Forestry Commission

Practice Guide

Managing deadwood in forests and woodlands

FOREST SERVICE

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Managing deadwood in forests and woodlands

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Forestry Commission: Edinburgh

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Introduction

In the UK up to a fifth of woodland species depend on dead or dying wood for all or part of their life cycle. Generally speaking, the greater the volume of deadwood the greater the value of the woodland for biodiversity, such that the amount of deadwood in forests and woodlands is now used as a key international indicator of the biodiversity of forest ecosystems. This Guide has been written for woodland owners and managers who want to know where and how to manage woodlands for deadwood – to help improve forest condition and fulfil objectives for sustainable forest management and the UK Biodiversity Action Plan. A specific purpose of the Guide is to help owners and managers implement the guidelines for managing deadwood set out in the UK Forestry Standard (UKFS) Guidelines on *Forests and biodiversity*. The Guide will also be relevant to those with a general interest in the subject of deadwood management.

Scope and aim of the Guide

All types of forests and woodlands in the UK are covered in the Guide but the focus is primarily on the bulk of the woodland resource where there is little existing deadwood. There is less emphasis on woodlands with a high value for deadwood habitats such as wood pasture or parkland, or on the management and arboriculture of veteran or ancient trees, which is covered elsewhere (see Further reading and useful sources of information on page 18).

The Guide aims to encourage owners and managers to develop a strategic approach to deadwood, with a strong emphasis on working with natural processes such as windthrow and decay (Figure 1). While there is some mention of species that are dependent on deadwood, full details of their ecological requirements are not included. Methods for carrying out quantitative assessment and monitoring of deadwood are not covered in detail. Management advice for deadwood should be considered alongside guidance for other aspects of biodiversity and within the context of other management priorities such as safety, timber, woodfuel and recreation.

Figure 1 Old fallen trees, such as this oak in the New Forest, provide an important source of deadwood.

The term deadwood is used in this Guide to include all types of dead and dying trees of 10 cm or more in diameter. This can range from whole or wind-snapped standing trees, fallen wood and stumps, through to decaying wood habitats on living trees – for example rot holes, dead limbs, decay columns in trunks and limbs and below ground in roots. More information and illustrations showing the different types of deadwood are presented in Figure 2.

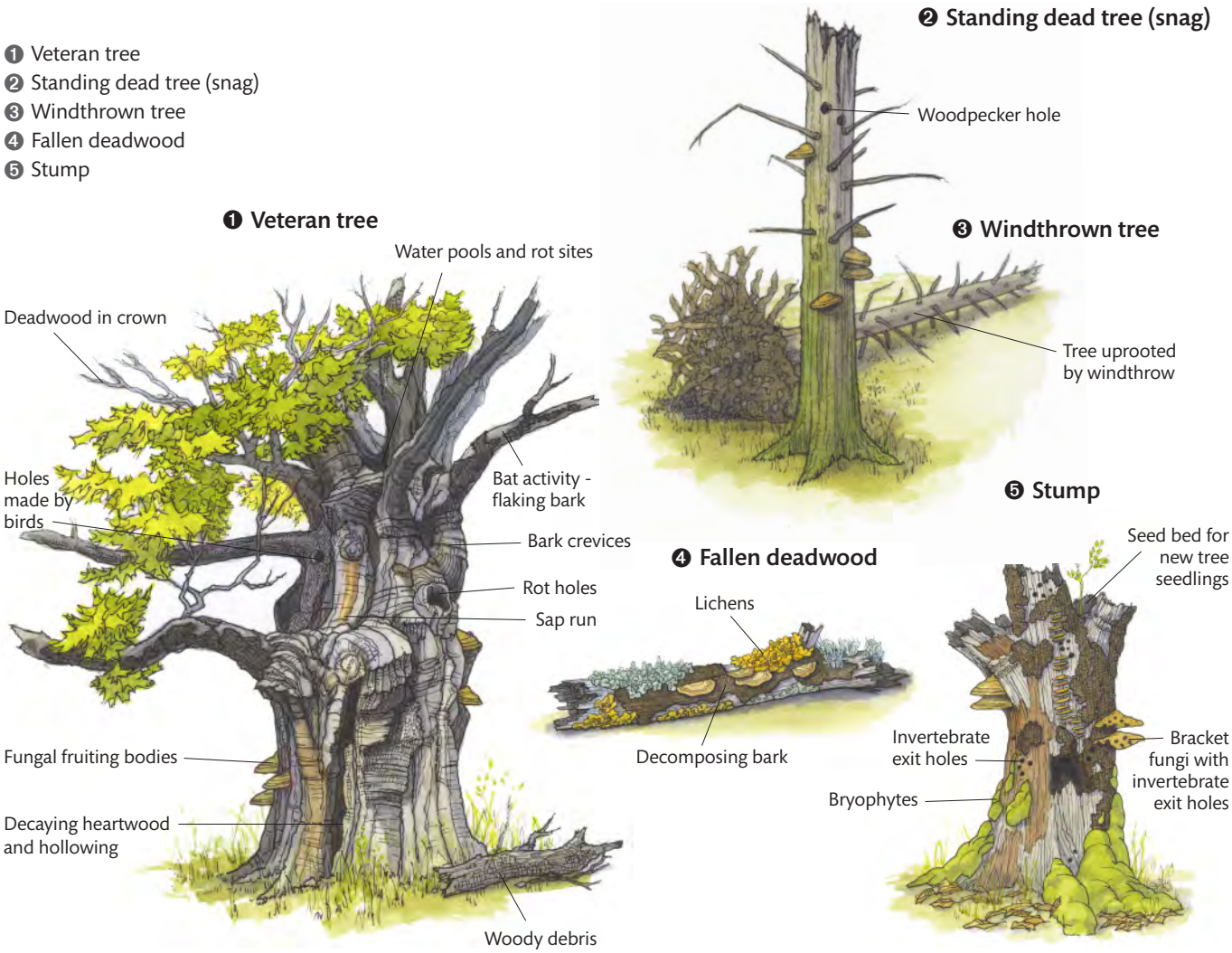
Why is deadwood important?

Dead and decaying trees are vital components of a properly functioning forest ecosystem and play a key role in sustaining biodiversity, soil fertility and energy flows such as hydrological processes in streams and rivers. Deadwood also plays a part in mitigating the effects of climate change by acting as a medium-term sink for carbon.

A natural forest ecosystem would feature most types of deadwood (see Figure 2), although smaller woods might quite naturally have a more restricted representation. In general, larger pieces of deadwood (10 cm or more in diameter for the purposes of this Guide) have more micro-habitats and support more species than smaller pieces. However, this does not imply that deadwood less than 10 cm diameter has no habitat value – small-dimension deadwood is normally present in most woodlands without active management intervention.

Historically, deadwood was systematically removed from woodlands for firewood. By contrast, in wood pastures and wooded commons, firewood was produced from pollards and this allowed old trees with internal decaying wood habitats to develop. Until the late 20th century, deadwood in managed forests was removed due to a misconception of the need to sanitise woodland to secure forest health – or simply to keep a wood looking 'tidy'. Over time this has led to the widespread impoverishment of woodland biodiversity.

Figure 2 Different types of deadwood found in forests and woodlands.



A wide range of plant and animal species depend on dead or dying wood for habitat or as a food source (Figure 3a and b). Many of these species are rare or threatened and, being poor colonists, are often restricted to relict habitats such as boreal pine and aspen woods, and ancient parkland and wood pasture where management has resulted fortuitously in a continuity of deadwood over many centuries.

However, while these relict habitats are of key importance, quite considerable gains for biodiversity can be made across the landscape by increasing and sustaining volumes of deadwood in all woodlands, including conifer plantations. The benefits are most obvious for common and widespread deadwood species (important in themselves for ecosystem functioning) but also for some of the rarer and more specialised species. As woodland area has increased, several species of deadwood insects previously considered to have poor dispersal powers have experienced a rapid expansion of their range (Figure 4).

