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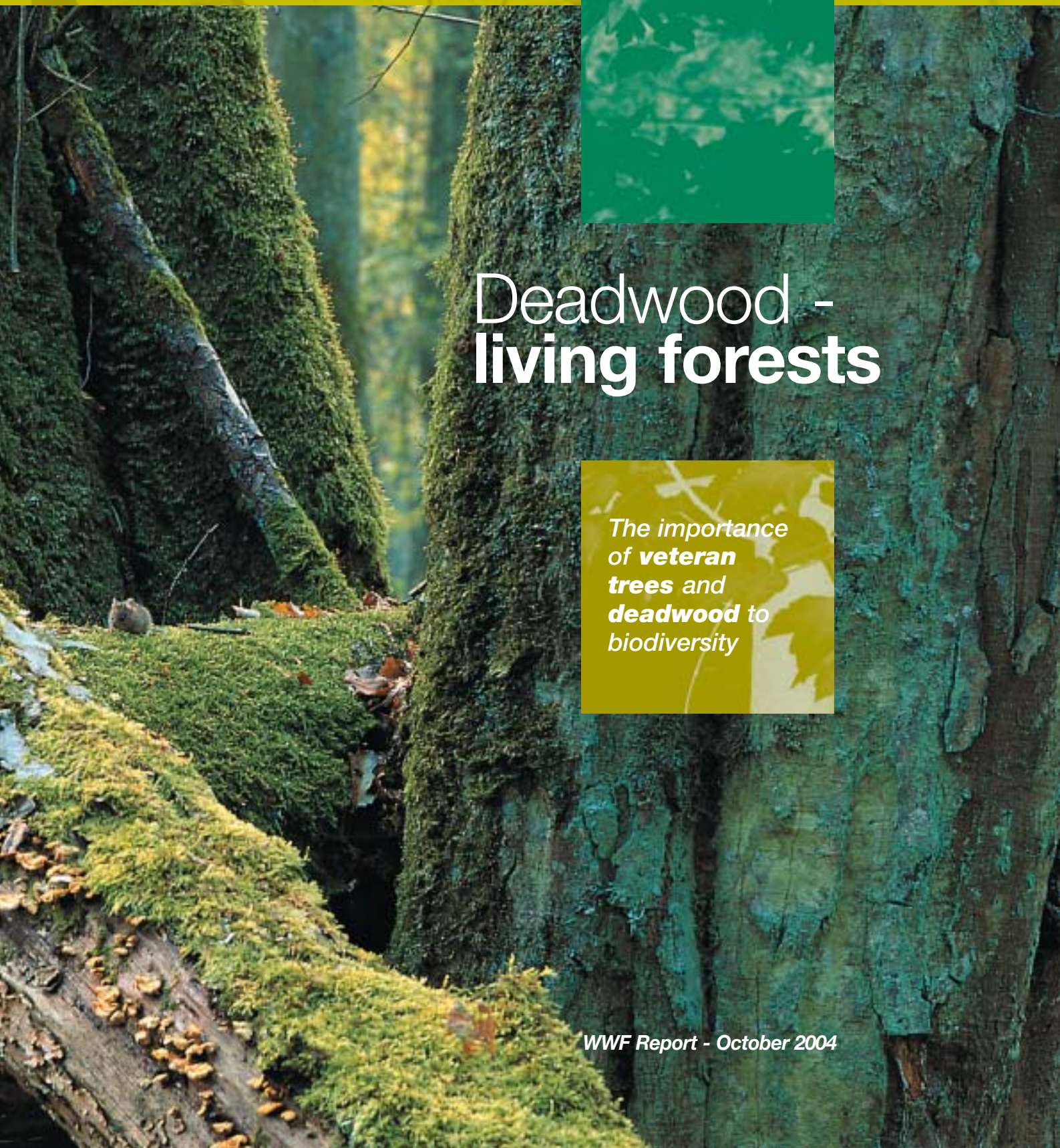

Deadwood - **living forests**

*The importance of **veteran trees** and **deadwood** to biodiversity*

WWF Report - October 2004

“Deadwood is the richest habitat in a healthy forest ” says Keith Kirby, English Nature’s woodland expert[1].

