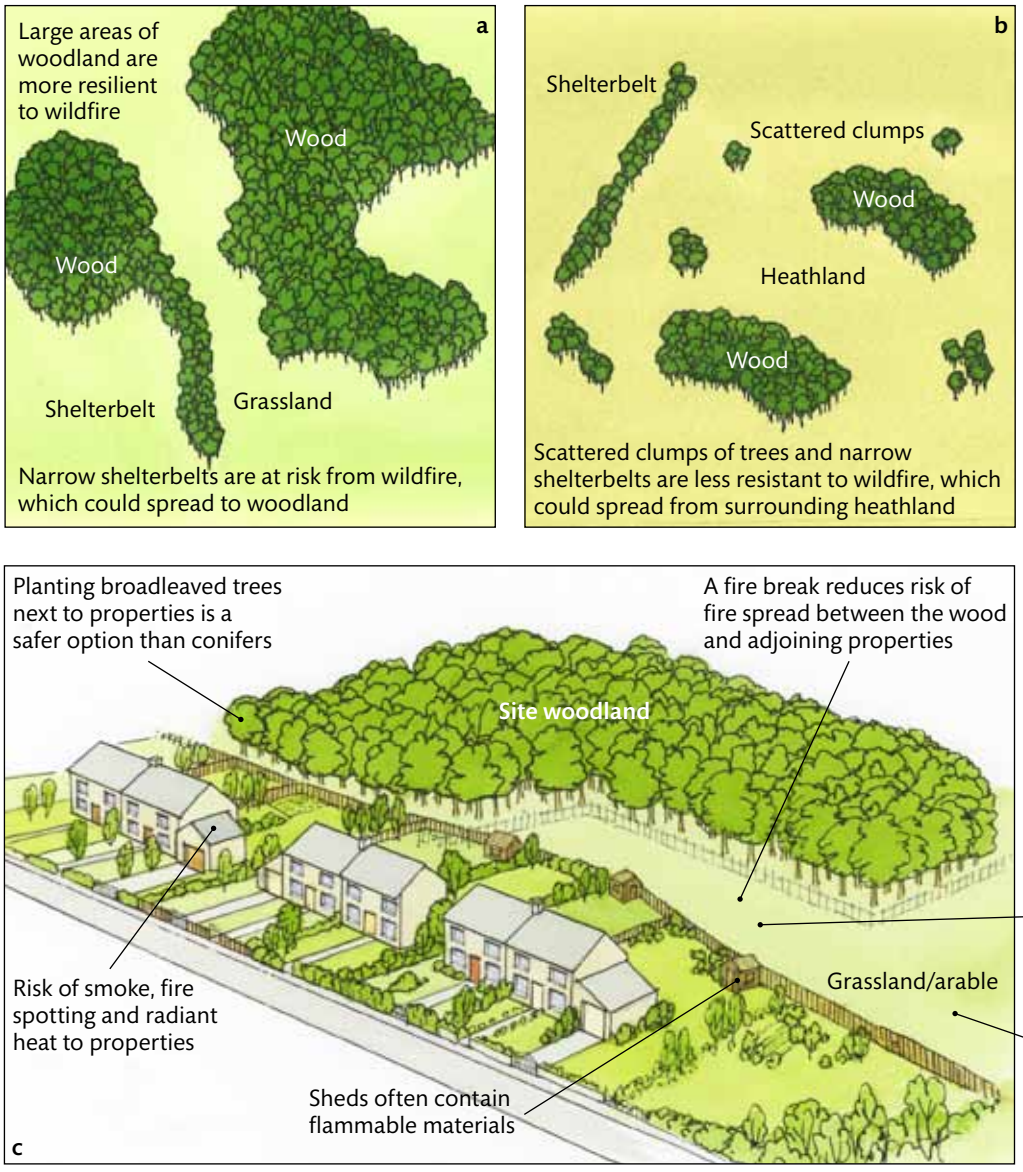
In many cases, improving wildfire resilience will have little visual or landscape impact. Indeed, well-designed fire prevention measures can make a positive contribution towards the visual diversity of a forest. However, in some prominent locations, prevention measures such as fire breaks and fire belts could have a negative visual impact.

The UK Forestry Standard Guidelines on *Forests and landscape* set out the design principles that should be followed to ensure that wildfire prevention measures do not detract from well-designed forests and woodlands, or features that make a particular landscape special. They should relate to the surrounding landscape character and reflect, protect and enhance important features.

Landscape design principles that should be considered when planning wildfire prevention measures are:

- Scale
- Shape
- Landform
- Enclosure
- Diversity
- Unity
- Spirit of place

Figure 14 Neighbouring land use can affect wildfire risk, shown here in (a) a wooded landscape, (b) an open habitat landscape, and (c) a woodland at the urban fringe.



Designing wildfire resilience in existing woodlands

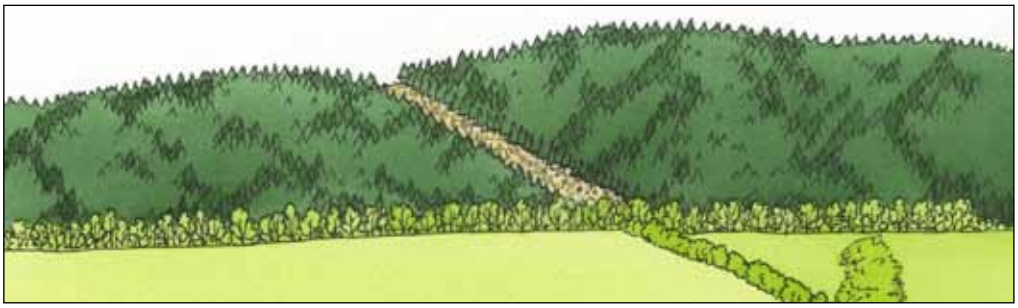
The principles set out in the UK Forestry Standard Guidelines on *Forests and landscape* should be followed when designing wildfire resilience measures in existing woodlands. Opportunities should be taken at felling and restocking to diversify forests by introducing fire-resistant species and varied age classes to improve woodland structure and resilience. If it is necessary to cut into a stand of trees to introduce a fire break, aim to minimise visual impacts (see Figure 15).

Designing wildfire resilience in new woodlands

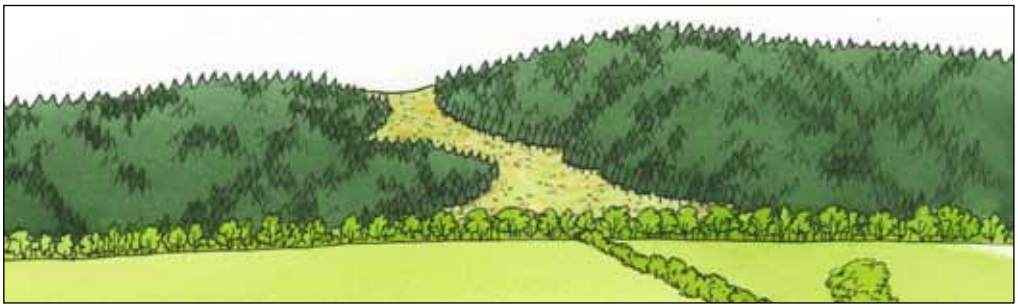
There are greater opportunities for building wildfire resilience into new forests and woodlands, rather than trying to 'retrofit' these into established woodland where wildfire has not been previously considered. Where possible, prevention measures should build upon natural features such as streams, marshes, wetlands and rock outcrops so that they fit naturally into the landscape. Features such as fire breaks and fire belts should be incorporated into the overall forest design, rather than being seen as separate components. Shape and scale are important considerations, and should always relate to the surrounding landscape character (Figure 16). Where possible, wildfire resilience measures in new forests and woodlands should make a positive contribution towards the visual diversity of a forest.

Figure 15a–c The visual impact of a new fire break or fire belt in an existing forest or woodland should be minimised by ensuring it is integrated with the surrounding landscape.

a) This fire break has been located to relate to landform (a dip in the hill) and neighbouring features (the hedge). However, straight, parallel-sided strips will look like power-line corridors.



b) In this scene, the cleared fire break has been given an irregular edge so that it has a more natural appearance.



c) In this scene, broadleaved trees have been planted in the cleared fire break to transform it into a fire belt. This will improve wildfire resilience while creating a visual link to the neighbouring hedge and broadleaved trees.

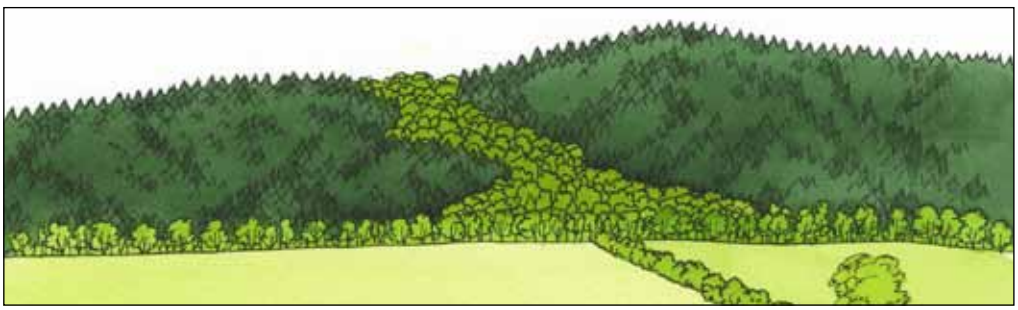


Figure 16a Wildfire resilience measures in new forests and woodlands should relate to the character of the surrounding landscape and not detract from those things that make a place special.