Deadwood is not just important on land, it also has considerable ecological value within watercourses, where it creates and improves physical habitat structure for a range of different species groups. For example, 147 species of invertebrates have been found associated specifically with deadwood (or woody debris) in streams, and debris dams are also known to benefit fish populations (Figure 5).

Species which depend on deadwood as a habitat or food source for all or part of their life cycle include **lichens, fungi, bryophytes** and a vast array of different kinds of **invertebrates, hole-nesting birds and mammals**.

Figure 3a The larvae of cardinal beetles feed on deadwood.

Figure 3b Bryophytes growing on a log.

Figure 4 The oak jewel beetle, an early colonist of deadwood, has expanded its range as deadwood habitat has increased.

Figure 5 Woody debris in streams can benefit aquatic invertebrates and fish. North Esk, Midlothian.

Sustainable forest management

Creating, maintaining and managing deadwood habitats is seen as a key component of improving the condition of native woodland (as part of the UK Biodiversity Action Plan – see Appendix 1) and of the sustainable management of planted and semi-natural forests. International initiatives such as the Convention on Biological Diversity (CBD), Forest Europe (formerly the Ministerial Conference on Protection of Forests in Europe) and the European Environment Agency 'Biodiversity Baseline' project include deadwood as a key indicator of sustainable forest management. The UK Forestry Standard (UKFS) and the UK Woodland Assurance Standard (UKWAS) both emphasise the need to take account of deadwood when seeking to attain standards of sustainable management.

Statutory and non-statutory requirements

There are a number of specific statutory and non-statutory requirements relating to biodiversity conservation and wildlife protection that have a bearing on how woodlands are managed for deadwood. These are described in more detail in Appendix 1. A list of priority and protected species that use deadwood is given in Appendix 2. In particular, owners and managers have a statutory duty of care with respect to European Protected Species (Figure 6), some of which depend on deadwood (see Appendices 1 and 2).

Figure 6 Otters are European Protected Species associated with deadwood.

Processes that create deadwood

The processes of decay that create deadwood are linked to differences between tree species and the way in which decay was initiated. Broadly, there are two processes:

- Decay from the inside out, where fungal colonisation initiates hollowing of heartwood.
- Decay from the outside in, where mechanical damage, storms, disease or drought cause decay of bark, sapwood and roots.

Decay from the inside out

Internal deadwood associated, for example, with heartwood in oak or ripewood in beech is continuously produced as the annual rings of living wood age and break down. As trees age this accumulation of heart or ripewood starts to decay due to the colonisation of fungi (many of which are rare and specialised) and the tree becomes hollow. Different fungi cause different types of decay and some organisms are specifically associated with a particular type of rot and stage of decay. The process of decay and hollowing creates a very special habitat that changes over time and is occupied by an increasingly specialised suite of associated organisms. Many of these are poor dispersers and rely on long-term continuity of the resource on a particular site. Where annual sapwood or living tissue continues to be produced the tree can continue to grow into old age. In many cases the fungi do not move into living sapwood unless the tree is killed or injured. As the deadwood breaks down, the nutrients are often taken up by the tree and have a rejuvenating influence. Once hollowing has started, the cavities that are created are vital for a range of fauna such as hole-nesting birds and roosting bats (Figure 7).

Providing a sustainable supply of decaying wood in trees through all stages of the hollowing process is a challenge. The decaying wood of hollowing trees is found most frequently where ancient or veteran trees occur, such as in ancient parkland and wood pasture. In the latter situation, tree management such as pollarding has meant that trees have been retained beyond normal felling cycles, thereby safeguarding a continuity of decay processes over many centuries.

Wood decay fungi have an important relationship with some deadwood invertebrates. To be able to use deadwood, many wood-boring insects require wood colonised by fungi as they lack enzymes to break down and digest undecayed wood.

Decay from the outside in

In contrast to hollowing trees, decay of bark, sapwood and roots can be initiated by the uprooting or snapping of trees or large branches by strong winds. Damage may also occur as a result of forest operations such as harvesting or thinning. This type of decay is relatively short-lived and supports a specialised, yet relatively mobile, fungal and insect fauna adapted to rapid exploitation of the resource. It is important therefore to maintain continuity of the resource across the landscape as well as within individual woodlands. In standing deadwood, the bark and sapwood dry out relatively quickly, but the heartwood tends to decay much more slowly. Fallen deadwood, in contrast, is in contact with the ground where the micro-climate speeds up fungal decay and the heartwood decays more rapidly. Some trees in high forest conditions, where there has been little thinning, die at quite a young age due to competition for light. The resulting deadwood, either standing or fallen, can be relatively short-lived. Most deadwood in high forest conditions has been found to decompose completely in less than 100 years, and decay is most rapid in areas with moderate levels of precipitation (between 1100 and 1300 mm per annum).

Figure 7 A veteran tree with many cavities in Savernake Forest.

Figure 8 Recent fallen aspen, Strathspey.

Managing deadwood

The UKFS Guidelines on *Forests and biodiversity* set out the Requirements for sustainable forest management with respect to biodiversity, including the management of deadwood. They form part of a suite of Guidelines that covers the various elements of sustainable forestry in the UK, and are an integral part of the UKFS. The Forests and biodiversity guidelines for deadwood are set out in Box 1 below.

Box 1 – Forests and biodiversity guidelines relevant to deadwood

23 Leave a proportion of standing and fallen deadwood: concentrate it in areas of high ecological value, where there is existing deadwood and where linkages can be provided between deadwood habitats – avoid uniform distribution across the forest management unit.

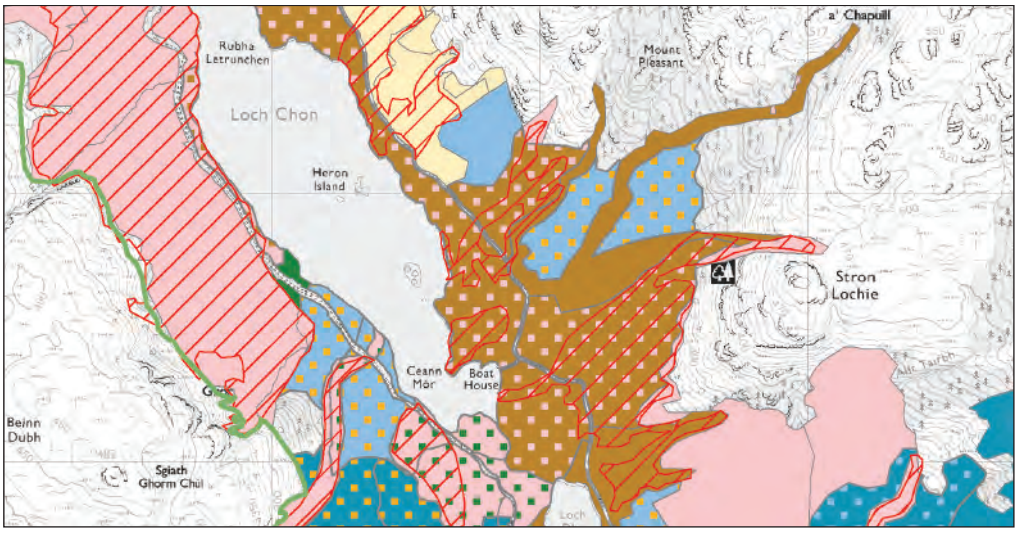
24 Retain existing veteran trees and select and manage suitable individuals to eventually take their place.

Approach to management

Although every forest and woodland is different, and owners and managers have different management objectives, deadwood should be considered in most situations. Current evidence suggests that, over the long term, deadwood (not including stumps, which are usually retained after felling) should amount to roughly 20 m^3 per hectare (equivalent to a lorry load per hectare) averaged – though not uniformly distributed – across the forest management unit (FMU).