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In Europe, forests further to the east and in mountain areas have usually conserved much higher deadwood volumes

Executive **Summary**

> Veteran trees, standing dead or dying trees, fallen logs and branches form one of the most important – yet often unrecognised – habitats for European biodiversity.

Up to a third of European forest species depend on veteran trees and deadwood for their survival. Deadwood is providing habitat, shelter and food source for birds, bats and other mammals and is particularly important for the less visible majority of forest dwelling species: insects, especially beetles, fungi and lichens. Deadwood and its biodiversity also play a key role for sustaining forest productivity and environmental services such as stabilising forests and storing carbon.

Despite its enormous importance, deadwood is now at a critically low level in many European countries, mainly due to inappropriate management practices in commercial forests and even in protected areas. Average forests in Europe have less than 5 per cent of the deadwood expected in natural conditions. The removal of decaying timber from the forest is one of the main threats to the survival of nearly a third of forest dwelling species and is directly connected to the long red list of endangered species. Increasing the amounts of deadwood in managed forests and allowing natural dynamics in forest protected areas would be major contributions in sustaining Europe's biodiversity.

For generations, people have looked on deadwood as something to be removed from forests, either to use as fuel, or simply as a necessary part of "correct" forest management. Dead trees are supposed to harbour disease and even veteran trees are often regarded as a sign that a forest is being poorly managed. Breaking up these myths will be essential to preserve healthy forest ecosystems and the environmental services they provide.

In international and European political processes, deadwood is increasingly being accepted as a key indicator of naturalness in forest ecosystems. Governments which have recognised the need to preserve the range of forest values and are committed to these processes can help reverse the current decline in forest biodiversity. This can be done by including deadwood in national biodiversity and forest strategies, monitoring deadwood, removing perverse subsidies that pay for its undifferentiated removal, introducing supportive legislation and raising awareness. WWF calls on European governments, forest owners and the forest industry to help conserve biodiversity by increasing deadwood in boreal and temperate forests to 20-30 cubic meters per hectare by 2030.

In this brochure WWF describes the importance of deadwood, outlines some necessary steps for its conservation and restoration, and invites forest managers, forest owners, governments and the public to give this vitally important microhabitat a chance. ■

> References:

There are no references in this pamphlet.
To access a fully referenced version of the text visit

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Deadwood in European forests: **not enough!**

> A severe lack of deadwood in managed forests and inappropriate protected area management are key reasons for biodiversity loss in European forests. A few remaining old-growth forests in Europe can be used as a direct evidence of the links between deadwood and biodiversity.

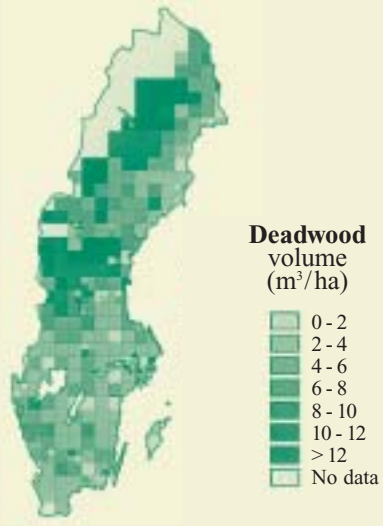
Naturalness is more than just a question of what species occur, but relates to the pattern of the forest canopy, the way that the forest functions ecologically, its resilience to change, the extent to which it has been fragmented and the process by which it regenerates itself. Because naturalness is so complex, it is often measured by using a suite of indicator species or microhabitats likely to be present in a natural forest. Deadwood is one of them.

