Deadwood management

Summary guidance for FES staff
1. POLICY CONTEXT AND FOREST CERTIFICATION REQUIREMENTS

This document summarises the policy and management guidance that Forest Enterprise Scotland (FES) staff need to follow in relation to deadwood. It describes the approach that FES staff should adopt when planning and delivering the deadwood resource on the national forest estate (NFE). This document should be regarded as a FES-specific supplement to the Forestry Commission Scotland (FCS) Practice Guide entitled: Managing deadwood in forests and woodlands (Humphrey & Bailey, 2012), which provides fuller details on some of the following content.

Current government policy (Box 1) requires FES to create a deadwood resource within forests and woodlands on the NFE, and many deadwood-dependent species are listed on the government's Scottish Biodiversity List. Furthermore, the Scottish Forestry Strategy (SFS) implementation plan (2015-18) includes mean deadwood volume as a progress indicator for delivery of the SFS. All of these policy objectives are reinforced by the requirements of forest certification, and this guidance complies with the United Kingdom Woodland Assurance Scheme (UKWAS) Fourth Edition; this is the certification scheme under which FES is certified.

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**Box 1**

The UK Forestry Standard (UKFS) sets out the governments’ approach to sustainable forest management in the UK. The UKFS Guideline document entitled: 'Forests and biodiversity’ requires the following good forestry practice for 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 management unit.

24. Retain existing veteran trees and select and manage suitable individuals to eventually take their place.
The UKWAS Fourth Edition has the following **requirements**:  

I. The owner/manager shall plan and take action to accumulate a diversity of both standing and fallen deadwood over time in all wooded parts of the WMU [woodland management unit], including felled areas.

II. The owner/manager shall identify areas where deadwood is likely to be of greatest nature conservation benefit, and shall plan and take action to accumulate large dimension standing and fallen deadwood and deadwood in living trees in those areas.

In addition, the UKWAS Fourth Edition gives the following **guidance**:

- The owner/manager should refer to deadwood guidance produced by relevant statutory conservation agencies, forestry authorities and others when identifying areas of greatest nature conservation benefit and when planning actions to accumulate deadwood.

- Current evidence suggests that, over the long term, deadwood (not including stumps, which are usually retained after felling) should accumulate to roughly 20 m³ per hectare averaged – though not uniformly distributed – across the WMU.

- In most hectares there should be a few standing and fallen stems contributing to the overall deadwood provision.

- Deadwood management should not conflict with safety of the public or workers or the health of the woodland.

The UKWAS guidance of 20m³ha⁻¹ is an average and deadwood will not be evenly dispersed across a WMU. For example, ancient semi-natural woodlands and natural reserves will have much more than 20m³ha⁻¹ and productive stands will have much less.

Mueller & Buetler’s (2010) review found published thresholds ranging from 10 to 80 m³/ha for boreal forests, and from 10 to 150 m³/ha for lowland forests. A threshold is a critical volume of deadwood above which a deadwood–dependent species (or group of species) is more likely occur. These threshold studies are useful for giving an indication of the range of deadwood volumes that are ecologically significant. Encouragingly, Humphrey *et al* (2003) demonstrated that even ‘normal’ plantation management systems in the UK seem to deliver enough deadwood to satisfy the UKWAS guidance. However, their measurements included low stumps (left after felling), which are explicitly excluded from the UKWAS guidance. Nevertheless, this finding is encouraging from the perspective of FES, which has to follow UKWAS guidance.
Deadwood provides a habitat and food resources for thousands of species of animals, plants, bryophytes, lichen and fungi (and unknown but enormous numbers of microbes). This habitat is ‘partitioned’ into innumerable ecological niches, with each species occupying a different niche according to parameters such as tree species, diameter, age, and exposure (the drying effects of sun and wind). Furthermore, because the physical nature of deadwood changes through time due to processes of decay, different assemblages of organisms use a piece of deadwood at different stages of decay. Deadwood is therefore a diverse and dynamic habitat and different organisms require different kinds of deadwood spread differently through space and time. This is problematic for woodland managers trying to create the ‘best’ deadwood resource to enhance biodiversity on their land. Simply put, it is impossible for managers to provide habitat for all saproxylic (deadwood dependent) species all the time.