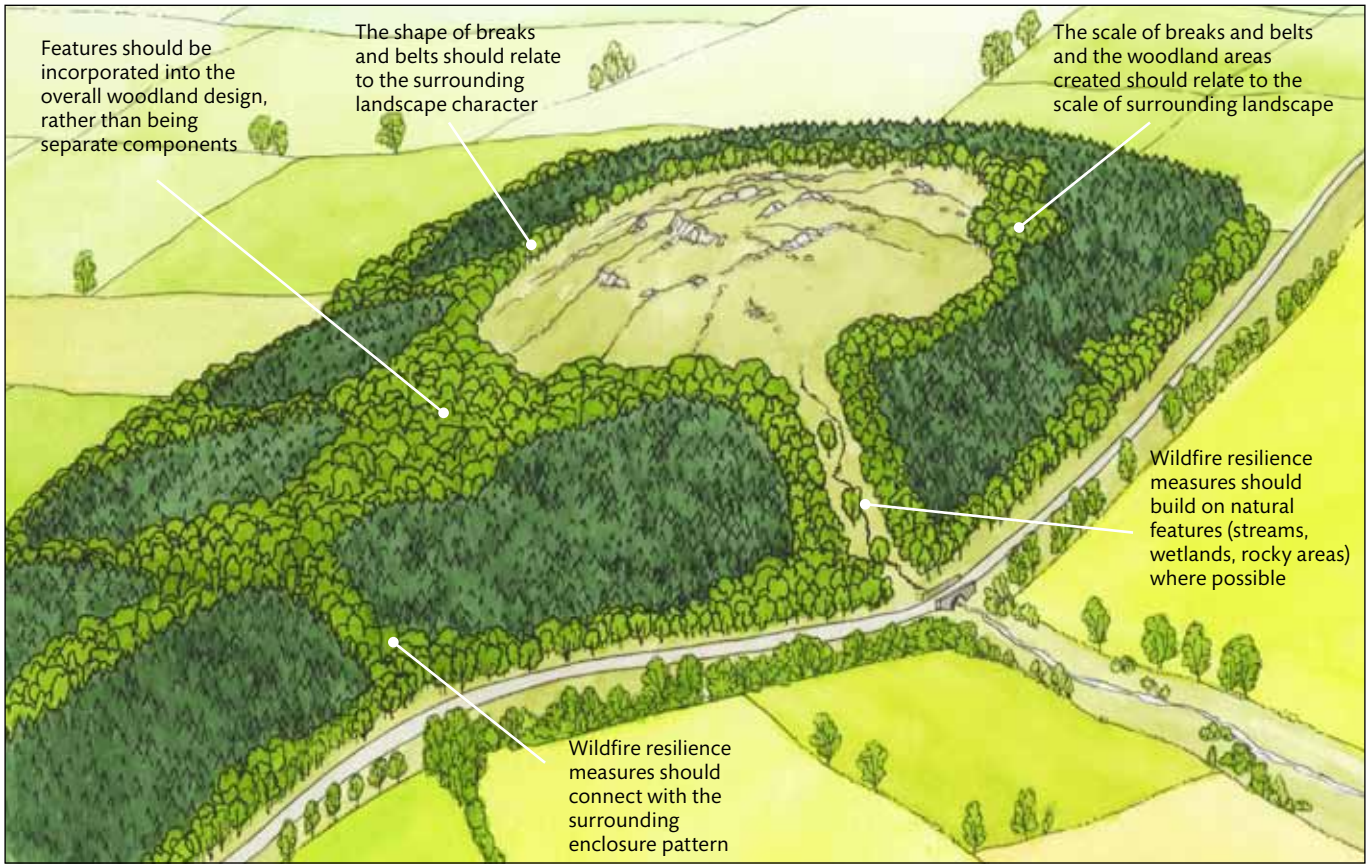


Figure 16b Fire breaks and belts should not detract from landscape character.

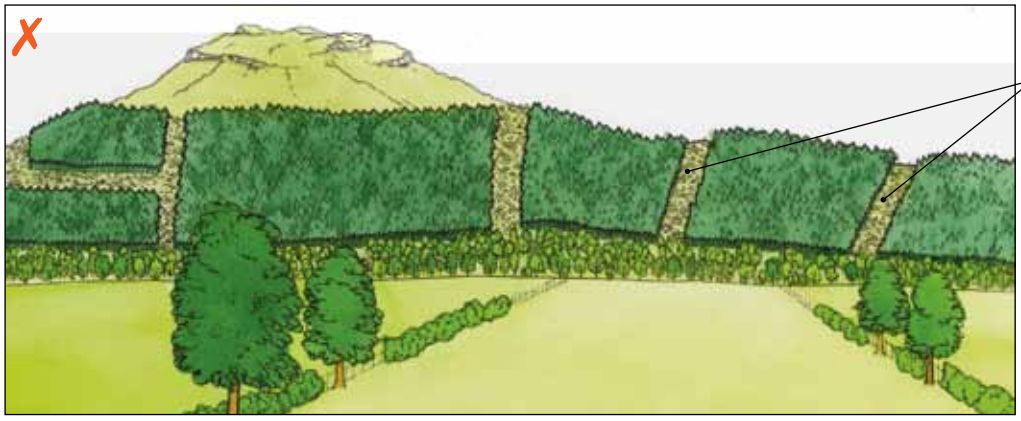
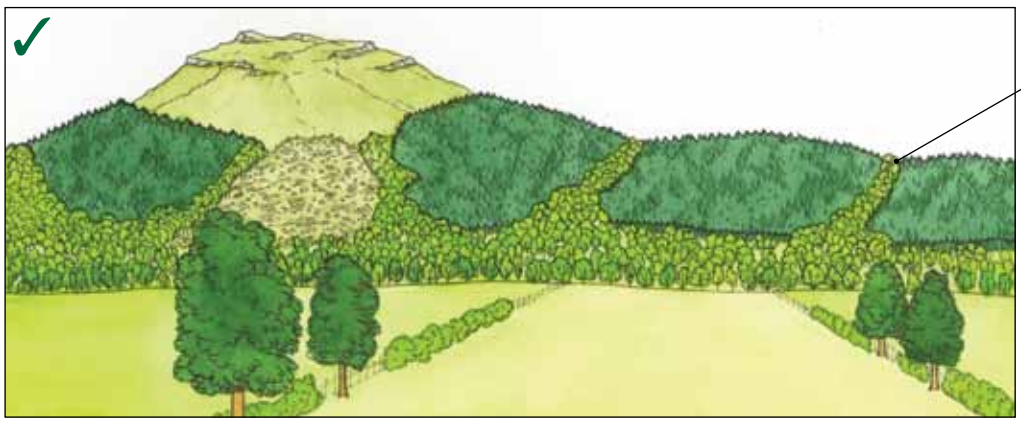


Figure 16c Fire breaks and belts should be designed to reflect landscape character.



Building silvicultural resilience

Wildfire resilience can be improved by choosing the right tree species and selecting and using appropriate silvicultural systems.

Choosing tree species

Several species of native and non-native trees and shrubs are at risk from wildfire and coniferous species are generally at higher risk than broadleaves (Table 7). Risk can be reduced by varying age classes and selecting appropriate silvicultural systems and management practices (e.g. high pruning and thinning). Eucalyptus species pose a particularly high wildfire risk and, in some high fire risk areas, should not be planted. Where it is decided to plant these species, special attention should be paid to wildfire prevention measures.

Table 7 Risk of fire by tree and shrub species.

Tree	Age at highest risk	Stage at highest risk	Notes
Pines	5–20 years	Thicket	If unthinned
Spruces	5–20 years	Thicket	If unthinned. More resistant to ignition in wetter locations
Firs	5–20 years	Thicket	If unthinned. More resistant to ignition in wetter locations
Eucalyptus	All ages	All stages	Do not plant in high-risk areas
Cypress	All ages	Thicket	Avoid planting near property

Selecting silvicultural systems

This section provides an assessment of the relative susceptibility to surface, crown and ladder fires of different silvicultural systems used in UK forestry. These include traditional clearfelling and restocking and continuous cover forestry systems. It is advised that no/minimum intervention woodland management and small/low intensity management systems are not used in forests and woodlands that are at high risk of wildfire.

Felling and restocking

Table 8 provides an assessment of the likelihood of wildfire in conventional felling and restocking forestry practice and highlights the stages where the trees are at high wildfire risk (e.g. thicket stage and before first thinning) and periods where the risk is much lower.

Table 8 Felling and restocking systems showing likelihood of fire (L = low; M = moderate; H = high).