Deadwood is an indicator that captures many elements of naturalness and is becoming a general reference for natural forests in Europe. If there are enough of the right kinds of deadwood in a forest then it is likely to be fairly natural. Researchers and governments are now surveying deadwood in forests to find out how much deadwood should be present in a natural forest as a reference[3], and how much is present in managed forests.

Volume of deadwood depends on productivity, pattern of natural disturbance, successional stages, forest history and human intervention. Deadwood type and decay trajectory (the way in which the tree decays over time) are influenced by the way in which it dies (lightning strike, storm damage, drought, disease etc)[4]. Deadwood type and volume vary between different forest types and management systems. Some types of disturbance are particularly linked to the production of either standing deadwood (e.g. dry-out), or fallen deadwood (e.g. storm damage)[5].

In unmanaged European broadleaf forest, deadwood will eventually rise to anything from 5-30 per cent of the total timber, with volumes normally from 40 to 200 cubic metres per hectare with for example an average volume of 136 m^3/ha[6] in old-growth beech forests. Deadwood can rise even higher after a catastrophic event like a storm. Some examples of reference forests are summarised in the box.

These figures contrast dramatically with deadwood volumes in managed forests, even those that are managed in quite a natural manner. For instance, deadwood in the Jura Mountains of Switzerland, which are managed under continuous cover forestry with large areas in an IUCN category V landscape protected area, was only 6.3 m^3/ha[7] in 1993-95. Some averages across Western Europe are given [see page 5]. Less natural forests, such as plantations of Eucalyptus or spruce, result in a further significant reduction of deadwood volumes[8]. ■



Sweden country-level map
Fridman and Walheim 2000

Some reference old-growth forests in Europe

> Poland: Bialowieza forest – one of the most natural forests in Europe, between Poland and Belarus, protected as a hunting reserve since the 1300s. On the Polish side 17 per cent of the forest (10,500 ha) is a national park, of which half has been strictly protected for over 80 years (no logging). Deadwood contributes about a quarter of the total above ground wood biomass in the reserve, ranging from 87 to 160 m³/ha.

> France: Fontainebleau – a 136 hectare forest reserve last cut over in 1372, protected from logging since 1853: mainly beech with oak, hornbeam and lime. Volumes of deadwood are 142-256 m³ per hectare, with higher volume following a severe storm. Volume is linked to decay time, with higher volumes but shorter retention time in the case of stands being suddenly knocked down by storms and lower, more constant volumes when trees fall naturally with age[9].

> The Carpathians: Havesova (Poloniny N.P., Slovakia) - a 171 hectare strict forest reserve of beech, was found to have an average of 121 m³/ha of deadwood. In Romania, a survey of 4 natural forest reserves (Sercaia, Gemenele, Izvoarele Nerei, Iauna Craiova) had measured from 49-128 m³/ha of deadwood[10]. Izvoarele Nerei in the Semenic-Cheile Carasului N.P. - a 5028 hectare forest reserve protected since 1975, is one of the largest virgin beech forest in Europe: volumes of deadwood are 78-121 m³/ha[11]. The reserve shows a pronounced ecologic stability.

> UK: a review of 16 sites found dramatic differences in deadwood volume, ranging from 6-501 m³/ha. For example Ridge Hanger, a 20 hectare ash and beech forest, was measured as having a deadwood volume of 273 m³/ha[12].

> Finland: lower productivity reduces deadwood volumes – the average volume of deadwood in old-growth forests in Finnish Lapland varied from 19 m³/ha in pine forests to 60 m³/ha in herb-rich spruce-dominated forests. The accumulation rate of new dead material was greatly reduced after cutting.

> The Mediterranean: there is generally a low level of awareness and evaluation of veteran trees and deadwood. Reference forests occur in Italy (e.g. Sassofratino in Tuscany), Greece (e.g. in the Rodopi mountains) and Croatia (e.g. Velebit Mountains). Old and veteran trees in managed forests are also important: cork oak in Italy, France, Spain, Morocco or Tunisia, but also chestnut forest stands and even orchards support many veteran trees of high importance to the conservation of Mediterranean species of birds, beetles or bats.