Given there is no single ‘solution’ to providing deadwood habitat, it is best to adopt a set of management principles when planning and delivering deadwood on the NFE. The following set of principles reflects the consistent findings of research across various deadwood taxa and will maximise the overall biodiversity benefits that can be accrued by FES. The principles have been developed with experts from SNH and the underpinning science is expanded upon in Appendix 1.

1. Retain and create as much deadwood as possible and create new deadwood on a continuing basis.
2. Retain and create as many kinds of deadwood as possible.
3. Favour native tree species when creating and retaining deadwood.
4. Favour the retention and creation of large-diameter deadwood.
5. Retain and create high stumps and snags (standing deadwood) within woodland and permanent open areas (but not on clear fells that will be restocked).
6. Design the distribution of deadwood to maximise connectivity at the WMU and coupe scale.
2.1 How to create deadwood

UKWAS guidance recommends the creation of snags. However, FES staff must not kill standing trees using techniques like ring barking and chemical injection to create standing deadwood, irrespective of where this ‘artificial’ deadwood is located. The potential liabilities and health and safety implications associated with such features are too significant for FES. Cutting of high stumps by harvesting machines is also no longer acceptable because the machines are not designed for such work and the safety of the machine operators may be compromised. This means that snags will not be created on the NFE. Therefore, the creation of deadwood, to augment retained, naturally-occurring deadwood, should be achieved using only the methods listed below to create ‘new’ deadwood and ‘future’ deadwood:

Creating new deadwood

- Retaining large-diameter (> 20cm) logs at the edge of coupes following operations.
- Retaining smaller-diameter logs in deadwood piles at the edge of the coupe.
- Creating brash piles at the edge of coupes.
- For specific, project-based reasons (e.g. to create standing deadwood for a single-species project) creating high stumps or standing deadwood using a qualified and certified arboriculturist, or a qualified chainsaw operator if creating high stumps of 1.5m or less. This is an expensive option and is only recommended for the purposes of creating habitat for an endangered species on a very small scale.
- For specific, project-based reasons, drilling tree stumps to create water-filled holes for larvae e.g. pine hoverfly Blera fallax.

Creating future deadwood

- Retaining damaged and dying trees wherever possible (providing they do not pose an obvious health and safety risk).
- Retaining wind-blown trees in appropriate locations
- Retaining individual live trees or small groups of live trees on clear fell sites. These are likely to be damaged by wind or blown over at some point and are therefore ‘future’ deadwood.

Note – Ongoing research suggests that deadwood that dies naturally is more valuable for biodiversity than deadwood that is created by cutting or killing of the tree. This is because trees that go through the entire process of dying and the subsequent decay stages support a wider spectrum of species, in successional stages. Trees that are killed artificially can be colonised rapidly by a small number of generalist species that subsequently inhibit colonisation by more specialist species. Research in Finland is detecting this pattern in fungal communities on deadwood. FES guidance on deadwood management will be revised in light on new research, but meantime the focus is on deriving deadwood from trees that die through natural processes.
3. DEADWOOD MANAGEMENT ON THE NFE THROUGH THE WORK PLAN PROCESS

Retaining and creating deadwood is probably the most cost-effective method of enhancing biodiversity on the national forest estate. FES Environment staff are responsible for ensuring the delivery of deadwood on the NFE, and should therefore make deadwood management a priority and allocate sufficient time and resource for this work. The overall objectives of deadwood management on the NFE are: i) to minimise the operational inconvenience caused by deadwood; ii) to satisfy UKWAS and other policy requirements; and iii) to maximise the biodiversity gains by adopting the management principles listed in Appendix 1.