Stage	Likelihood of surface fire	Likelihood of crown fire	Likelihood of ladder fires
New planting	M	N/A	N/A
Pre-thin	H	H	H
Post-thin	L	L	L
Fell and restock	M	N/A	N/A

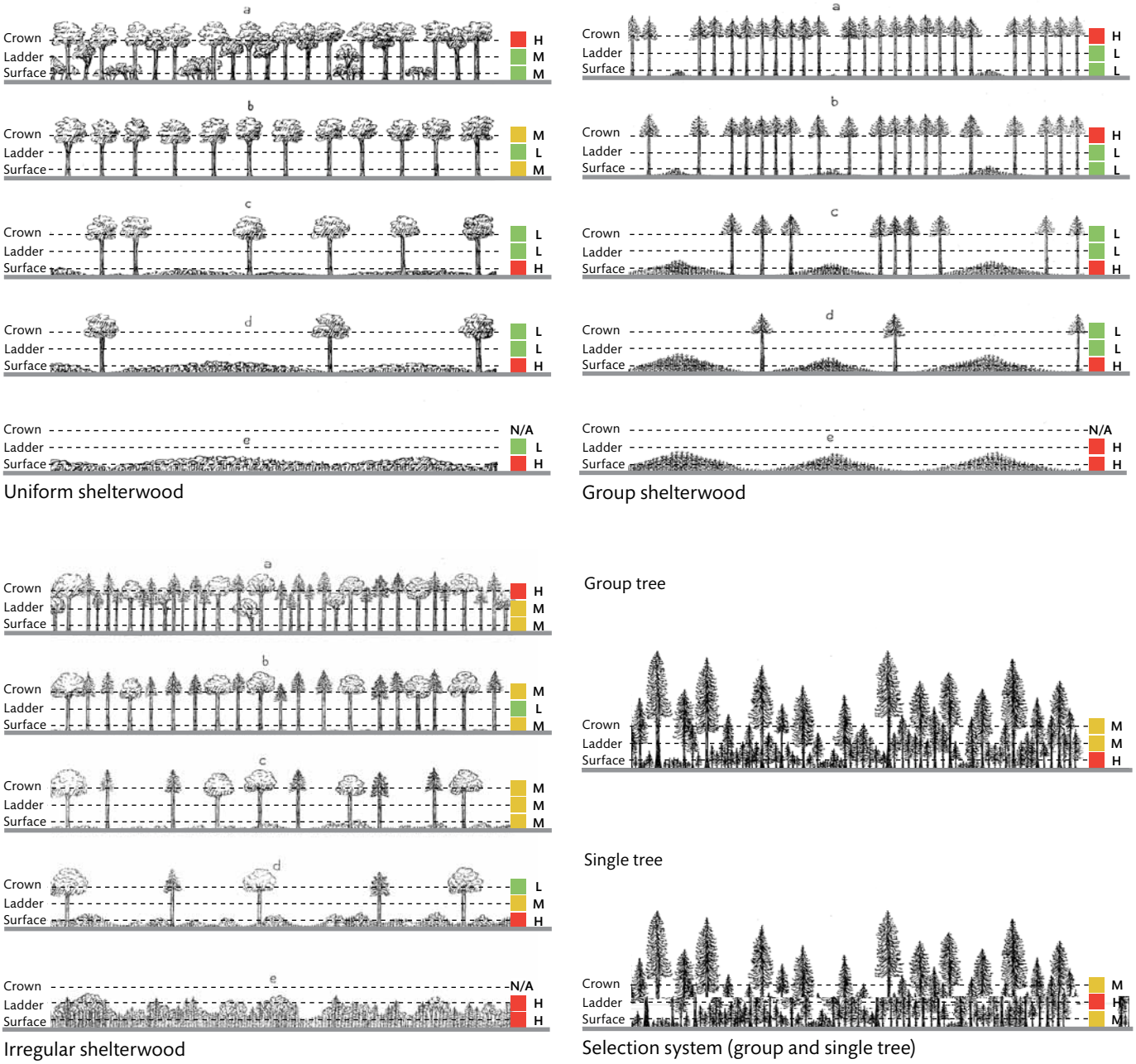
Continuous cover forestry

Continuous cover silviculture is based upon a presumption against clearfelling, the use of natural regeneration and the creation of a varied forest structure containing a range of species.

Defining the wildfire resilience of different continuous cover systems is difficult because forest structure will change through time as transformation progresses. However, Figure 17 provides an indicative hazard rating for four classic continuous cover forestry systems, according to the vegetation structure and fuel type typical of each at different stages of their development. For each stage fire hazard is indicated using a 'traffic light' system for surface, ladder and crown fires.

Preventing extreme fire behaviour such as crown fires and torching (caused by fuel ladders moving a fire between the surface and the crown) should be a key objective.

Figure 17 Fire hazard ratings for surface, ladder and crown fuels in continuous cover systems: (L = low; M = moderate; H = high).



Forest managers using continuous cover systems of management should consider the risk of wildfire alongside ecological processes and timber production in forest planning. A system of adaptive management should be adopted that allows the site to dictate the type of stand structure that is finally achieved, while maintaining wildfire resilience. The impact of choice of silvicultural system upon wildfire resilience should be considered on a site-by-site basis, in light of all the factors that could affect fire risk and fire behaviour, including those associated with the forest going through the process of 'transformation', altering the structure from that of an even-aged plantation to a structurally, visually and biologically diverse forest.

At a forest scale, the adoption of areas of continuous cover forestry in close proximity to clearfell systems leads to the development of diverse landscapes of multi-structured woodland with diverse species mixes. This creates a mosaic of vegetation with improved resilience to wildfire.

Managing deadwood

Deadwood should be managed in accordance with the UK Forestry Standard and Forestry Commission Practice Guide *Managing deadwood in forests and woodlands*. In forests and woodlands where there is a high risk of wildfire, and where wildfire management zones have been established to protect assets, deadwood in Zones A, B and D should be minimised to reduce the risk of standing and fallen deadwood fuelling a high-intensity fire and subsequent long-term smouldering. Deadwood should instead be focused in Zone C.

Managing windthrow

Windthrown, wind-snapped and damaged trees create ladder fuels which increase the risk of crown fires. In line with good forestry practice, felling coupe boundaries should be designed so that they follow wind-firm edges. If windthrow does occur on sites with a high risk of wildfire, it should be removed and a new wind-firm boundary established. Severance cuts (premature felling of rides within a forest to create future wind-firm felling coupe boundaries) should also be used to reduce the risk of windthrow. These have the added benefit of providing wildfire resilience if well located. Note that wildfires can also damage the resilience of existing wind-firm edges.

Managing harvested wood products and residues

Harvested wood products and residues that arise after thinning and felling operations (e.g. timber stacks, individual and windrowed tree stumps, brash mats and 'lop and top') can create a hazard in areas at risk of wildfire. Where these operations are carried out in forests where wildfire management zones have been established, forest managers should ensure that all residues are removed from Zone A and minimised in Zone B. Burning brash and harvesting residues should be avoided altogether unless it can be demonstrated that it is a management necessity, all impacts have been considered, and the necessary approvals obtained. However, brash should never be burned in Zones A and D, and only outside the fire season in Zone B.

Managing forest and tree health

Pest and disease outbreaks reduce the resilience of forests and woodlands to wildfire. Diseased, damaged, dead or dying trees can increase the likelihood and severity of wildfires, as well as increasing fuel loading inappropriate to the requirements of wildfire management plans. Diseased, damaged, dead and dying trees should be considered for removal in wildfire management Zone A. Tree health surveillance in Zones B and D will alert managers to when intervention is required to reduce fuel loading.

Planning for people

Considering how people access and use forests and woodlands and planning accordingly will help to reduce the chance of a wildfire occurring, minimise the potential impact of a fire if it does occur, and improve detection and response rates.

In forests and woodlands that are at high risk of wildfire, such as community woodlands or forests that are regularly used by the public, ensure that staff, contractors, neighbours and visitors are aware of wildfire risk and the appropriate actions to take in the event of a wildfire. There should be effective signage and adequate marked orientation points so that the location of a fire and the direction of spread can be accurately reported.

Raising awareness

Education and awareness-raising programmes, for example with local schools or youth groups, can be very helpful, as can encouraging volunteering and community participation in woodland activities. This will generate a sense of shared ownership and respect for woodlands as well as improving the overall forest management planning process. This is particularly important if evidence suggests that previous wildfire incidents at a site were started deliberately.

Engage with visitors and recreational users through posters, leaflets and signs about safe forest use (Figure 18). Where they have been found to be useful in preventing fires, ensure that posters and signs are located to provide maximum awareness during periods of high fire risk by erecting them in prominent locations with explanations of what to do and who to contact in an emergency. For maximum impact, posters and signs should only be used at times of high wildfire risk; they should be taken down promptly when conditions return to normal.

Figure 18 Temporary signs and posters, such as this one used by Forestry Commission Scotland to highlight the dangers of campfires, can be used to raise fire safety awareness during periods of high wildfire risk.

More vigilance is required at certain times of year; wildfire risk is at its highest during warm and dry periods in spring and summer, and increases at weekends, during bank holidays and school holidays and around 5 November (Guy Fawkes Night).