Some management actions are general to all woodlands, but there are others which are specific to woods or areas of higher ecological value. Implementing a differential approach to deadwood management should ensure that deadwood is not uniformly distributed across the FMU and effort is focused where it is most needed. This approach requires that areas of high ecological value be identified during management planning (Figure 9). Methods for assigning areas to different levels of ecological value (High, Medium and Low – see Table 1) are described in the next section.

Figure 9 Areas with high ecological value for deadwood should be considered during management planning, for example when drawing up felling and restocking plans.



The influence of species composition and management regime on deadwood habitats are covered in more detail on pages 13 and 14. Managers and owners are encouraged to consider not just doing the minimum required for each woodland type or area, but to take positive action to shift areas of Low and Medium value to a higher level. Specific management actions for increasing deadwood are described under four categories (Table 2 and pages 13 and 14):

- Working with natural processes.
- Protecting and adding value to existing deadwood.
- Creating and expanding deadwood habitat.
- Improving linkage between deadwood habitats.

In all cases there is a need to consider the implications of management actions for public and worker safety (this is dealt with in more detail on page 15).

Identifying areas of high ecological value

The value of a woodland, in terms of deadwood habitats, can be assessed using five broad factors:

1. Current levels of deadwood on site.
2. Continuity and diversity of deadwood habitats over time.
3. Known interest for species associated with deadwood.
4. Ecological connectivity.
5. History of management.

These factors are interrelated to a large extent and overall value is determined by the highest 'score' for an individual factor.*

Table 1 Identifying the ecological value of a woodland for deadwood habitat.

Factor	Ecological value of a woodland for deadwood habitat		
	Low	Medium	High
Current levels of deadwood on site	0–10% of total stems dead or containing some decaying wood habitats.	11–20% of total stems dead or containing some decaying wood habitats.	>20% of total stems dead or containing some decaying wood habitats.
	Few veteran trees and mature trees also scarce (less than one tree per 100 paces).	Average of 1–3 veteran trees per hectare or majority of trees mature (around one tree per 100 paces).	Average of more than 3 veteran trees per hectare and some/many mature trees (around one tree per 50 paces or less).
Continuity and diversity of deadwood habitats over time	Known that there has been little continuity of habitat, and current resource is of recent origin with a reduced range of decay stages and types of decaying wood.	History of current resource unknown and continuity not clear but some evidence of a range of different decay stages and types of decaying wood.	Known or suspected high continuity of deadwood habitat, occurrence of large diameter deadwood and/or deadwood in a wide range of different decay stages and types.
Known interest for species associated with deadwood	No known species interest.	Small numbers of mainly common species known to be present.	High numbers of species, including a range of specialist or UKBAP species.
Ecological connectivity	Woodland isolated, with few woods or hedgerow trees within 3 km.	Some woodlands or hedgerow trees present within surrounding 3 km.	Woodland and veteran trees common in landscape; some high value sites within 3 km).
History of management	Little history of management to promote deadwood; frequent interventions to remove deadwood.	At least 25% of wood managed as minimum intervention or managed to promote decaying wood habitats.	At least 50% of wood managed as minimum intervention or managed to promote decaying wood habitats.

*Field observations should only be necessary where value cannot be determined from existing mapped and other information.

Table 2 Management actions needed to implement Forests and biodiversity guidelines 23 and 24.

<table>
<tr><th rowspan="2">Management category</th><th colspan="3">Ecological value of a woodland for deadwood habitat</th></tr>
<tr><th>Low</th><th>Medium</th><th>High</th></tr>
<tr><td>Working with natural processes</td><td>Only harvest windblow when it is of significant economic value or is more than is required to contribute to accumulating deadwood volumes on site. Allow some trees to age and hollow. (23)</td><td colspan="2">Allow natural processes such as wind, riverbank erosion and accumulation of woody debris in streams to create and maintain deadwood habitats. Allow trees to age and hollow. (23)</td></tr>
<tr><td rowspan="3">Protecting and adding value to existing deadwood</td><td colspan="3">Unless there are overriding safety concerns, retain all existing standing, veteran and fallen dead trees (including major branches) and thickets of scrub with decaying stems, where these occur. (23)</td></tr>
<tr><td colspan="3">Match retained deadwood to the requirements of species likely to be important on the site. Improve habitat diversity by having a range of tree/shrub species at varying stages of decay and in a variety of light conditions; stems greater than 10 cm diameter; at least half of all stems as snags of variable height. Some stumps should also be retained. (23)</td></tr>
<tr><td>Leave stems of no commercial value that die through shading. (23)</td><td colspan="2">Carry out gradual thinning/haloing to open up existing veteran trees and glades, especially where there is dense shading by young trees – for example non-native conifers. (24)</td></tr>
<tr><td rowspan="3">Creating and expanding deadwood habitat</td><td>Create snags and fallen deadwood where insufficient exists (i.e. <10%). On clearfells, group deadwood in association with live stems, native trees and shrubs, and other semi-natural vegetation or wet flushes – rather than distributing uniformly across the coupe. (23)</td><td colspan="2">Identify and retain potential veteran trees or trees with decaying wood. Halo to allow full crown development if required. Pollarding can help keep old, previously pollarded trees alive and maintain a range of habitats. Consider killing selected (e.g. non-native) trees and leaving in situ to increase deadwood, create groups of high stumps, snags and cavity trees. (24)</td></tr>
<tr><td rowspan="2">Consider scope for transforming some stands to a lower impact silviculture system to allow decay in semi-shaded conditions. (23)</td><td>Diversify the structure of uniform woodland and hasten stand development by small-scale felling or variable density thinning leaving windfirm stems likely to survive for at least another 50–100 years. (23)</td><td>Only fell trees where necessary to improve diversity of structure, to ensure a sustainable variety of decaying wood habitat, and to maintain canopies of existing and potential veteran trees. (24)</td></tr>
<tr><td colspan="2">Consider scope for designating some stands as Natural Reserves and manage on a minimal intervention basis. (23)</td></tr>
<tr><td>Improving linkage between deadwood habitats</td><td colspan="2">Target the creation of deadwood habitats to enable buffering of High or Medium value areas. (23)</td><td>Encourage owners of nearby woodlands and land with ancient and veteran trees to manage positively for deadwood. (23)</td></tr>
</table>

Current levels of deadwood on site

Levels of deadwood can be estimated by eye as a percentage of total stems. Table 1 includes broad percentage bands for each of the three categories of value, so there is no need for precise measures of the amount of deadwood.* Remember to include all snags, fallen deadwood and living trees with decaying wood in the estimate (stumps should be excluded as discussed previously). Figure 2 gives an example of a veteran tree and salient features are described in Appendix 3 and the Glossary. The average number of veteran trees per hectare can be estimated by taking account of the distance between individual trees on a walk through the site or area of interest (see Table 1).

*Quantitative information on deadwood volumes in British woodland is collected by the Forestry Commission's National Forest Inventory. For further information and details of the methodology see www.forestry.gov.uk/inventory.

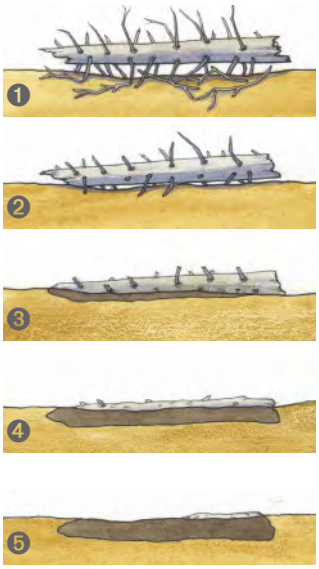
Continuity and diversity of deadwood habitats over time

In general, the greater the diversity of different types of deadwood, the higher the value of the forest or woodland will be for decaying wood habitats (see Figure 2 for examples of different types of deadwood). The Institute of Ecology and Environmental Management has recently published guidance in *Rapid dead wood assessment*, including how to identify and assess the diversity of deadwood habitats.