The following flowchart summarises the approach FES Environment staff should follow to manage deadwood at the coupe level via the Work Plan process, and further details are provided in Sections 3.1 to 3.4:

**Deadwood management in coupes on the NFE via the Work Plan process**

1. Obtain Deadwood Ecological Potential (DEP) class of coupe from the national deadwood layer (Section 3.1)
2. Specify the appropriate deadwood management prescription for the coupe in the Work Plan (High, Medium or Low - Section 3.2)
3. Visit the site and identify specific features and opportunities to create deadwood and include these in the contract maps, which form part of the Work Plan
4. If possible, mark valuable deadwood features (see Table 2) in the coupe with tape
5. Liaise with FES harvesting managers and contractors to ensure the deadwood management prescription is followed - attend 75% completion meeting
3.1 WMU deadwood ecological potential classes

The UKWAS term ‘woodland management unit’ (WMU) equates to an FES Land Management Plan (LMP), and therefore a WMU may include several individual blocks. For each WMU, all areas have been assigned the appropriate ‘deadwood ecological potential’ (DEP) class in a national deadwood layer, based on different woodland management categories (see Table 1). This layer is available on ForesterWeb and also on forest district servers. A map showing the DEP classes for the whole WMU should be included in Land Management Plans at the time of the plan production or revision (see Map 1 below).

Table 1 – Deadwood Ecological Potential classes of FES woodland management categories

<table>
<thead>
<tr>
<th>Deadwood ecological potential (DEP) class</th>
<th>FES woodland management categories included in this DEP class</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Natural reserves, ancient semi-natural woodlands, native pinewoods, riparian buffers along watercourses, PAWS with high ecological potential, wood pasture.</td>
</tr>
<tr>
<td>Medium</td>
<td>Minimum intervention areas of broadleaved woodlands, PAWS, LEPOs, long-term retentions, LISS coupes.</td>
</tr>
<tr>
<td>Low</td>
<td>All other stands (i.e. stands where timber production is the priority)</td>
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</tbody>
</table>
3.2 Deadwood management prescriptions for coupes

When a coupe comes up in the Work Plan process, apply the appropriate deadwood management prescription (High, Medium or Low). The deadwood management prescriptions for each DEP class are shown in Table 2 below; this is a simplified and FES-specific version of the measures detailed in Table 2 of Humphrey & Bailey’s (2012) FCS Practice Guide.

Wherever possible during pre-operational surveys, identify particularly valuable features and record these features in work plans, so that they can be included in contracts and retained during operations. Particularly valuable features should be marked using tape prior to commencement of operations. Liaise with FES harvesting managers and contractors to ensure deadwood management prescription is followed and that valuable features are retained during harvesting.

Particularly valuable features are veteran and dying trees; large-diameter standing deadwood, particularly of native species; and deadwood from native broadleaves. These deadwood types are under-represented on the NFE and increasing their abundance is a priority.
Table 2 – DEP class deadwood management prescriptions

<table>
<thead>
<tr>
<th>DEP class</th>
<th>Deadwood management prescription</th>
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</table>
| **High**  | 1. Retain all existing veteran trees and deadwood apart from that which is a health and safety risk.  
2. Retain all wind blow apart from that which is a health and safety risk  
3. Deadwood distributed throughout the coupe  
4. Seek opportunities to create particularly valuable deadwood e.g. import some large-diameter logs from nearby coupes when they are thinned or clear felled |
| **Medium** | 1. Retain all existing veteran trees and deadwood apart from that which is a health and safety risk. Only harvest wind blow of significant value or which poses a health and safety risk  
3. Seek opportunities to create particularly valuable new deadwood e.g. when felling big trees, retain some large diameter logs at the edge of the coupe  
4. Where wind blow is harvested, retain some blown trees in a group as ‘future deadwood’ |
| **Low** | **During thinning**  
1. Retain all existing deadwood apart from that which is a health and safety risk  
2. Take obvious opportunities to create particularly valuable new deadwood e.g. when felling big trees, retain one or two large diameter logs at the edge of the coupe  
3. Where wind blow is harvested, take opportunities to retain a few blown trees in a group as ‘future deadwood’ in a location that will not restrict future operations e.g. in the corner of a coupe |
| | **During clear felling**  
1. Retain all deadwood and living trees in areas that are uneconomic or too difficult to harvest (e.g. wet, steep or rocky areas)  
2. Where an obvious opportunity arises, create new deadwood in a location that will not restrict future operations e.g. a pile of logs and brash in the corner or along the edge of a coupe |
| | **Additional notes for Low DEP class areas**  
1. Deadwood should only be retained in areas that will not restrict future operations  
2. Standing deadwood (snags) should not be retained on clear fells, except in areas that will not restrict future operations and that do not pose a health and safety risk e.g. in the corner of a coupe  
3. Large diameter (>20cm) deadwood logs and snags are particularly scarce on the NFE. Take opportunities to retain this kind of deadwood. When harvesting large diameter trees, seek opportunities to retain some standing deadwood, if safe to do so, and consider retaining a few large-diameter logs on site in a location that will not restrict future operations.  
4. Large diameter deadwood from native broadleaves is particularly scarce. When harvesting large diameter native broadleaves, retain standing deadwood, if safe to do so, and retain some large diameter logs on site in a location that will not restrict future operations. |