Managing access and recreation

The management of access and recreation should be considered when designing new forests and woodlands or when preparing a forest management plan for a forest where there are high levels of public access. For example:

- Plan routes and trails so that they steer people away from high fire risk areas.
- Identify areas where people congregate, or where there is evidence of anti-social behaviour, to establish the location of potential ignition points.
- Manage vegetation in areas where there is evidence of vandalism, including fire lighting, so that the area is visible from surrounding areas; widely spaced, high-pruned trees will improve lines of sight from paths and trails and neighbouring properties, deter anti-social behaviour and aid early detection and reporting.
- Increase vegetation management and establish fire-resilient species and habitats in areas of high public access and around facilities such as picnic sites to provide a buffer zone. Remove or mulch branches and fallen deadwood, and remove litter or any other flammable material in these areas.
- Locate fire pits and barbeque sites in areas of low fire risk away from vegetation and provide a safe way for people to use, extinguish and dispose of barbeques (Figure 19).
- Ensure that new recreation sites are planned with access to water for fire fighting. If an existing recreation site has no access to water, consider constructing a fire pond, but ensure that public safety is taken into account.

Working with neighbours

When designing new forests and woodlands adjacent to neighbouring communities or individual properties, ensure that a sufficiently wide and resilient fire break or belt is established and maintained at the boundary. In established forests, use opportunities at felling and restocking to create wildfire prevention measures.

Liaise with neighbours where a problem such as anti-social behaviour is shared.

Figure 19 This metal plate is used to prevent wildfires and protect picnic furniture and other flammable surfaces from damage by disposable barbeques.

Planning for an incident response

Although responses to wildfire incidents are not part of the forest management planning process, the design and layout of a forest or woodland will be a critical factor in the success of a fire and rescue service response to an incident, and therefore should be a consideration in areas of high wildfire risk. This section sets out the main aspects that should be considered during forest management planning to facilitate the response to a wildfire incident.

Improving access to water

Water supplies are valuable assets in areas where there is a high risk of wildfire and, to be effective during a wildfire incident, they must be easily accessible. They should not be sited within or directly adjacent to habitats with a high wildfire risk (e.g. dwarf heath scrub, grasslands, thicket-stage conifers) and must not be at risk from heat, smoke or spot fires.

Details of all usable water supplies should be given in the wildfire response plan, together with any specific requirements and constraints for each supply. The locations of water sources should also be easily identifiable on the ground. Examples of different types of water sources and an idealised layout designed to improve the response to a wildfire incident are described below and illustrated in Figure 20.

Lakes, rivers and streams

Lakes, rivers, streams, reservoirs and other open water features are a more desirable source of water than fire ponds and dams as they provide a constant supply of water. However, they should only be considered if they are resilient to drought, have sufficient flow and capacity, are accessible to vehicles and have not been affected by a build-up of silt and debris. For remote sites with access to water mains, water hydrants should be considered in preference to open water sources.

Fire ponds and fire-fighting dams

Appropriate locations for fire ponds and temporary and permanent fire-fighting dams for use during a wildfire incident should be considered during planning and clearly identified in the wildfire response plan. Ponds and dams should be easily accessible and provide stable access to the fire appliances, water carriers and the light portable pumps used by the fire and rescue services. However, appropriate safety measures must be implemented for both fire ponds and temporary and permanent dams to protect members of the public and animals.

Fire ponds should have a minimum capacity of 10 000 litres of water* during drought periods and a minimum depth of 1.5 m if required to refill helicopter buckets.

Temporary and permanent fire-fighting dams should be:

- deployed on level ground to ensure they hold their full carrying capacity of water;
- suitably maintained, tested and able to hold an appropriate amount of water to cope with the level of threat and planned use;
- located on the tops of hills if likely to be used for helicopter fire suppression techniques;
- deployed in advance of the fire season and regularly checked to ensure they hold an appropriate volume of water.

*Ponds with dammed capacities in excess of 10 000 m³ (10 million litres) or more will be regulated as reservoirs under the Flood and Water Management Act, and subject to significant monitoring and reporting requirements.

Fire appliances can carry around 1500–1800 litres of water. Landrovers will hold 400 litres and water carriers 8000–12 000 litres. Water carriers are likely to carry one or two temporary dams that can hold up to 10 000 litres each.

Water hydrants

Where forests and woodlands at risk of wildfire are close to water mains, or have water mains running through them, consider extending the hydrant network beyond the public highway and onto the site. Locate hydrants at strategic points that are identified during planning and clearly mark their location on the map in the wildfire response plan. Take into consideration opportunities with adjacent landowners and work at the landscape scale. If it is likely that helicopters will be used for fire suppression, improve access by locating hydrants on hilltops and provide open spaces for temporary or permanent dams.

High-volume pumps

High-volume pumps are large, industrial-scale devices that provide 'above-ground water mains' that can pump over many kilometres. They may be used by the fire and rescue services at large wildfire incidents. The pumps can only be used where there is access to large, open water bodies such as lakes and rivers. They are ideal for more remote rural areas where the pressure from, or availability of, hydrants is insufficient.

The pumps are delivered by large-goods vehicles and require special consideration in forest management plans, which should be agreed in consultation with the fire and rescue services (Figure 20). Due to their scale and access and operational requirements, potential locations for high-volume pumps, hoses and associated infrastructure should be identified during forest management planning and clearly marked on the wildfire response plan.

Access considerations

Access to water sources should not be obstructed by overhead vegetation or other obstacles. Areas of hardstanding that can accommodate several large vehicles are needed close to water sources (Figure 20). If space on site is limited, a 'one-way system' should be defined that allows for an entry and exit point where fire appliances and water carriers can move freely (Figure 21).

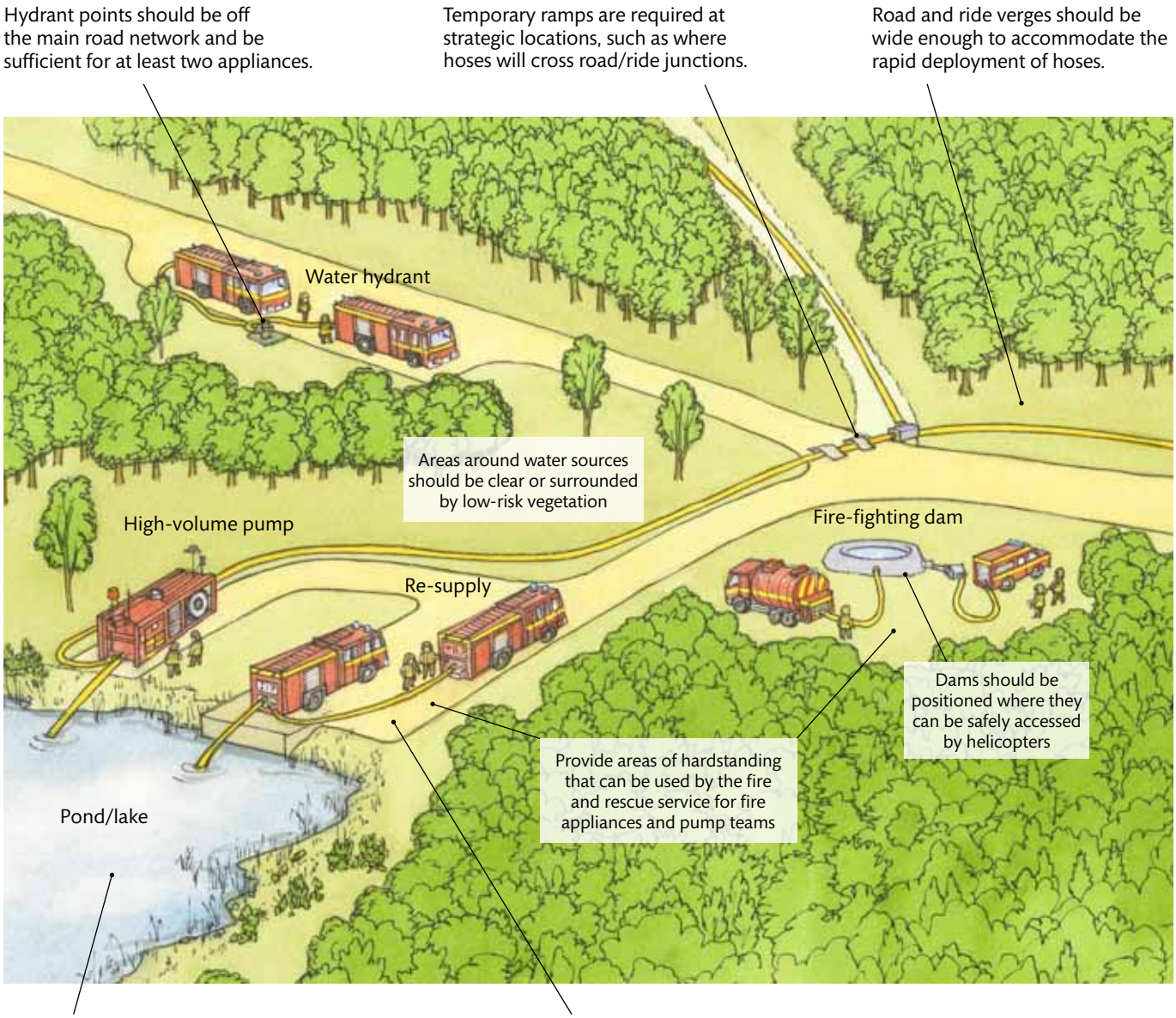
To aid helicopter fire suppression, should it be needed, hardstandings and firm and level ground for temporary dams should be identified at the planning stage. Helicopter landing zones should be planned to avoid potential hazards such as mature trees and power lines. Landing zone dimensions will be dependent on the type of helicopter used. If no suitable locations are available in high-risk forests, consideration should be given to clearing new sites for temporary dams in strategic locations.