Continuity of supply of deadwood is indicated by the presence of dead trees in varying states of decay (Figure 10), ranging from the completely intact, through lost bark and degraded heartwood and sapwood, to complete loss of structure and incorporation into the soil.

The presence of large-diameter deadwood is likely to indicate longer-term continuity, as large pieces of deadwood take longer to decay than small ones. In lowland broadleaved woodland, longer-term continuity is indicated by the presence of veteran and ancient trees; in upland woodlands, such large trees may not be present and continuity is best estimated by reference to historical information, e.g. archived records of management, or old photographs if available.

Figure 10 Typical range of decay classes in fallen deadwood.



Known interest for species associated with deadwood

An assessment of species present in the woodland and in the surrounding area is rarely practical or affordable. Species records for localities may be held in local biodiversity record centres and the National Biodiversity Network (www.nbn.org.uk). A checklist of protected and priority species associated with deadwood (Figure 11) is given in Appendix 2.

There is also a range of shortcut and cheaper assessment techniques, which will give an indication of the likely value of the woodland or the deadwood habitats within it. For example, exit holes are formed when insect larvae that live in deadwood emerge in the adult stage of their life cycle (Figure 2 on page 2). Similarly, holes in bracket fungi can indicate the presence of specialist beetles. Some species may be directly observed if assessments are carried out at times when, for example, insects are emerging or in their flying phase. Information is also available linking habitat types in England to different invertebrate groups (see Further reading and useful sources of information).

Figure 11 The larvae of the stag beetle feed on rotting wood.

Connectivity is an attribute of the landscape that relates to ecological processes such as the movement of species between habitat patches. It is different from physical 'connectedness', which is simply a measure of the proximity of different habitat patches to each other.

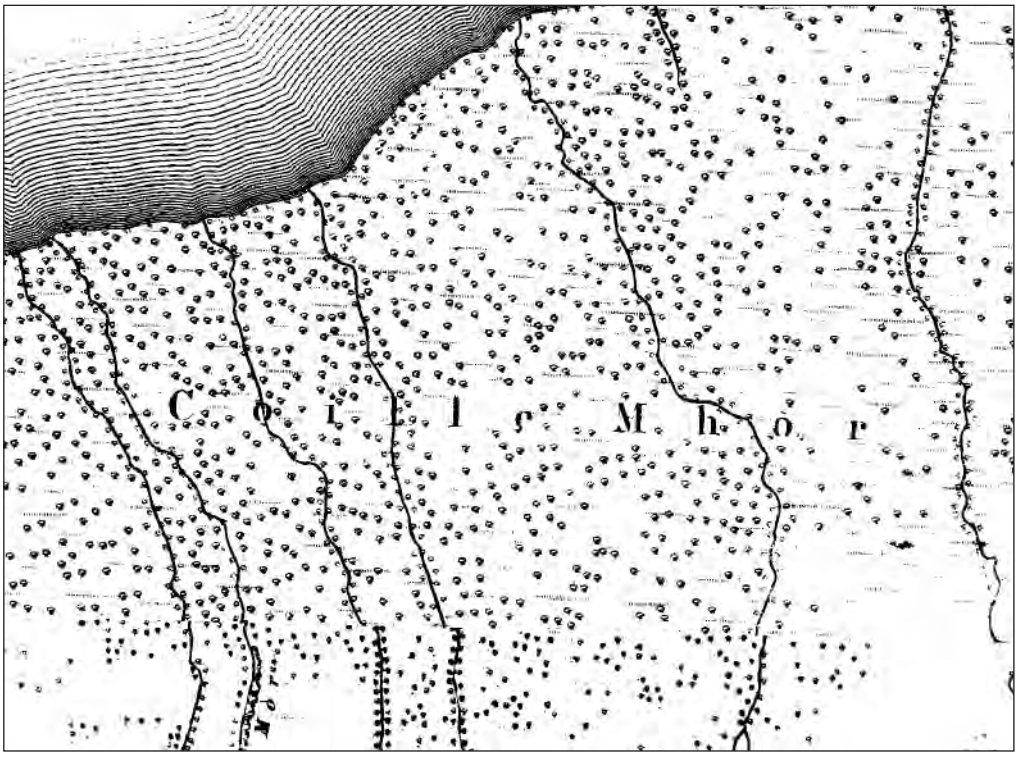
Ecological connectivity

Ecological connectivity in the wider landscape gives an indication of the degree of linkage between deadwood habitats in different forests and woodlands. Planning tools are available to help evaluate ecological connectivity, see for example the Forestry Commission Information Note *Evaluating biodiversity in fragmented landscapes: applications of landscape ecology tools*. The Ancient Woodland Inventory can provide information on the distribution of semi-natural woodland within the surrounding landscape, and this can be supplemented by local knowledge of small enclaves of woodland, isolated veteran trees and hedgerows. The Ancient Tree Hunt project is identifying locations of important veteran and ancient trees (www.ancienttreehunt.org.uk).

History of management

The presence of ancient or veteran trees can give an indication of past management. Where available in Scotland, longer-term management can be indicated from Historic Land Use Assessments (www.rcahms.gov.uk) carried out by Historic Scotland and the Royal Commission for Ancient and Historic Monuments Scotland (RCAHMS). In England and Wales, English Heritage and Cadw, respectively, can also provide information on historic landscapes. These historic assessments may provide some information on the past distribution of parkland sites. The 1st edition and First series Ordnance Survey maps provide accurate notation of the past distribution of scattered woodland, which may indicate potential wood pasture and common land (Figure 12). Other sources, for example estate and management records for the site, may also provide an indication of the influence of past management on deadwood habitats.

Figure 12 Extract from Ordnance Survey 1st edition (1860) for an area south of Loch Katrine (Loch Lomond and Trossachs National Park) showing mapping convention for broadleaved wood pasture (scattered tree symbols).



Examples of woodland types of differing value for deadwood

Low value woodland types currently have little value for deadwood species, but would benefit from deadwood enhancement over the long term. Examples include:

- Recent (<50-year-old) plantation stands of both native and non-native tree species, managed by conventional clearfelling and restocking (including short rotation forestry), where opportunities exist to create deadwood during thinning or felling (Figure 13a and b).
- New native woodland, scrub and other young semi-natural woodland.

Figure 13a Area retained for the development of deadwood on a clearfell coupe in upland Sitka spruce forest in Galloway.

Figure 13b Group of conifers retained for the development of deadwood on a clearfell coupe in upland Sitka spruce in Galloway.

Medium value woodland types currently have some value for deadwood species and would benefit greatly from deadwood enhancement. Examples include:

- Broadleaved woodland which has been managed historically as high forest or coppice, but where stands are ageing (e.g. 100–120 years) and there is good potential to increase the amount of deadwood (Figure 14).
- Plantations on ancient woodland sites (PAWS) where there are remnants or hot spots for biodiversity including deadwood in veteran trees and coppice stools, and where additional deadwood can be created by killing non-native conifers in situ.

Figure 14 Standing deadwood retained in an old hornbeam coppice woodland.

- Long-established plantations such as those of Scots pine in the Scottish Highlands where sympathetic management can provide habitat for deadwood species associated with native pinewoods.
- Plantation stands managed using lower-impact silviculture (e.g. variable density thinning) where there is potential to develop larger-diameter deadwood and allow decay in semi-shaded conditions.