Notes for Table 2: a. A health and safety risk equates to deadwood that has the potential to fall on recreation routes, or other places likely to be used by people, or buildings, or other infrastructure; b. These retained, living trees will have a high likelihood of being damaged by wind, or blown over, and dying naturally, thereby becoming high-value deadwood.
3.3. Riparian zones and in-stream deadwood

Riparian zones often have large accumulations of deadwood and are an important resource in terms of planning linkages between High and Medium DEP class areas. The deadwood in riparian zones can make a significant contribution to the overall deadwood volume in a WMU, and regeneration or planting of riparian trees should be a priority to provide future deadwood.

The maintenance and management of buffer strips of riparian trees, and the consequent input of woody debris, influences a wide range of physical habitat characteristics within watercourses; including light, temperature, flow, sediment transport and substrate conditions, thereby promoting high levels of biodiversity within the river environment (Gurnell et al 1995).

Photo 1 – Riparian woodland with abundant deadwood.
Riparian woodland is the main source of inputs of large woody debris into watercourses, which has beneficial impacts for many species, including fish (Howson et al 2012). Inputs of large woody deadwood are probably inadequate in most areas of the NFE (i.e. below natural levels of input) and the direct input of woody debris into watercourses should be employed as a management action – particularly into watercourses used for breeding by trout and salmon and where riparian deadwood is limited or absent. The design and management of riparian woodland to sustain the delivery of large woody debris to watercourses is an explicit action in the UK Forestry Standard Guidelines on forests and water. Further advice on large woody debris input to watercourses is available from the FES ecologists.

Photo 2 – Fallen trees are a major source of woody material within rivers. Such natural events are important for the ecology of fish and invertebrates.
3.4 Visitor Zoning Operations

The FC Practice Guide (Humphrey & Bailey, 2012; pages 15 to 16) gives advice on minimising risks to public and worker safety. Where dangerous trees, wind blow or dead stems have to be removed from within priority Visitor Zoning areas:

- Retain as many as possible on site.
- Move the stems to an area where they would provide significant ecological benefit (as identified above).
- Alternatively, they could be cut into manageable blocks and moved out of site as per the visitor zoning guidance.
- Larger diameter native species are likely to provide the highest benefit and retention of these stems on site should be a priority.
- Opportunities should be taken to retain significant native standing deadwood in place and use them as a focus for highlighting their biodiversity benefit through interpretation. This will always have to be weighed up against H&S and the practicalities of doing so.

The health and safety of people on site and members of the public is paramount. Environment staff should work with CRT staff to ensure standing deadwood within one tree length of roads, tracks and paths are risk assessed. Two documents provide guidance in this regard: OGB1 and the NTSG guidance entitled ‘Common sense risk management of trees’ (see references). New paths and tracks should be designed to avoid veterans (important future deadwood) and areas of minimum intervention where possible.