The fire and rescue services should be consulted to ensure that access to water supplies is possible using their equipment. Access points should be inspected at the beginning of each fire season to ensure that they are usable and conditions have not deteriorated.

Protecting the environment

The location of water sources should be considered in terms of potential environmental impacts and should be kept away from sensitive wetland habitats and designated sites. Any water run-off from water sources must have appropriate pollution control measures, including natural and man-made interceptors, and contingency plans should be in place to prevent contamination of watercourses and other aquatic habitats. This may be especially pertinent where certain types of foam, fuel and other chemicals are inadvertently washed from vehicles and equipment. Further information is given in the UK Forestry Standard Guidelines on *Forests and water*.

Figure 20 Diagram to show the different types of water sources and an 'ideal' water supply layout.



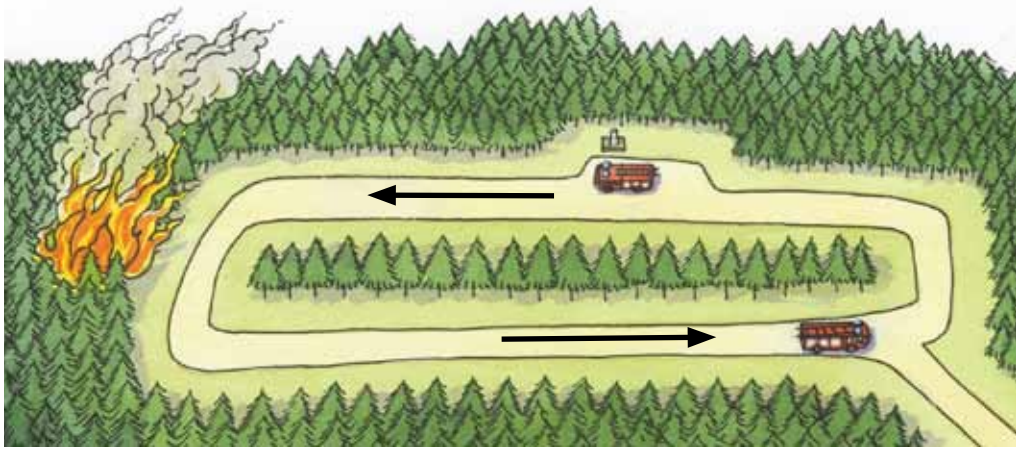


Figure 21 Plan for a one-way system in forests and woodlands with a high risk of wildfire and where the roads are narrow and unsuitable for passing vehicles.

Improving the response to a wildfire incident

Good forward planning will reduce the likelihood of a wildfire occurring and allow any wildfires that do occur to be rapidly reported and tackled while still small. However, it is prudent to consider measures that will help to prepare for a larger-scale incident – this is particularly important for large landholdings and forests and woodlands with a high wildfire risk. In the event of a wildfire incident, the information provided to the fire and rescue services in the form of the wildfire response plan (see Appendix 3) will be critical.

Think beyond your forest or woodland for:

- Vantage points from high buildings or structures.
- Vantage points from neighbouring land that overlook your site.
- Prominent features beyond your site that can be used for orientation.
- Suitable rendezvous points for the fire and rescue service – work with neighbours and other landowners to identify suitable locations.

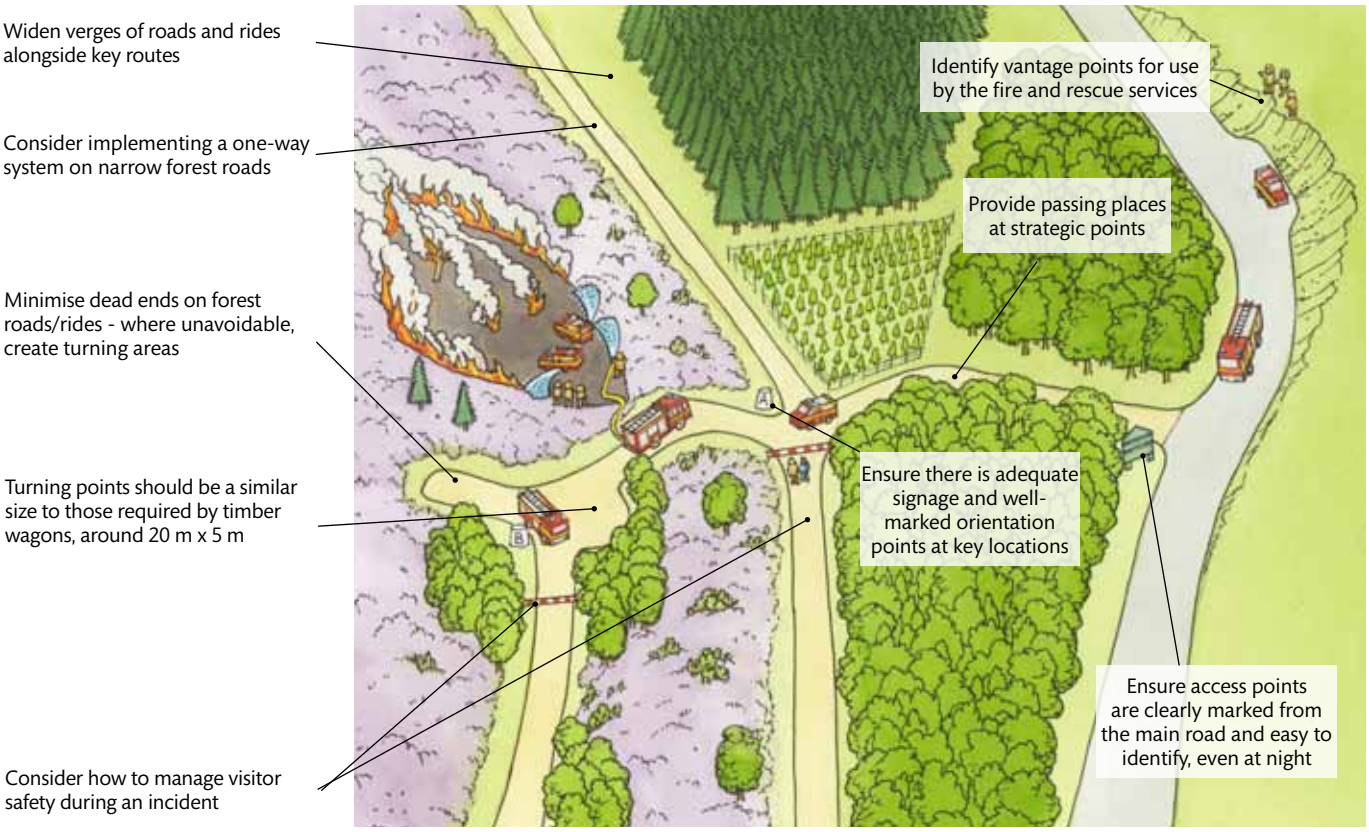
Planning for access by the fire and rescue services

Figure 22 illustrates some of the access and road network features that should be considered when planning to facilitate the response to a wildfire incident by the fire and rescue services. In larger or more high-risk woodlands it is also helpful to identify potential assembly points from which the fire and rescue services can co-ordinate fire suppression activities (areas known as harbour, staging and marshalling areas). These should be areas of hardstanding (such as timber stacking areas) located away from habitats with a high wildfire risk, which should be kept clear during the fire season. All access features should be marked on the wildfire response plan.

Planning for the use of control lines

Control lines are fire and fuel breaks adopted or constructed during the response phase of a wildfire incident. Once established at critical points, they can significantly help the success of fire suppression activities. Potential locations for control lines that link to existing fire resilience features should be identified in the wildfire response plan to assist the fire and rescue services, who may need to create new control lines during an incident by widening existing breaks and belts by using machinery or hand tools to remove vegetation or excavate soil.

Figure 22 Factors to consider when planning to facilitate an incident response.