***All** those involved in the conservation, planning, managing and harvesting of forests can make a big difference with little effort.*

Average volume of deadwood in the forests in a few European countries[14].

Although figures are difficult to compare due to different sampling methods, data from national forest inventories contrast dramatically with deadwood volumes in old-growth forests.

Country	Volume of deadwood (m³/ha)	Nature of data
Austria	0.6	Productive forests (88% of total), over 35 cm diameter
Belgium	9.1	Regional average (Wallonia), standing and fallen deadwood
Finland	2-10	Average production forest
France	2,2	National average
	6,7	Departmental maximum (Savoie)
Germany	1 - 3	Regional average (Bavaria)
Luxemburg	11,6	National average
Sweden	6,1	National average
	12,8	Regional maximum (North)
Switzerland	12	National average
	4.9	Average in the “plateau” region
	11.6	Average south of the Alps
	12.2	Average in the pre-Alps
	19.5	Average in the Alps

Deadwood importance for **biodiversity** and **people**

Over and above *its importance for biodiversity, deadwood plays a key role in maintaining the forest's health and life-cycle.*

> Veteran trees support life, for example for nesting black storks

> Deadwood in streams provides habitats for fishes

> Deadwood stabilises forests, sustains forest productivity, stores carbon and provides food and habitat for thousands of specialised species.

Deadwood is not an optional extra, but a critical component in forest functioning, which plays five major roles in the ecology of a healthy, natural forest:

- Maintaining forest productivity by providing organic matter, moisture, nutrients and regeneration sites for conifers – some tree species germinate preferentially on logs
- Providing habitats for creatures that live, feed or nest in cavities in dead and dying timber, and for aquatic creatures that live in the pools created by fallen logs and branches
- Supplying a food source for specialised feeders such as beetles and for fungi and bacteria
- Stabilising the forest by helping to preserve slope and surface stability and preventing soil erosion in the event of storms, heavy rainfall and other climatic extremes
- Storing carbon in the long-term, thus mitigating some of the impacts of climate change [see page 13][16].

Even before a tree dies completely, it attracts specialised species; for example around 115 species of hoverfly (Syrphidae) are saproxylic, but almost exclusively in dying rather than dead timber[17]. Veteran trees provide specific habitat and nesting spaces for some species, such as the black stork *(Cigonia nigra)*.

When a tree is newly dead it attracts specialised organisms capable of breaking down the tough lignin layer that protects it, principally fungi (like the familiar bracket fungi) and bacteria.

These colonisers open up the resources locked in the wood, by making cracks in the tough outer skin and modifying the heartwood so that it can be assimilated by other feeders. Next to arrive are plant and animal species that eat the "evolved" organic matter, including many beetle species. Research in hardwood floodplain forest in South Moravia in the Czech Republic found 14 saproxylic ant species and 389 saproxylic beetle species[18]. Similarly 37 per cent of beetles in La Massane old-growth forest in France were associated with deadwood[19], and there are about 100 saproxylic beetles species in the Mediterranean cork oak forest of Les Maures[20]. Around Lake Vatten in Sweden forests harbouring rare saproxylic beetles had on average 10-30 times more deadwood than other forests[21]. Also in Sweden around 2500 fungi species rely on dead timber[22] along with over 50 moss species[23].

As soon as herbivores move in, their predators arrive as well. Woodpeckers are the best known, with their deep drumming accompanying any walk through a natural forest. Many are highly dependent on deadwood particularly in winter. For instance, the great spotted woodpecker (*Dendrocopus major*) relies on insects from snags or down logs for 97 per cent of its winter food[24]. Between 80 and 130 ha of old-growth forest is required for one breeding pair of three-toed woodpecker (*Picoides tridactylus*), which forages mainly on recently dead spruce[25].