Antisocial behaviour is not sufficient reason for removing or minimising deadwood in WIAT sites. Following guidelines above, retention on-site of large diameter lengths of broadleaf, particularly native species, moved to shady damp areas (protected by shrubs such as bramble) will reduce potential for burning.
4. GLOSSARY

Ecological niche – The place occupied by an organism within an ecosystem, including its habitat and its effect on other organisms and the environment

Saproxylic – Pertaining to species that live on or in deadwood for at least part of their life cycle

Snag – Standing dead tree

Species diversity – A measure of the diversity within an ecological community that incorporates both species richness and the evenness of species’ abundances

Species richness – The number of species within an ecological community or within an otherwise defined area or volume

Woodland Management Unit – The area to which management planning documentation (e.g. Forest Design Plan or Land Management Plan) relates. A WMU is a clearly defined woodland area, or areas, with mapped boundaries, managed to a set of explicit long term objectives.

5. ACKNOWLEDGEMENTS

This guidance draws upon previous work by Keith Black, Kenneth Sinclair, Philippa Murphy, Graeme Findlay and Yvonne Grieve (especially for Visitor Zoning section). Many other FES staff – including Richard Thompson, Dave Anderson, Giles Brockman, Charles Hutchinson and Colin Leslie – have provided invaluable views and information on this subject. Andrew Jarrott kindly provided several photos.
APPENDIX 1 – RESEARCH-BASED DEADWOOD MANAGEMENT PRINCIPLES

1. **Retain and create as much deadwood as possible and create new deadwood on a continuing basis.** As explained above, UKWAS guidance recommends about 20 m³/ha, which is an average, but in some sites much higher volumes will exist or the creation of higher volumes per hectare will have even greater ecological gains. As the deadwood volume increases, so does the deadwood diversity and therefore the species richness and diversity of associated organisms. For example, Mueller & Buetler (2010) demonstrated that the number of critically endangered saproxylic beetle species was positively correlated with the amount of deadwood available in their sampling plots. They recommended establishing several forest stands with deadwood amounts >20 to 50 m³/ha within a network (WMU). Constant inputs of new deadwood are necessary to maintain a spectrum of ages and stages of decay into the future – so new deadwood needs to be created on a continuing basis. This is necessary because deadwood changes continually. For example, Makinen et al (2006) found that all Scots pine, Norway spruce and birch stems (snags) had fallen down by forty years after their death. Veteran trees are important in this regards as they represent future deadwood, and have the potential to capture the entire spectrum; starting with newly dead wood when the veteran dies.

2. **Retain and create as many kinds of deadwood as possible.** As the number of kinds of deadwood increases in an area, the number of microhabitats increases. Consequently, the species richness and diversity of associated organisms increases. For example, Hjaltén et al (2010) showed that there were clear differences in saproxylic beetle assemblages between different deadwood substrate types. Brunet & Isacsson (2009) conclude that for high species diversity there is a requirement for snags in different stages of decay, size and degree of sun exposure. Therefore, FES managers should attempt to create and maintain deadwood of as many different ages (from newly dead to nearly completely decayed), heights (stumps to high snags), sizes (from small branches on the ground to large-diameter snags), types (snags, logs, stumps, log piles, felling debris etc), and degree of exposure (always shaded at one extreme to always exposed to direct sunlight at the other) as possible. In addition, deadwood from a wide range of tree species should be retained to support more exacting species of fungi (Hielmann-Clausen 2003), bryophyte (Rothero 2008), lichen and invertebrate. There is no exact recipe for the provision of this varied resource, so FES managers should simply aim for as much variety at the coupe level as is reasonably possible, taking advantage of the available opportunities.

3. **Favour native tree species when creating and retaining deadwood.** Deadwood retention and creation should utilise native tree species wherever possible. However,
deadwood from non-native tree species is still valuable and is certainly better than no deadwood.

4. **Favour the retention and creation of large-diameter deadwood.** Numerous studies show that bigger snags and logs support more species, particularly rare species. For example, Brin et al. (2011) showed that more indicator saproxylic species were observed in large logs than in small logs. Studies in Scandinavia (e.g. Kruys et al 1999) confirm that decaying logs >20cm provide a much richer habitat for bryophytes than smaller diameter logs. This is thought to be due to larger logs holding more moisture, providing a greater range of micro-habitats, decaying more slowly and being less likely to become over-grown by competitive vegetation. One informative conclusion of Humphrey et al (2003) was that large diameter, well-decayed deadwood, which is particularly valuable for biodiversity, occurs at a very low frequency and volume in most forest and stand types in the UK. The UKWAS Standard defines large as greater than 20cm diameter.