High value woodland types are characterised by a recent history of minimal intervention or positive management to retain deadwood, e.g. maintenance of veteran trees. Examples include:

- Ancient semi-natural broadleaved woodland with a high frequency of veteran trees and good potential to develop future veterans. These woods are also structurally diverse, with glades and well-developed edge habitats.
- Native pinewoods in the Scottish Highlands with a high proportion of granny (veteran) pines, and standing and fallen deadwood including stumps.
- Woodland alongside watercourses where fallen trees and deadwood play an important role in freshwater ecosystems by fostering the development of 'debris dams' (Figure 15).
- Wood pasture (often common land) and parkland, a key habitat for deadwood species, characterised by large, open-grown trees at various densities, in a matrix of grazed grassland or heathland. The trees usually show some signs of having been managed on a more or less formal basis (e.g. pollarding) over a long timescale.
- Natural Reserves in planted woods of native and/or non-native species, where old-growth habitat conditions can develop over time and include large trees, structural diversity and deadwood (Figure 16).

Natural Reserves are predominantly wooded, are permanently identified and are in locations which are of particularly high wildlife interest or potential. They are managed by minimum intervention unless alternative management has higher conservation or biodiversity value.

Figure 15 Debris dam in a stream within lowland mixed broadleaved woodland.

Figure 16 Natural Reserve in upland conifer forest showing large-diameter fallen deadwood. Galloway Forest Park.

Working with natural processes

Retaining standing and fallen deadwood and maintaining a proportion of ageing trees is one of the easiest ways to establish good quality decaying wood habitats (Table 2). Moreover, deadwood created by natural processes (Figure 17) generally provides greater benefits for deadwood-dependent species such as fungi and invertebrates than artificially created habitat. Working with natural processes such as wind and natural mortality over long time frames (20 or more years) should allow the development, build up and linkage of deadwood habitats. This implies taking a minimal intervention approach wherever possible, but especially in High and Medium value areas, while striking a balance with other management objectives.

Figure 17 Windthrow in upland forests can be an important source of deadwood.

Protecting and adding value to existing deadwood

It is important to maintain a spectrum of different stages and types of deadwood across the woodland. Native deadwood is thought to provide more valuable habitats than non-native deadwood, and should be retained wherever possible. However, there is good evidence to suggest that retaining large-diameter timber of non-native species such as beech (in northern Britain) and Norway and Sitka spruce can provide important habitat – particularly in cool and wet conditions. In some circumstances it may be necessary to protect or augment decaying wood habitats for specific species (Figure 18), although care should be taken to ensure that single-species management does not compromise overall conservation objectives for a woodland. In general, habitat diversity can be improved by having larger stems in a variety of light conditions (Table 2). Veteran trees should be identified and protected unless there are over-riding safety considerations. Where veterans are being shaded by young trees, they should ideally be opened up gradually to increased light, although this may not always be practical.

Figure 18 Coppice stacked to provide deadwood habitat.

Creating and expanding deadwood habitat

Artificially injuring or felling trees, and leaving some felled trees and logs when thinning, can be of great benefit where there is currently a lack of habitat but a pressing need to ensure continuity, such as maintaining a constant supply of fresh deadwood. Areas of low ecological value, e.g. plantations, have potential to provide deadwood habitat over the longer term, given appropriate management. There are also wider ecosystem benefits (e.g. carbon and nutrient cycling) of providing some deadwood and generally increasing provision over a number of rotations. It is better to take a broad-brush approach, rather than focusing on detailed specifications, and

make provision for deadwood when harvesting or thinning, rather than carrying out separate operations. A good starting point is to retain areas where deadwood can be grouped with live stems, native trees and shrubs, riparian zones and other semi-natural vegetation or wet flushes – rather than scattering it across the coupe. The location of these 'within-coupe retentions' should vary from coupe to coupe, with some in full sun in the middle of the coupes and others in shadier conditions near coupe edges (Table 2). Artificial snags and high stumps can be created by using a harvester head to cut the upper part of the tree and removing the foliage to a height dependent on machine capabilities and safety considerations (Figure 19). Diversifying woodland structure and adopting lower-impact silvicultural systems can also have a positive impact on deadwood, if undertaken sensitively with an eye to promoting dead and decaying wood habitats wherever possible, such as by retaining thinning residues and windblown patches. An important consideration in High and Medium value sites is to identify and retain potential veteran trees, while prolonging the life of existing veterans until the new ones can be recruited (Table 2).

Figure 19 Creating artificial snags using a harvester, such as in this example at Abernethy Forest in Scotland, can help maintain a supply of fresh deadwood which is beneficial to a range of species.

Improving linkage between deadwood habitats

Enhancing linkage between existing areas of deadwood can be achieved by targeting the creation of deadwood to enable buffering of High and Medium value sites (Table 2). In addition, establishing deadwood habitat within the wider landscape can also increase ecological connectivity, improving the chances of deadwood species being able to move through the landscape (Figure 20).

Figure 20 The landscape context should be considered when planning the provision of deadwood.

Balancing management objectives

In most woods there will be a need to balance the provision and enhancement of deadwood with other factors, some of which may include:

- risks to public and worker safety of retaining and managing standing deadwood;
- visual and recreational impact of deadwood and of management operations;
- other biodiversity objectives;
- economic objectives, especially timber and woodfuel production;
- the extent to which pests and diseases associated with large amounts of dead and dying trees might be encouraged, to the detriment of living trees.

Minimising risks to public and worker safety

The chance of people being injured by deadwood is generally very low, but rigorous risk assessment procedures should be followed for deadwood in areas which are regularly used by the public for recreation, adjacent to public paths, roads and car parks, or where people are working. These procedures include:

- taking account of deadwood during the planning and management of forestry operations;
- re-routing existing paths and planning new infrastructure away from ancient/veteran trees and high value deadwood areas where possible;
- determining the frequency of tree inspections, which should include zoning so that tree inspections can be prioritised (Figure 21);
- making sure any remedial works identified by the tree inspections are carried out (Figure 22).

Try to avoid completely removing deadwood or veteran trees from a site. If a tree (or trees) has been identified as a hazard but is of particular value for deadwood and you wish to retain it, it must be subject to an individual risk assessment by a competent person and specific control measures (such as fencing) put in place. Where the management or removal of deadwood may have a detrimental effect on a European Protected Species, a licence will be required from the relevant nature conservation agency.

Further guidance on managing safety aspects of deadwood and veteran trees is available in *Common sense risk management of trees*, published by the National Tree Safety Group.

Figure 21 Low-use zones may only require irregular tree inspections.

Figure 22 Snag next to path reduced in height for safety purposes.

Minimising visual and recreational impacts

Creating and enhancing deadwood habitats as part of the sustainable management of forests and woodlands is a relatively new activity requiring good communications between managers, planners, operational staff and other users of the woodland. Leaving or creating deadwood can be considered visually intrusive in some situations; isolated snags in clearfell areas can give a temporary 'graveyard' look, whereas deadwood will often go unnoticed within native woodlands. In areas regularly used by the public, opportunities should be taken to use interpretation to explain what is happening and the environmental benefits provided by deadwood (Figure 23). Guidance on deadwood and forest design issues is available in the Forestry Commission Practice Guide *Forest design planning*; local landscape architects can also provide advice.

The impact of deadwood on recreation is best dealt with through risk assessment (see above). There is scope for innovation and positive management, such as making safe fallen deadwood so that it can function as an educational resource, or as a barrier alongside trails. In some urban fringe woodlands there is an increased risk of damage to veteran trees and deadwood by fire. However, this should not be used as an excuse for proactive removal of deadwood; the problem could be addressed by encouraging dense bramble around prominent examples and regularly clearing up litter, which, if left, could attract damaging activity.

Figure 23 Illustrated poster explaining the role of deadwood in pinewoods.

Other biodiversity objectives

The need to enhance deadwood and deadwood-dependent species should be balanced with the needs of other species and habitats. For example, in some forests and woodlands it may be desirable to maintain areas of regularly-worked coppice for butterflies and other insects. Although there may be less scope for developing large standing or fallen deadwood in these situations, very rarely will coppicing have a negative impact on the rest of the habitat. The restoration of open-ground habitat may be a priority in some areas, e.g. restoring areas of lowland heathland within and around pine plantations. In most circumstances proper objective setting and management planning should allow a balance to be struck between deadwood and other components of biodiversity.