Further reading and useful sources of information

Forestry Commission publications

- The UK Forestry Standard (FCFC001)
- The UK Forestry Standard Guidelines – Forests and climate change (FCGL002)
- The UK Forestry Standard Guidelines – Forests and landscape (FCGL004)
- The UK Forestry Standard Guidelines – Forests and water (FCGL007)

Guidance and good practice

- Design techniques for forest management planning (FCPG012)
- Managing deadwood in forests and woodlands (FCPG020)

Operational guidance

- Planning controlled burning operations in forestry (FCTN002)
- Forest and moorland fire suppression (FCTN003)
- Burning forestry residues (FCTN004)

Other publications

- Civil protection common map symbology (Cabinet Office)
- Environmental protection. Fire and rescue manual – Volume 2: Fire service operations (TSO)
- Eurofire Training Unit EF2: Apply techniques and tactics to control vegetation fire (Eurofire)
- European glossary for wildfires and forest fires (Eurofinet – European Forest Fire Networks)
- Fire and rescue service operational guidance: wildfire (Scottish Government)
- Fire fighting. FISA Safety Guide 803 (Forest Industry Safety Accord)
- Integrated risk management planning: policy guidance – wildfire (Department for Communities and Local Government)
- Keeping the country running: Natural hazards and infrastructure. A guide to improving the resilience of critical infrastructure and essential services (Cabinet Office)
- Pollution Prevention Guidelines – Managing fire water and major spillages (Environment Agency)
- Pollution Prevention Guidelines – Incident response planning (Environment Agency)
- Pollution Prevention Guidelines – Controlled burning (Environment Agency)
- UK climate change risk assessment (Defra)

Codes of practice

- The Heather and Grass Burning Code (2007)
- The Muirburn Code (2011)
- The Heather and Grass Burning Code for Wales (2008)
- Prevention of Environmental Pollution from Agricultural Activity: A Code of Good Practice (2005)

Websites

- Health and Safety Executive – www.hse.gov.uk/treework
- UK climate projections – http://ukclimateprojections.metoffice.gov.uk
- Environment Agency – www.environment-agency.gov.uk
- Scottish Environmental Protection Agency – www.sepa.gov.uk
- Natural Resources Wales – www.naturalresourceswales.gov.uk
- Northern Ireland Environment Agency – www.doeni.gov.uk/niea

Legislation and policy

Legislation and other regulatory information that should be considered when building wildfire resilience through forest management planning.

More information can be found at: **www.legislation.gov.uk**

Fire, safety, contingency and emergency planning

- Health and Safety at Work etc. Act 1974
- Highways Act 1980
- Roads (Scotland) Act 1984
- Clean Air Act 1993
- Countryside and Rights of Way Act 2000
- Civil Contingencies Act (2004)
- The Civil Contingencies Act 2004 (Contingency Planning) (Scotland) Regulations 2005
- Fire and Rescue Services Act 2004
- Fire (Scotland) Act 2005
- The Regulatory Reform (Fire Safety) Order 2005
- The Fire and Rescue Services (Northern Ireland) Order 2006
- Waste Management (Northern Ireland) Regulations 2006
- Forestry Act (Northern Ireland) 2010

Environmental protection

- Hill Farming Act 1946 as amended by the Wildlife and Natural Environment (Scotland) Act 2011 and the Climate Change (Scotland) Act 2009
- Wildlife and Countryside Act 1981
- Wildlife (Northern Ireland) Order 1985, as amended by the Wildlife and Natural Environment (Northern Ireland) Act 2011
- Environmental Protection Act 1990
- The Environmental Impact Assessment (Forestry) (England and Wales) Regulations 1999
- The Environmental Impact Assessment (Forestry) (Scotland) Regulations 1999
- Nature Conservation (Scotland) Act 2004
- The Environmental Impact Assessment (Forestry) Regulations (Northern Ireland) 2006
- Natural Environment and Rural Communities Act 2006
- The Heather and Grass etc. Burning (England) Regulations 2007
- The Heather and Grass etc. Burning (Wales) Regulations 2008

Water management

- Control of Pollution Act 1974
- Reservoirs Act 1975
- Salmon and Freshwater Fisheries Act 1975
- The Water Environment (Water Framework Directive) Regulations (England and Wales) 2003
- The Water Environment (Water Framework Directive) Regulations (Northern Ireland) 2003
- Water Environment and Water Services (Scotland) Act 2003
- The Water Environment (Controlled Activities) (Scotland) Regulations 2005
- Flood Risk Management (Scotland) Act 2009
- Flood and Water Management Act 2010
- Reservoirs (Scotland) Act 2011

Appendix 1 – Wildfire risk assessment

A wildfire risk assessment is an evaluation of the likelihood of a wildfire occuring and the severity of damage it might cause if it does occur. The level of detail required will be proportionate to the level of risk and will depend on the nature and extent of the forest or woodland and the type of operations involved. The assessment may be a broad scale, map-based exercise for large forest areas, or a more detailed matrix-based approach for small woodlands at very high risk.

If required, it is possible to quantify wildfire risk using the formula: 'Risk = Likelihood x Severity' and the descriptions and scales in the tables below.

Likelihood of a wildfire starting

Scale	Likelihood	Chance (%)	Description
1	Very unlikely	0–20	Event may occur only in exceptional circumstances
2	Unlikely	21–40	Event could occur at some time
3	Moderate	41–60	Event will occur at some time
4	Likely	61–80	Event could occur in most circumstances
5	Very likely	81–100	Event will occur in most circumstances

Severity of a wildfire

Scale	Severity	Chance (%)	Description
1	Negligible	0.005	Life: Minor local first aid treatment (e.g. minor cuts/abrasions). Property/business: No financial loss or damage. Environment: Minor damage; habitats and species will recover in less than a year.
2	Minor	0.05	Life: Injury requiring first aid treatment. Property/business: Minor financial losses (up to 1% of profit), disruption or damage. Environment: Minor damage; habitats and species will recover in 1–5 years.
3	Serious	0.5	Life: Medical treatment required. Property/business: Serious financial losses (up to 5% of profit), disruption or damage. Environment: Serious damage; habitats and species will recover in 5–10 years.
4	Major	5	Life: Permanent or life-changing injuries. Property/business: Major financial losses (up to 10% of profit), disruption or damage. Environment: Major damage; habitats and species will recover in 10–20 years.
5	Fatalities	50	Life: Single or multiple deaths. Property/business: Destruction of the property (total loss) or business. Environment: Irreversible impact on habitats or species.

The wildfire risk (Low, Moderate, High or Unacceptable) can be calculated using the matrix below.

		Likelihood				
		1	2	3	4	5
Severity	1	1	2	3	4	5
	2	2	4	6	8	10
	3	3	6	9	12	15
	4	4	8	12	16	20
	5	5	10	15	20	25

1–5	Risk rating 1	Low
6–10	Risk rating 2	Moderate
12–16	Risk rating 3	High
20–25	Risk rating 4	Unacceptable

Forest/woodland name: Monk's Heath Wood

Location: Thetford, SE England

What are the fire hazards?	Who/what might be harmed and how?	What are you already doing to manage risk?	Initial risk rating			What else do you need to do?	Revised risk rating		
			L	S	R		L	S	R
Fire spread from lowland heath SSSI next to Monk's Wood	General public Fire fighters	First thinnings are carried out at year 20	4	4	16 H	Implement fire belts around high-risk sub-compartments	3	3	9 M