Larger animals also make use of dead timber for shelter. All but one of the eleven European woodpecker species excavate nesting holes in dead timber, and at least ten European owl species use tree holes as do species like flycatchers (Muscicapidae), nuthatches (*Sitta spp.*), treecreepers (*Certhia spp.*), tits (*Parus spp.*), and even ducks like the goldeneye (*Bucephela clangula*)[26]. Other users include many bat species and large mammals like bears. In La Massane in the French Pyrenees, a quarter of mammals and over a sixth of birds are associated with deadwood[27].

When a tree falls in the forest it creates disturbance that helps some plants to germinate and grow[28]. Deadwood falling into streams and rivers also provides important habitats[29], including assisting the creation of gravel bars and pools which reduce water flow, creating fish and insects habitat[30] and providing valuable substrate for algae[31]. These slow flowing areas retain up to 70 per cent of the litter fall thus increasing nutrients. Research in the USA found that pools created by logs and branches provide over 50 per cent of the salmonoid spawning and rearing habitats in small streams[32]. ■

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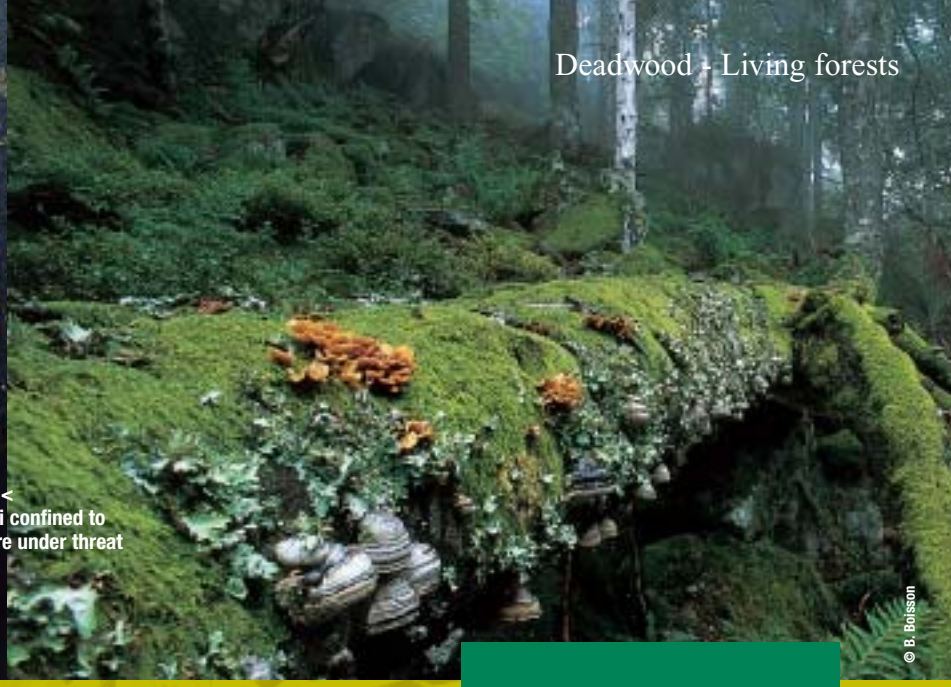
< Many fungi confined to deadwood are under threat



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Loss of deadwood means **loss of life**

© La Massane Natural Reserve

***Without sufficient amounts** of veteran trees and deadwood the biodiversity of European forests will continue to decline.*

> Many threatened species are associated with deadwood in Europe, ranging from simple organisms to complex, mobile species like woodpeckers. Deadwood is now one of the most threatened habitats in the forest.

Over much of Europe, forests have been managed for hundreds of years. Management has already taken a heavy toll on species associated with deadwood and we know from sub-fossils in peat deposits and insects preserved in amber that many saproxylic beetle species have already become extinct in the last few thousand years, almost certainly because their habitat disappeared. It is likely that the extinctions we know about are a small proportion of the real losses. In this impoverished environment, those that remain are precious.