Timber and woodfuel production

With the growing impetus to reduce carbon emissions and develop renewable energy resources, including woodfuel and firewood, there could be a threat to deadwood habitats in some woodlands. Actions such as increased frequency and intensity of thinning in neglected middle-aged woodlands, and the restoration of neglected coppice woodlands to short fuelwood cycles, could all have a significant impact on the amount and distribution of deadwood. The emphasis should be on using sound timber for fuel (Figure 24) but, depending on the demand for firewood logs, there might be a growing pressure in accessible woodlands to remove existing dying trees and standing and fallen deadwood, with serious consequences for dependent wildlife.

Figure 24 Sound timber ready to be chipped for woodfuel.

Woodfuel production initiatives and harvesting should therefore comply with current forestry environmental standards and guidelines and be targeted carefully to avoid high value deadwood areas (see Table 2) wherever possible. In low value areas such as clearfells in plantations, the aggregation of deadwood in specific retained groups or patches across the coupe will cater for the development of deadwood habitats (see Table 2) while allowing scope for the removal of woody debris for woodfuel on non-retained proportions of the coupe. It is recommended that where woodfuel (excluding stumps) is left in piles, these should be removed from the woodland as soon as possible before they are colonised by invertebrates.

Pests and diseases

In some planted forests of coniferous or broadleaved species, there may be a balance to strike between the ultimate conservation value of deadwood and the shorter-term risks of providing resources for damaging bark and wood-boring insects and fungal pathogens (e.g. Dutch elm disease). However, most bark beetles will not move onto living trees as they can only utilise stressed or newly dead trees. The exceptions are *Ips typographus* (not yet present in Britain) and *Dendroctonus micans* (present in Britain), which can kill healthy trees.

The switch to the colonisation of living trees only occurs after the beetles have built up in numbers in stressed or recently dead trees. In the case of *Ips typographus*, the risks are greatest in large forest blocks with contiguous areas of spruce that may be subject to windthrow and other environmental stresses. However, in the UK, surveillance, preventative harvesting and restructuring has ensured that numbers of these potentially damaging insect pests have not approached, and are not likely to approach, anything like the pest proportions which would threaten the sustainability of the forest.

Figure 25 The stump lichen *Cladonia botrytes* is a priority species found on pine stumps between 4 and 10 years old.

The treatment of conifer stumps with urea (a fungal retardant) to reduce infection by butt-rot *Heterobasidion annosum* has been a potential concern in long-established pine plantations and native pinewoods where stumps provide habitats for rare species (Figure 25). Research has shown that urea can have damaging effects on plants and fungi surrounding the stump and, in some cases, temporarily reduce the value of the cut surface as a substrate for fungi and other wood-boring invertebrates.

Current advice is that there should be no need to administer urea in pinewoods, as effective biological control is available. 'PG Suspension' is registered and approved for use on pine in the UK, and is currently used in pine-growing areas such as Thetford Forest in East Anglia where *Heterobasidion annosum* is a particular problem. The active ingredient is the wood-rotting saprophytic fungus *Phlebiopsis gigantea,* which is part of the natural mycoflora in pine forests.

Further reading and useful sources of information

forestry.gov.uk/publications
forestry.gov.uk/ukfs

Forestry Commission publications

- The UK Forestry Standard (FCFC001).
- UKFS Guidelines - Forests and biodiversity (FCGL001).

Guidance and good practice

- Forest design planning: a guide to good practice (FCPG012).
- Hazards from trees: a general guide (FCPG013).
- Life in the deadwood: a guide to managing deadwood in Forestry Commission forests.
- Woodland management for bats.

Research

- Environmental effects of stump and root harvesting (FCRN009).
- Evaluating biodiversity in fragmented landscapes: applications of landscape ecology tools (FCIN085).

Other publications

- Common sense risk management of trees. National Tree Safety Group.
- Common standards monitoring guidance for woodland. Joint Nature Conservation Committee (JNCC).
- EU 2010 Biodiversity Baseline. European Environment Agency Technical Report 12/2010.
- Habitat management for invertebrates: a practical handbook. JNCC/RSPB.
- Large woody debris in British headwater streams: physical habitat role and management guidelines. Research and Development Technical Report W185. Environment Agency.
- Managing woody debris in rivers, streams and floodplains. Staffordshire Wildlife Trust.
- Rapid dead wood habitat assessment. Quarterly Journal of Forestry 102(1).
- The development of ISIS: a habitat-based invertebrate assemblage classification system for assessing conservation interest in England. Journal of Insect Conservation 10.
- UK Woodland Assurance Standard. UKWAS Steering Group.
- Veteran trees: a guide to good management. English Nature.
- Woodland management for birds: a guide to managing for declining woodland birds in England. RSPB, Forestry Commission England.

Websites

- Natural England – www.naturalengland.gov.uk
- Scottish Natural Heritage – www.snh.gov.uk
- Countryside Council for Wales – www.ccw.gov.uk
- Northern Ireland Environment Agency – www.ni-environment.gov.uk

- Forest Research – www.forestry.gov.uk/forestresearch
- Northern Ireland Forest Service – www.forestserviceni.gov.uk
- Joint Nature Conservation Committee – www.jncc.defra.gov.uk
- European Protected Species – www.forestry.gov.uk/eps
- UK Biodiversity Action Plan – www.ukbap.org.uk
- National Biodiversity Network – www.nbn.org.uk

Appendix 1: Statutory and non-statutory requirements

There are a number of specific statutory and non-statutory requirements relating to biodiversity, wildlife protection and conservation that have a bearing on the management of deadwood.

Further information on UK wildlife legislation can be found at: legislation.gov.uk

- Wildlife and Countryside Act 1981 (as amended) and the Wildlife (Northern Ireland) Order 1985 transposes the EC Birds Directive (2009/147/EC) (ec.europa.eu/environment/nature/legislation/birdsdirective) into UK law and offers protection to many specified plants and animals, as well as broad protection to unspecified plants and animals such as nesting birds. The degree of protection and scope of the various measures are not confined to rare species. They include methods of controlling species and prevention of the establishment or release of non-native species.

  Appendix 2 contains a list of scheduled species associated with deadwood.

- Conservation of Habitats and Species Regulations 2010 (as amended). These consolidate all the various amendments made to the Conservation (Natural Habitats, &c.) Regulations 1994 with respect to England and Wales.

  The 1994 Regulations transposed the EC Habitats Directive (ec.europa.eu/environment/nature/legislation/habitatsdirective) into national law. In Scotland, the Habitats Directive is transposed through a combination of the Habitats Regulations 2010 (in relation to reserved matters) and the 1994 Regulations. The Conservation (Natural Habitats, etc) Regulations (Northern Ireland) 1995 (as amended) transpose the Habitats Directive in relation to Northern Ireland.

  The regulations make it an offence to destroy or damage the breeding sites or resting places of, or to significantly disturb, species protected under this regulation (European Protected Species). Species particularly relevant to deadwood include the noctule and barbastelle bat, otter and great crested newt (see Appendix 2 and www.forestry.gov.uk/eps).

- Countryside and Rights of Way (CRoW) Act 2000 places a duty on government ministers and departments in England and the National Assembly Government for Wales to have regard for the conservation of biodiversity in the exercise of their functions and to maintain publication of official lists of priority habitats and species in England and Wales (these are the UK Biodiversity Action Plan species and habitats) for which conservation steps should be taken or promoted, in accordance with the Convention on Biological Diversity (www.cbd.int).

- Nature Conservation (Scotland) Act 2004 places a duty on public bodies in Scotland to further the conservation of biodiversity when carrying out their functions. It requires Scottish Ministers to designate a Scottish Biodiversity Strategy, and to publish lists of species of flora and fauna and habitats of principal importance for biodiversity. A number of species are targeted for special conservation action in Scotland's Species Action Framework. Of these, the great crested newt, pine hoverfly (*Blera fallax*) and hazel gloves fungus (*Hypocreopsis rhododendri*) are associated with deadwood (see Appendix 2).