Completed by: R Gazzard

Date of assessment: 1/4/2014

Review date: 1/4/2024

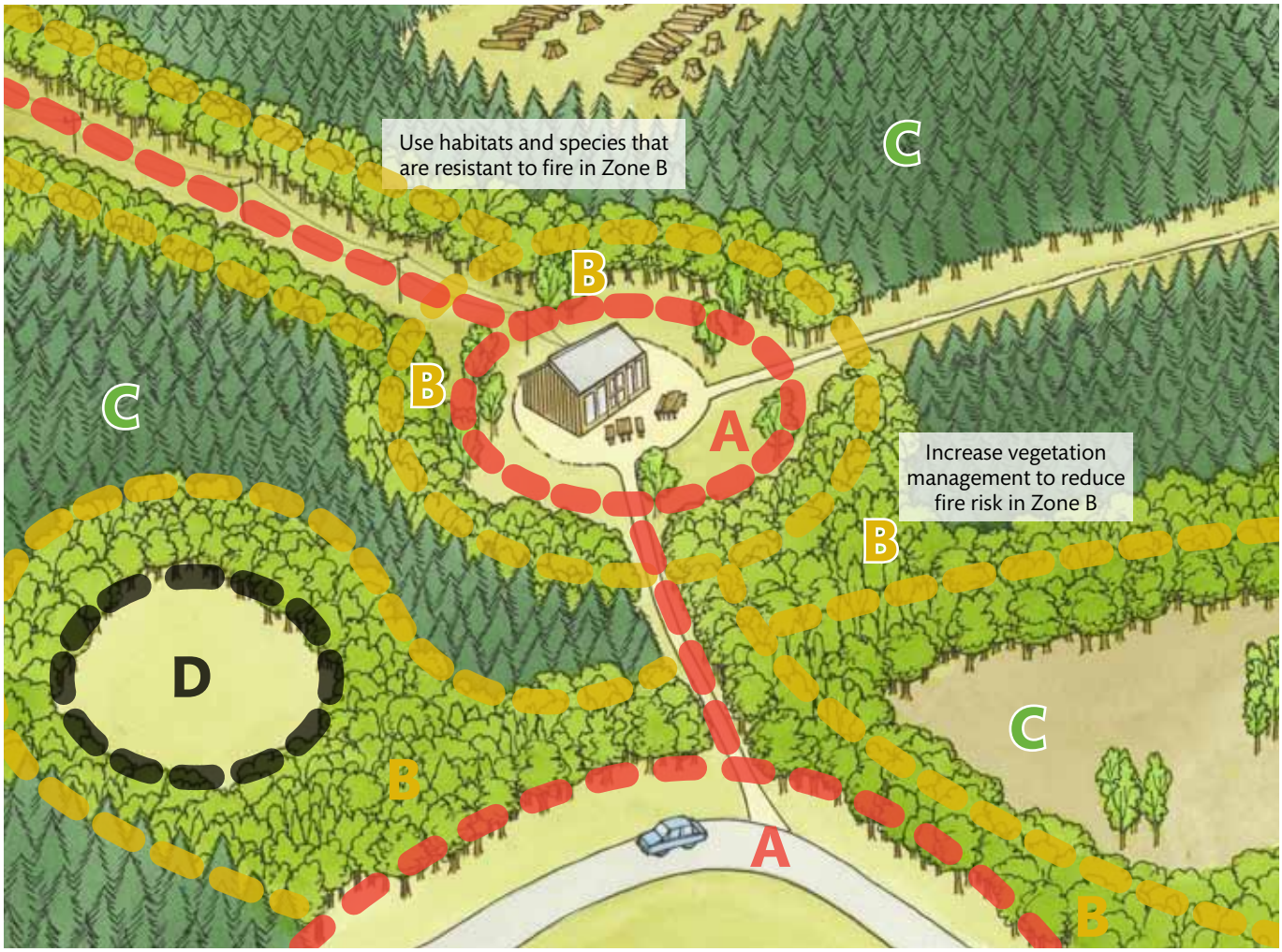
Appendix 2 – Wildfire management zones

The aim of wildfire management zones is to protect health and safety and important assets and infrastructure. They can provide a useful framework to help forest and woodland managers identify and prioritise wildfire prevention measures across a site, based on level of wildfire risk. Wildfire management zones are determined during the forest management planning process.

Where there are assets and infrastructure in other ownership adjacent to the forest or woodland, the management of the equivalent of Zone A around these will be the responsibility of the relevant landowner. In some cases there may be third party arrangements in place for the maintenance of utility corridors and wayleaves running through a forest or woodland, in these cases vegetation management is the responsibility of the relevant utility company.

Zone A is the asset zone, where health and safety and important assets and infrastructure must be protected from wildfire. This zone requires a high level of fire prevention measures such as fuel management. To achieve this Zone A can be broken up into smaller zones with appropriate vegetation management regimes (see overleaf). Where there are wayleave agreements, maintenance will be the responsibility of the relevant utility company.

Zone B is the buffer zone, where increased fuel management is carried out to protect Zone A. The aim should be to reduce the rate of spread and intensity of a wildfire. The width of Zone B should be proportionate to the level of risk and the potential impact of radiant heat, smoke and spot fires on Zone A. In low-risk areas of forest it may be as narrow as a fire belt. In higher-risk landscapes, the width will be increased.



Zone C is an area of low wildfire risk where normal land management activities can be carried out. However, it is recommended that wildfire prevention measures are considered where Zone C is adjacent to, or could threaten, Zone B.

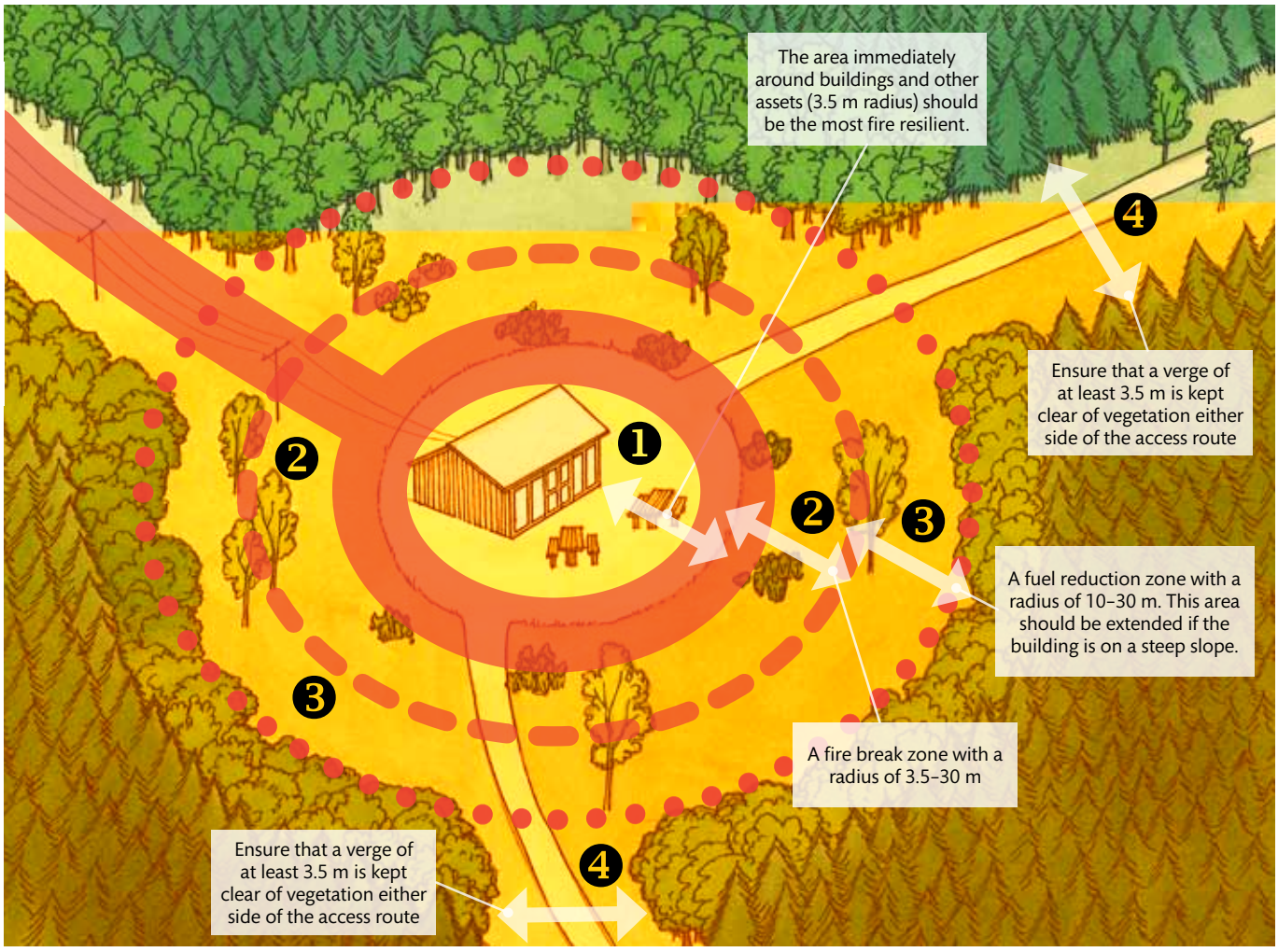
Zone D is a fire exclusion zone, where operations such as prescribed burning or suppression fires should not be permitted as they could damage important ecosystems and habitats such as deep peat, wet heaths and wetlands.

Vegetation management in Zone A

Zone A can be further zoned for progressive levels of vegetation management if required, and on the advice of the fire and rescue services. The goal is to reduce the direct impact of a wildfire in high-risk areas in addition to protecting buildings and structures from radiant heat and fire spotting in the event of an incident. The diagram below sets out appropriate vegetation types and treatments designed to protect people and facilities such as this building and picnic area.

❶ **Area around asset**: vegetation in this area should comprise of sparsely-planted, well irrigated fire-resistant species. Carry out annual maintenance before the start of the fire season. Do not burn cleared vegetation in this area – cut, chip and remove. Clear deadwood and remove leaves/needles from rooftops and guttering.

❷ **Fire break area**: vegetation in this area should comprise of fire-resistant trees kept at a low density. Fragment larger areas of forest or woodland to increase resilience and thin or prune trees to minimise ladder fuels. Manage areas of grassy open space to minimise fuel loading and keep deadwood to a minimum.



❸ **Fuel reduction area**: larger areas of forest or woodland should be fragmented in this area. Plant fire belts of fire-resistant species and manage these so that the undergrowth remains suppressed. Bonfires and prescribed burning (with appropriate control measures) can be carried out in this zone outside the fire season.

❹ **Access routes**: trees and shrubs should be managed along access routes and all vegetation should comprise of fire-resistant species. Remove all ladder fuels and ensure that trees, shrubs and other vegetation do not grow too large and/or close in across the access corridor.

Appendix 3 – Wildfire response plan

Wildfire response plans provide vital information to the fire and rescue services and other responders in the event of a wildfire incident. This appendix sets out the information that should be included in the response plan, which should include a fire map to illustrate key locations and other geographical information. Fire maps are usually produced at 1:10 000 scale and use the standard symbols set out below*. The information provided in the response plan will be used by the fire and rescue services to develop their own plans for use in the event of a wildfire incident.

As well as the name of the site, the plan should contain the contact details of all the people that may be required to provide information, make decisions or offer assistance in the event of an incident, including:

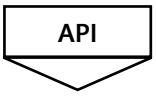
- Key contact (forest or woodland owner or manager)
- Insurance company
- Fire and rescue service wildfire liaison officer
- Trained forestry contractors.

The availability and location of fire-fighting and forestry equipment that might be of use in responding to a wildfire incident should also be listed in the plan.