Unfortunately they are also often highly at risk. Species associated with deadwood now make up the largest single group of threatened species in Europe. For example, of the 1,700 species of invertebrates in the UK dependent for at least part of their life cycle on deadwood, nearly 330 are Red Data Book-listed because they are rare, vulnerable or endangered[33]. In Sweden, one of the most densely forested countries in Europe, 805 species dependent on deadwood are on the national Red List[34].

■ The white-backed woodpecker (*Dendrocopos leucotus*) has declined dramatically because of the disappearance of old-growth deciduous forests (sallow, alder and birch). It is highly threatened in Sweden and Finland, with 90 per cent of the Fennoscandian population (1700 pairs) now confined to coastal forests of Norway[35].

■ The Bechstein's bat (*Myotis bechsteinii*) is one of many bat species to have undergone a catastrophic decline: it is now very rare in some countries and vulnerable throughout its range. In Italy[36], sub-fossil records suggest it was once abundant in the region and the current decline is attributed particularly to loss of the hollow trees used as summer roosts[37].

■ The Hermit beetle (*Osmoderma eremita*) lives in hollows of dead trees in 33 European countries but is declining and protected by the Bern Convention. In Poland, for instance, researchers conclude that its survival is threatened by the felling of hollow or rotting trees[38]. Most of the beetle species living in hollow trees do not fly more than a few tens of metres making dispersal difficult in a fragmented forest landscape.

■ Many fungi confined to deadwood are now under threat, although data on distribution and status in Europe are very incomplete. Threatened species include *Laricifomes officinalis* growing principally on veteran trees in pine-larch woods, and *Pycnoporellus alboluteus*, confined to thick logs in herb-rich spruce forests in Fennoscandia. Both are protected by law in some countries and were recently recommended for listing in the Bern Convention[39]. The importance of fungi is often underestimated; for example in the Alps, a single hectare of spruce forest can support over 300 species of fungi.

These threats are unlikely to disappear very soon because current problems will be increased by fragmentation and future shortages. Even where natural forest fragments are conserved or where deadwood components are restored, dispersal problems make surviving populations vulnerable[40]. And in some countries, even where deadwood currently exists, lack of young or middle-aged trees will cause a problem in the future unless there is intervention as for instance it has been identified in Latvia[41]. ■

Deadwood : supporting **never-ending forest** cycles

***Deadwood** is not a single habitat, but dozen of micro-habitats inhabited by thousands of different species.*

> The final stages in the life cycle of a tree – from veteran to dying trees and deadwood – attracts specialised species which play a key role in maintaining the forest's health and stability.

Deadwood is not a single habitat, but instead a complex range of different microhabitats, which change and evolve over time.

The quality of deadwood, and its usefulness for different species, depends on how long it has been decaying and also on the tree species, age at time of death, cause of death, position (standing, fallen etc) and size, and on the surrounding climatic conditions. In Sweden fine deadwood material forms a richer habitat for fungi like morels, and cup fungi[42]. Elsewhere, research shows that small logs and branches do not decay in the same way as large trunks, so that necessary habitat types will not occur[43]. The process of deadwood recycling can sometimes take hundreds of years to complete and includes three main phases[44]:

- A short colonisation phase during which the wood is invaded by primary and vigorous saproxylic organisms, often longhorn beetles associated with fungi, which attack the wood when it is still hard.
- A long decomposition phase during which the primary saproxylic organisms are joined or replaced by secondary saproxylic organisms, which feed on material that has already been partially converted by colonisers, or are their predators.
- A long humification (formation of humus) phase through which the saproxylic organisms are progressively replaced by scavenging organisms like springtails or millipedes, who incorporate wood residues into the ground when it has been sufficiently transformed during the decomposition phase.