- Natural Environment and Rural Communities (NERC) Act 2006 affords increased protection for certain wild birds (none of which are explicitly associated with deadwood) and creates a new offence of taking, damaging or destroying nests at any time during the year. Two new provisions relating to SSSIs are also included. Sections 41 and 42 of the Act require the

Secretaries of State in England and Wales, respectively, to publish a list of habitats and species which are of principal importance for the conservation of biodiversity. These include all UKBAP woodland-related priority species and habitats.

- Wildlife and Natural Environment Act (Northern Ireland) 2011 largely supersedes the Wildlife (Northern Ireland) order 1985 (as amended). The legislation aims to protect wild animals, birds, plants and their habitats. It is an offence to kill, injure, disturb, take or sell:

  – specially protected wild animals, such as badger, otter and red squirrel;
  – all wild birds, their nests and eggs (with certain exceptions for pest and sporting species).

  It is also an offence to uproot, pick or sell specially protected plants.

- Designated sites - National Nature Reserves (NNR), Sites of Special Scientific Interest (SSSI) in GB and Areas of Special Scientific Interest (ASSI) in Northern Ireland, Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) offer statutory protection to habitats and species. Protection for SSSIs in England and Wales was strengthened by the CRoW Act 2000 (see above), and in Scotland by the NCS Act 2004 (see above). Deadwood is considered as one of the key aspects of woodland structure and natural processes used in assessing the condition of woodland on designated sites where there may be species that require particular types and amounts of deadwood.

- The UK Biodiversity Action Plan (www.jncc.defra.gov.uk). As with designated sites, deadwood is included as an attribute of woodland structure and natural processes used in assessing the condition of priority woodland types covered by Habitat Action Plans (HAPs). There are also a range of UKBAP priority species that are linked to deadwood (see Appendix 2).

Deadwood management may also be affected by other legislation covering felling licences, tree preservation orders, environmental impact assessments and work in controlled watercourses.

Appendix 2: Priority and protected species

Group	Scientific name	Common name	Statutory protection[1]	UK Biodiversity Action Plan Priority Species[2]			
				Scotland	Wales	England	N. Ireland
Amphibian	*Triturus cristatus*	Great crested newt	EPS/Scheduled	•	•	•	
Amphibian	*Triturus vulgaris*	Common newt	Scheduled				•
Bird	*Bucephala clangula*	Golden eye	Scheduled				•
Bird	*Columba oenas*	Stock dove	Scheduled				•
Bird	*Dendrocopos minor*	Lesser spotted woodpecker			•	•	
Bird	*Ficedula hypoleuca*	Pied flycatcher	Scheduled		•		•
Bird	*Lophophanes cristatus*	Crested tit	Scheduled				
Bird	*Mergus merganser*	Goosander	Scheduled				•
Bird	*Muscicapa striata*	Spotted flycatcher	Scheduled				•
Bird	*Oriolus oriolus*	Golden oriole	Scheduled				
Bird	*Passer montanus*	Eurasian tree sparrow	Scheduled	•	•	•	•
Bird	*Phoenicurus phoenicurus*	Redstart	Scheduled				•
Bird	*Poecile montanus kleinschmidti*	Willow tit		•	•	•	
Bird	*Sturnus vulgaris*	Starling					•
Fungus	*Calocybe onychina*	Lilac domecap		•			
Fungus	*Chlorencoelia versiformis*	Flea's ear				•	
Fungus	*Hericium coralloides*	Coral tooth				•	
Fungus	*Hericium erinaceus*	Bearded tooth	Scheduled		•	•	
Fungus	*Hypocreopsis lichenoides*	Willow gloves			•	•	
Fungus	*Hypocreopsis rhododendri*	Hazel gloves		•		•	
Fungus	*Mycena renati*	Beautiful bonnet				•	
Fungus	*Pholiota astragalina*	Conifer scalycap				•	
Fungus	*Piptoporus quercinus*	Oak polypore	Scheduled	•	•	•	
Fungus	*Podoscypha multizonata*	Zoned rosette				•	
Fungus	*Stropharia hornemannii*	Conifer roundhead		•			
Fungus	*Tremella moriformis*	Mulberry brain				•	
Fungus	*Tricholoma colossus*	Giant knight		•			
Fungus	*Tricholoma robustum*	Robust knight		•			
Invertebrate	*Amiota variegata*	Spotty sap fly				•	
Invertebrate	*Ampedus rufipennis*	Click beetle				•	
Invertebrate	*Blera fallax*	Pine hoverfly		•			
Invertebrate	*Callicera spinolae*	Golden hoverfly				•	
Invertebrate	*Chrysura hirsuta*	Ruby-tailed wasp		•			
Invertebrate	*Clusiodes geomyzinus*	Pine heart-wood fly		•			
Invertebrate	*Gnophomyia elsneri*	Royal cranefly				•	
Invertebrate	*Gnorimus nobilis*	Noble chafer				•	
Invertebrate	*Gnorimus variabilis*	Variable chafer				•	
Invertebrate	*Hammerschmidtia ferruginea*	Aspen hoverfly		•			
Invertebrate	*Lacon querceus*	Click beetle				•	
Invertebrate	*Limoniscus violaceus*	Violet click beetle	Scheduled			•	
Invertebrate	*Lipsothrix ecucullata*	Scottish yellow splinter		•			
Invertebrate	*Lipsothrix errans*	Southern yellow splinter		•	•	•	
Invertebrate	*Lipsothrix nervosa*	Northern yellow splinter		•	•	•	
Invertebrate	*Lipsothrix nigristigma*	Scarce yellow splinter			•	•	
Invertebrate	*Lonchaea ragnari*	Large birch lance fly		•			
Invertebrate	*Lucanus cervus*	Stag beetle	Scheduled		•	•	
Invertebrate	*Megapenthes lugens*	Click beetle				•	
Invertebrate	*Melandrya barbata*	Bearded false darkling beetle				•	
Invertebrate	*Myolepta potens*	Western wood-vase hoverfly				•	
Invertebrate	*Neoempheria lineola*	Giant wood-gnat				•	
Invertebrate	*Osmia uncinata*	Mason bee		•			
Invertebrate	*Pechipogo strigilata*	Common fan-foot				•	
Invertebrate	*Philorhizus quadrisignatus*	Ground beetle		•		•	
Invertebrate	*Platycis cosnardi*	Cosnard's net-winged beetle				•	
Lichen	*Catillaria alba*	Lichen		•		•	
Lichen	*Cladonia botrytes*	Stump lichen		•			
Lichen	*Lecania chlorotiza*	Lichen		•	•	•	
Lichen	*Parmelia minarum*	New Forest parmelia	Scheduled				
Lichen	*Ramonia chrysophaea*	Lichen		•	•	•	
Mammal	*Barbastella barbastellus*	Barbastelle bat	EPS/Scheduled		•	•	•
Mammal	*Erinaceus europaeus*	West European hedgehog	Scheduled				•
Mammal	*Lutra lutra*	European otter	EPS/Scheduled	•	•	•	•
Mammal	*Nyctalus noctula*	Noctule bat	EPS/Scheduled	•	•	•	•
Mammal	*Pipistrellus nathusii*	Nathusius' pipistrelle bat	Scheduled				•
Mammal	*Pipistrellus pygmaeus*	Soprano pipistrelle bat	Scheduled				•
Mammal	*Plecotus auritus*	Brown long-eared bat	Scheduled				•
Mollusc	*Limax cinereoniger*	Ash-black slug	Scheduled				•
Moss	*Aulacomnium androgynum*	Bud-headed groove moss	Scheduled				•
Moss	*Buxbaumia viridis*	Green shield-moss	Scheduled	•			
Moss	*Daltonia splachnoides*	Irish daltonia	Scheduled	•			•

1 Species protected under one or more statutory instruments. EPS = European Protected Species listed in Annex 2 of The Conservation of Habitats and Species Regulations 2010. Scheduled = species scheduled under the Wildlife and Countryside Act 1981 (as amended) and the Wildlife (Northern Ireland) Order 1985 (as amended).