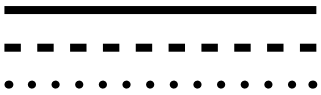
> **!**
>
> Wildfire response plans should be regularly reviewed to ensure they accurately represent what exists on the ground. Operations such as felling and thinning will affect vegetation structure and fuel loadings.

Fire map information and standard symbols

Access and communications



Access points to the forest/woodland from the main road and key locations in the forest/woodland that provide the best access to the main road/ride network.

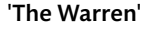


Forest roads/tracks that can be used by fire appliances.
Forest tracks that can be used by off-road vehicles.
Forest tracks that can be used by all-terrain vehicles.

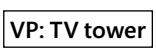
Passing place/hardstanding (solid black rectangle); turning point (open circle); dead end (solid black circle).

Areas where radio and mobile phone communication are not possible due to poor signal.

Signage and orientation features



Orientation points.
Local landmarks.



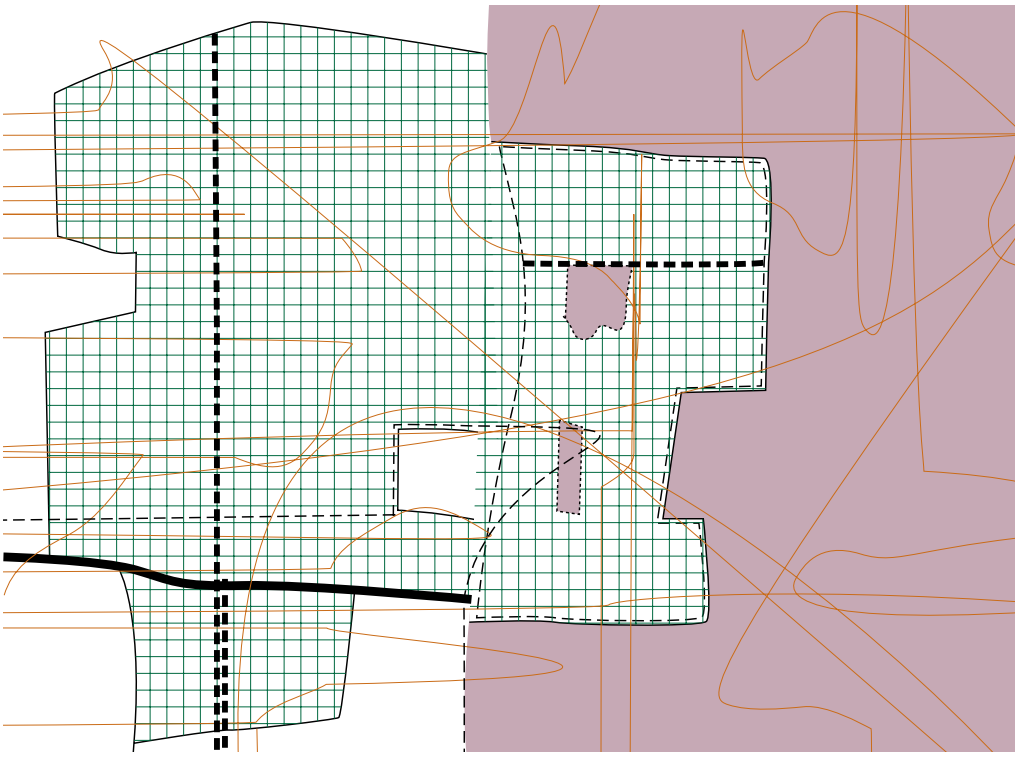
Vantage points.

Assembly/rendezvous points

Locations that can accommodate vehicles and fire appliances without obstructing access. Ideally this should be hardstanding on the main forest road/ride network that can be used by the fire and rescue services for:

- Marshalling areas (e.g. car parks that can support a large number of vehicles).
- Harbour areas (e.g. areas that provide room for at least six fire appliances).
- Staging areas (e.g. areas that provide room for at least four fire appliances).

*Note that not all of the fire map symbols apply to Northern Ireland.



Glossary

Adaptive management A systematic process for continually improving management policies and practices by learning from the outcomes of operational programmes.

Brash The residue of branches, leaves (or needles) and tops of trees, sometimes called 'lop and top', usually left on site after harvesting.

Brashing The removal of the lower branches of conifers (to about 2 m) to allow access for inspection and marking thinnings.

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

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

Control line A constructed or natural barrier that can be used to limit or stop the spread of a fire.

Critical point A geographic location where a number of factors that influence fire behaviour combine to significantly influence fire intensity or the rate/direction of fire spread.

Crown fire (or canopy/aerial fire) A fire burning at tree canopy level. The ignition of a crown fire is termed 'crowning', where a fire burns freely in the upper foliage of trees.

Fire behaviour The reaction of a fire to the influence of fuel, topography and weather. Extreme fire behaviour is a fire that has become erratic or difficult to predict.

Fire hazard Any situation, process, material or condition that can cause a wildfire or that can provide a ready fuel supply to augment the spread or intensity of a wildfire, all of which pose a threat to life, property or the environment.

Fire risk The likelihood of a fire occurring and its potential impact on a particular location at a particular time. It can be calculated using the formula: fire risk = likelihood x severity.

Fire regime The pattern of fire occurrence, fire frequency, fire seasons, fire size, fire intensity and fire type that is characteristic of a particular geographical area and/or vegetation type.

Fire season The period or periods within a year when wildfires are likely or most likely to occur. There are two fire seasons in the UK, which are spring and summer. The duration of the season is dependent on climate and weather.

Fire suppression plan A plan prepared by the fire and rescue services to outline the likely selection of tactics and resources needed for a particular wildfire incident.

Fire type Classification of a fire or section of fire according to the fuel level within which it occurs. For example, aerial, crown, understorey, surface and ground fires.

Forest management plan (woodland management plan) A plan which states the objectives of management, together with details of forestry proposals over the next 5 years, and outlines intentions over a minimum total period of 10 years. Forest management 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.

Fuel hazard A fuel complex that forms a special risk. It can be defined by, for example, type, volume, density and arrangement.

Fuel layers The classification of fuels according to their height relative to the ground surface. There are five general fuel layers:

- Crown/aerial fuels: >3.5 m
- Elevated fuels: 1.5–3.5 m
- Near-surface fuels: 0.5–1.5 m
- Surface fuels: <0.5 m
- Ground fuels: sub-surface material such as peat and organic matter.

Fuel loading The amount of fuel present within a particular area, usually expressed in relative terms from 'light' to 'heavy' fuel loading.

Fuel management The process of managing the quantity or arrangement of vegetation to reduce wildfire risk.

Harbour areas Areas used to provide safe refuges for fire and rescue service personnel and resources.

Hazard Anything that can cause harm, for example fire, electricity, chemicals. Hazards may be man-made or naturally occurring.

High pruning The removal of live branches from a tree stem up to 7.5 m so that subsequent growth produces a cylinder of knot-free timber around a knotty stem core. Usually confined to timber-producing trees to improve quality.

Marshalling areas Areas where fire and rescue service personnel and resources are put on stand-by at large and complex wildfire incidents.

Operational plan The operational details of how planned work will be implemented at site level within the framework of a forest management plan or wildfire management plan.

Prevention measure A planned forest management technique used to increase the resilience of the forest to fire and reduce the severity and spread of a wildfire event.

Risk The chance, high or low, that somebody could be harmed by a particular hazard, together with an indication of how serious the harm could be.

Risk assessment A quantitative or qualitative determination of risk related to a particular situation and recognised hazard. A wildfire risk assessment is based on evaluation of the likelihood of a wildfire occurring and the severity of damage it might cause if it does occur.

Spot fire A fire outside the main fire perimeter caused by sparks and embers transported by the wind or convection column.

Staging areas Areas used by the fire and rescue services for the temporary location of personnel while they await operational assignment. The minimum dimensions for staging areas should be 10 m x 16 m with 3.5 m height clearance.

Thicket A stage of forest growth after canopy closure when lower branches of the trees meet and interlace to form a dense, often impenetrable, growth. Especially applied to conifer forests around 10–20 years of age.

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.

Torching The behaviour of a fire that burns from the ground through surface and ladder fuels and into the crown of a single tree or small group of trees.

Wildfire management plan A strategic scheme or programme of activities formulated in order to prevent or mitigate wildfire incidents, and the evidence upon which it is based.

Windthrow (or windblow) The uprooting of trees by wind.

Wildfire events are predicted to increase in frequency in the UK due to increased land-use pressure and climate change. Wildfires can have a number of impacts on sustainable forest management and, in some extreme cases, may have devastating human and environmental consequences. Reducing the incidence and impact of wildfires in forests and woodlands through good management planning is important to protect the delivery of forest ecosystem goods and services. It can also help to prevent small wildfire incidents escalating into large-scale, out-of-control events. This Practice Guide supports the UK Forestry Standard by setting out good practice for building wildfire resilience into forest management planning. It describes the factors that can increase wildfire risk, sets out the planning measures that should be considered and outlines the forest management techniques that can be implemented to mitigate the risks to our forests and woodlands.

Forestry Commission

Silvan House
231 Corstorphine Road
Edinburgh
EH12 7AT

£11.00

www.forestry.gov.uk