5. **Retain and create high stumps and snags within woodland and permanent open areas (but not on clear fells that will be restocked).** Several studies (e.g. Hjalten et al 2010) indicate that there are clear differences in species’ assemblage composition between substrate types e.g. low stumps compared to high stumps. Low stumps left after harvesting provide important habitat for many deadwood species, including fungi and beetles. However, the higher parts of high stumps and high snags (>2m high) support different species, and can be particularly important for lichens (see Photo 3).

High snags (frequently called standing deadwood) on clear fell sites are much less valuable for deadwood species in Scotland. This is because of the extreme exposure makes the wood unsuitable for most deadwood species. Additionally, in Scotland, we have a much-reduced invertebrate fauna due to past extinctions, and none of the remaining species are dependent on exposed deadwood snags. Exposed wood is good for some lichens, but replanting of clear fells means that snags will shaded by dense conifers within a relatively short timescale and lichens cannot survive without light. Snags on clear fells are not important for birds.

Therefore, it is important to retain and create (but see Section 2.1) high stumps and snags within woodland and permanent open areas, in order to provide habitat for a wide range of species. Snags on clear fells are ecologically much less important and are a significant constraint on operational activity. Snags should not be retained on clear fells that will be restocked, except in locations that will not constrain future operations e.g. along the edges or in the corner of coupes.
Photo 3 – Naturally-occurring Scots pine ‘bones’ within woodland and open woodland are particularly important for lichens in Scotland. These valuable features should be retained (unless they pose a health and safety risk e.g. by being close to tracks).
6. **Design the distribution of deadwood to maximise connectivity at WMU and coupe scales.** Numerous papers indicate that the spatial distribution and connectedness of the deadwood resource is an important determinant of occurrence of many saproxylic species. Studies of saproxylic beetles show that they respond to habitat factors (e.g. amount of deadwood) at different spatial scales i.e. at both the forest stand and landscape scales. For example, Bergman et al (2012) showed that some beetle species respond to both local (e.g. forest stand) and landscape (e.g. forest block) habitat factors. In this study, 16 oak-dependent saproxylic species showed a clear relationship with substrate (snag) density at scales ranging from 52m to >5200m. How large and connected areas of High deadwood volumes (>20 to 50 m³/ha) need to be is still unknown for most groups, even though some information indicates that the surroundings also play an important role (Oakland et al 1996). Several research projects (e.g. Franc et al 2007, Ranius & Roberge 2011) recommend concentrating deadwood into a network of low-intensity-management sites within a more intensively-managed-forest matrix.
APPENDIX 2 – EXAMPLES OF GOOD DEADWOOD MANAGEMENT

Retain and create as much deadwood as possible and create new deadwood on a continuing basis.

Photo 4 – A long-term retention on a hillside that will be subject to wind blow, which will cause many of the trees to die naturally at different times. This will create large amounts of deadwood on a continuing basis for many years.
Photo 5 – Retention of native tree species within a crop of exotic tree species. Such retentions act as ‘life boats’ for many species of invertebrates, fungus and lichens, allowing them to persist in the coupe. The retention also facilitates and maintains dispersal of many species within a forest block. Many of the trees in the retention will be subject to wind damage, which will create a range of deadwood habitats on the tree and on the ground. The trees will be damaged and will die at different times, thereby providing a range of deadwood habitats at different stages of the decay process. This is a far more valuable way of creating deadwood than retaining lots of dead and bark-less snags across a restock.
Photo 6 – A large retention of wind thrown trees and six living trees at the edge of a coupe. The blown trees will die at various times in the future, thereby creating inputs of new deadwood on a continuing basis. Dying trees are extremely valuable deadwood habitats. This is because changing assemblages of species colonise the wood as it goes through the varying decay stages: from weakened and dying, to recently dead, and right through to the stage where the tree is almost decomposed. So, from death to decomposition, each tree provides a spectrum of changing habitats that are invaluable for literally thousands of species. The standing trees are likely to snap in the wind and die or blow down and die. Either way, it creates very valuable deadwood habitat in the future.
Retain and create as many kinds of deadwood as possible.