2 All UKBAP species with some association with deadwood are listed here, including the country(ies) they are listed against.

Appendix 3: Simple guide for identifying veteran trees

A tree may be classified as a veteran if it has at least three of the following four tree attributes or is of large size. Note that large, old, non-native species can be valuable veterans.

Tree attributes

Tree attributes are measures of the accumulation of deadwood, decay and hollowing that are associated with canopy reduction and death as the tree ages.

- **Deadwood** either attached or fallen which must be a minimum of 1 m in length and over 25 cm in circumference.
- **Rot sites** an area of rot equal to or greater than 300 cm^2.
- **Rot holes** at least one cavity ~10 cm diameter, i.e. about the size of a clenched fist.
- **Hollowing** the trunk or major limbs show signs of hollowing.

Additional features that may be present include bark loss; crevices in bark; natural water pools; sap runs; fungal fruiting bodies; epiphytic plants; obvious signs of bat roosts.

Tree size

Trees may be considered as veterans if they significantly exceed the normal size for the species in the locality in which they occur. The following diameters (at 1.3 m height) are considered large for the species listed and they indicate minimum diameters for trees that may be regarded as veterans. However, the size classes are only indicative and may be inappropriate for upland areas and other sites with unfavourable growing conditions.

- **75 cm** field maple, rowan, yew, birch, cherry, holly and other smaller tree species;
- **100 cm** oaks (upland), ash, alder, willow;
- **150 cm** oaks (lowland), sycamore, lime, horse chestnut, sweet chestnut, elm species, poplar species, beech.

Adapted from: Veteran trees in the landscape: a methodology for assessing landscape features with special reference to two ancient landscapes. In: *Landscape ecology of trees and forests* (IALE); and *Veteran trees: a guide to good management* (English Nature).

Glossary

Ancient semi-natural woodland (ASNW) Ancient woodland composed of mainly locally native trees and shrubs that derive from natural seedfall or coppice rather than from planting.

Ancient trees Trees of biological, aesthetic or cultural interest because of their great age.

Ancient woodland Woodland which has been in continuous existence since before AD 1600 in England, Wales and Northern Ireland, and before AD 1750 in Scotland. The term ancient woodland site refers to the site of an ancient woodland irrespective of its current tree cover.

Ancient Woodland Inventory A map-based record of the location and boundaries of ancient woods held and maintained by the statutory conservation agencies in Great Britain. In Northern Ireland, the Woodland Trust produced the inventory.

Arboriculture The selection, planting, care and removal of individual trees and the study of how they grow and respond to cultural practices and the environment.

Below-ground deadwood Decay habitats associated with roots and stumps.

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

Coppice An area of woodland in which the trees or shrubs are periodically cut back to ground level to stimulate growth and provide wood products. The same stool is used through several cycles of cutting and regrowth and can contain considerable deadwood if ancient.

Debris dam Accumulations of fallen deadwood of various sizes within streams which causes temporary but incomplete damming of water flow.

Decay columns Columns of dead and dying wood within trees caused by fungal or bacterial infection.

Ecosystem The interaction of communities of plants and animals (including humans) with each other and the non-living environment.

Ecosystem services The benefits people obtain from ecosystems, including provisioning services such as food and water; regulating services such as regulation of floods, drought, land degradation and disease; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious and other non-material benefits.

European Protected Species Species of plants and animals (other than birds) which are protected under European and UK law.

Fallen trees Fallen deadwood of 100 mm or more in diameter. Also known as coarse woody debris, large woody debris or logs.

Fine woody debris Small-dimension material in any setting.

Forest management unit (FMU) An area subject to a forest plan or proposal.

Glade A small area of open ground that forms an integral part of a woodland.

Haloing Thinning in a circle around veteran or ancient trees to open up their crowns.

Heartwood Dense wood in the central part of trees such as oak which is no longer involved in transporting food or water around the tree.

High forest Woodland which is not managed as coppice or pollards and which may or may not be managed for timber.

Invertebrate exit holes Holes of different shapes and sizes created when invertebrates emerge from the decaying wood or fungi.

Large woody debris Pieces of deadwood >100 mm diameter and 1 m length, comprising whole trees, logs, branches and root boles that can accumulate within river systems.

Long-established plantations Woodland planted in the 17th, 18th and 19th centuries – often managed using a non-clearfell silvicultural system.

Lower-impact silvicultural systems Alternative silvicultural systems to clearfelling, including: group selection; shelterwood or underplanting; small coupe felling; coppice or coppice

with standards; minimum intervention; and single-tree selection systems, which are suitable for windfirm conifer woodlands and most broadleaved woodlands.

Minimal intervention Management with no systematic felling or planting of trees, but may include fencing and control of grazing and non-native species.

Old growth Stands that have the structures and biodiversity associated with old primary woodland such as large, veteran trees, multi-layered canopies and understorey and deadwood habitats. Mixed tree/open habitats such as wood pasture and parkland are also included if they contain ancient trees.

Parkland Enclosed area for keeping deer and/or amenity use.

Plantations on ancient woodland sites (PAWS) Planted forests of native or non-native tree species that have replaced the original 'natural' woods on sites with a long history of woodland cover. See also Ancient woodland.

Pollard A tree cut 2–4 m above ground level, producing a crop of branches which can be harvested in subsequent years.

Restoration The re-establishment of native trees and natural processes on planted ancient woodland sites and the conversion of recent woodland to semi-natural open ground.

Retentions Trees retained, usually for environmental benefit, beyond the age or size generally adopted by the owner for felling.

Riparian zone An area relating to, or situated adjacent to, a watercourse or water body.

Ripewood Wood of trees with an indistinguishable sapwood/heartwood boundary.

Sapwood Living wood adjoining the inner surface of the bark comprising the xylem vessels which transport water and nutrients around the tree.

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

Short rotation coppice (SRC) Trees (usually willow or poplar) typically grown as an energy crop and harvested at intervals of about three years.

Species assemblages Collections of species making up any co-occurring community of organisms in a given habitat.

Structural diversity Degree of physical variation in forest elements, particularly the spatial distribution of trees, and vertical distribution of the canopy and other layers of vegetation.

Stump Cut or rotted tree less than 1.3 m in height.

Sustainable forest management The stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity and vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions at local, national and global levels, and that does not cause damage to other ecosystems.

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.

UK Biodiversity Action Plan (UKBAP) A programme of action to conserve and enhance biological diversity. The UKBAP articulates the UK response to the UN Convention on Biological Diversity (see Appendix 1).

Variable density thinning A thinning practice involving the removal of trees of varying sizes within a stand and at different densities throughout the stand.

Veteran tree A tree of biological, cultural or aesthetic interest because of its age, size or condition.

Windfirm Trees that are unlikely to blow over when exposed to strong winds.

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

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

Wood pasture Areas of historical, cultural and ecological interest, where grazing is managed in combination with a proportion of open tree canopy cover.

Deadwood is a vital component of a properly functioning forest ecosystem. It plays an important role in sustaining biodiversity and in delivering ecosystem services such as soil formation and nutrient cycling. In the UK up to a fifth of woodland species depend on dead or dying trees for all or part of their life cycle and many of these species are rare or threatened. This Practice Guide has been written for the owners and managers of forests and woodlands who want to increase the value of their woodlands for biodiversity. It provides advice and practical guidance on managing deadwood to support sustainable forest management and the UK Forestry Standard Guidelines on Forests and Biodiversity.

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