Photo 7 – Log and brash piles created in a corner of a coupe that was not going to be restocked. This ‘deadwood centre’ provides habitat for many species of invertebrate, fungus and lichen. In addition, such features are often used as resting places or breeding sites by protected species such as otters and pine martens, and reptiles and amphibians. By providing these features in appropriate locations (e.g. in riparian zones or at the edge of permanently open ground), it minimises the likelihood that protected species will rest or breed in the middle of productive areas. This reduces the constraints associated with these widely-distributed species.
Deadwood management

Photo 8 – A ‘deadwood centre’ at the edge of a productive coupe. The opportunity to create this feature arose because of the accumulation of different types of deadwood in a location that will not hinder future operations. Off cuts have been placed in the deadwood centre and a few living pines with poor form have been retained. These will likely be damaged by wind at some stage and are therefore ‘future deadwood’. Having ongoing inputs of new deadwood over time is important because different species use different decay stages of deadwood.
Photos 9, 10 and 11 – Examples of deadwood retained in locations that will not impinge on future operations. In all cases, a variety deadwood has been collected into ‘deadwood centres’ along of edge of coupes that will be restocked in the future. The bottom photo shows an area with a retained snag, a large-diameter stump with retained log section, and a variety of brash and small diameter deadwood.
Favour native tree species when creating and retaining deadwood.

Photo 12 – Retained birch snag. Deadwood from native tree species is more valuable than deadwood from non-native tree species.
Photo 13 – Rot holes in dead and dying broadleaf are very valuable habitats for a range of saproxylic species. Such habitats are very scarce on the NFE and should be retained.

Photo 14 – Retained Scots pine snags following removal of spruce crop.
Favour the retention and creation of large-diameter deadwood.

Photo 15 – Large-diameter deadwood supports remarkable biodiversity but is rare on the NFE. Large diameter deadwood from native broadleaves is particularly valuable and scarce.

Photo 16 – These large diameter and flared butts are valuable deadwood habitat, but have been left over the drain at roadside. In such cases, ask the machine operator to lift them into the edge of the adjacent coupe.
Photo 17 – Large diameter, windblown tree left in-situ on the boundary of two productive coupes. An extremely valuable and ever-changing habitat, left in a location that will not hinder future operations.
Retain and create high stumps and snags (standing deadwood) within woodland and permanent open areas (but not on clear fells that will be restocked)

Photo 18 – High stumps resulting from trees snapping should be retained during thinning operations (unless they pose a health and safety risk e.g. by being close to tracks).
Photo 19 – High stumps with cavities are particularly important for a range of birds, mammals and invertebrates and should be retained.
Photo 20 – Snapped trees such as this provide a range of deadwood habitats, including dying branches. These trees are likely to die standing and go through much of the decay process whilst standing. This provides different habitat to stems on the ground. On clear fells, retain any such trees along edges of coupes.
Design the distribution of deadwood to maximise connectivity at the WMU and coupe scale.

Photo 21 – A network of retentions of dead, dying and living trees (future deadwood) in Galloway Forest Park.
Some species have extremely limited dispersal ability (e.g. see Jackson et al 2012), and habitat fragmentation occurs for some saproxylic insects at a local scale through the isolation of single deadwood pieces (Schiegg 2000). Therefore, as a general rule, deadwood at the coupe level should have a high level of connectivity to benefit such species. In practice, this means that there should only be a few metres between individual logs and snags, or that it should be clumped and touching or nearly touching in the case of felling debris such as branches and logs (Photo 18). This approach is compatible with minimising operational inconvenience as deadwood can be clumped along coupe edges or in corners.

Photo 22 – Felling debris and logs clumped to ensure habitat connectivity for dispersal-limited species.
REFERENCES