Managing for deadwood requires a thorough understanding of the numerous habitats and associated species. The following typology[45] provides an initial and simplified guide to deadwood likely to be found in forests under natural conditions. Any one tree will not go through all these stages, and the trajectory of decay will depend on how an individual tree died along with other external environmental factors. ■

	Typology	Associated wildlife
Living veteran trees	Very old trees with large canopy for perching or nesting	Large raptors like the golden eagle (*Aquila chrysaetos*), black stork (*Cigonia nigra*)
	Cavities on very old trees	Cavity nesters as Tengmalm owl (*Aegolius funereus*) or Ural owl (*Strix uralensis*)
	Deadwood on live trees	For example hoverflies, beetles (*Lucanus cervus, Cerambyx cerdo*) and lignicolous fungi
Standing dead trees	Very old trees with large branches, providing perches and nest sites	Birds, squirrels and other species along with bark-eating beetles and their predators
	Standing trunks (snags) of different ages (gradually losing bark and branches)	Colonised by fungi, lichens, ferns and invertebrates and by larger species who bore (like woodpeckers) or take over nesting holes
	Snags with major cavities large enough to shelter large animals	Brown bears
	Young dead trees	Specialised associated fungi and bacteria/algae
Lying timber	Recently fallen logs with bark and twigs present	Associated species include fungi and large longhorn beetles
	Down logs largely intact, wood starting to soften internally, still elevated but sagging	Beetles and fungi continue to be important although species may change
	Down logs without bark or twigs, softening, sinking to the ground	Numerous insect species including flies and beetles, fewer fungi present
	Down logs well decayed, no bark or twigs and entirely on the ground	Insects, specialised fungi
	Down log almost completely decayed, wood powdery but still whole	Woodlice, millipedes, etc. Nurse log facilitating germination of conifers in mountain forest, and of broadleaves like alder in alluvial forests...
	Uprooted trees with root system still attached	Roots can shelter bird nests and insects
Litter to soil and water	Large woody debris	The wood becomes a substrate for many bryophyte species and flowering plants
	Fragments of woody debris including branches, twigs and bark	Specialised species of fungi (e.g. morels and cup fungi) and animals such as springtails and woodlice
	Coarse woody debris in rivers and streams	Algae, fly larvae, breeding fish

< Logging in protected areas, like here in Sumava National Park (Czech Republic), should be banned…

> … to protect this woodpecker from becoming homeless

Deadwood in **Protected Areas**

***Allowing natural dynamics** in protected forest areas is a precondition for the conservation of forest biodiversity.*

> Protected areas should be dedicated primarily to biodiversity conservation. Allowing natural dynamics guarantees greater diversity of habitats and species. Deadwood is still often lacking in protected areas thus considerably undermining their overall value.

An integrated protect-manage-restore policy for forests is promoted by WWF. All three of these approaches have a role to play in protecting species associated with deadwood.

Protection – increasing both the number of protected areas and protecting individual trees and microhabitats – lies at the heart of efforts to protect saproxylic species. An integrated strategy in protected areas should include:

■ **Quantifying the extent of the challenge:** deadwood species have often been ignored and including them in national Red Lists of endangered species and on international agreements like the Bern Convention is important, both to quantify and publicise their conservation problems. Recent attempts to increase data quality, for instance through inventories of threatened fungi in Macedonia and Greece[46], need to be extended.

■ **Identifying and protecting key sites:** the richness of remaining natural forest fragments is increasingly recognised, yet many are currently threatened or degraded. Use of the Natura 2000 network and additions to national protected area networks can help to maintain essential reference forests and "arks" for deadwood species. Currently Western European countries still have few strict forest reserves (IUCN category Ia and Ib, MCPFE categories 1.1) and forest harvesting is often allowed even in category II national parks[47], which is bad for deadwood[48]. Further east, many valuable old forests have been protected in the past, but the pressure for logging (both legal or illegal) of these areas is now very high.

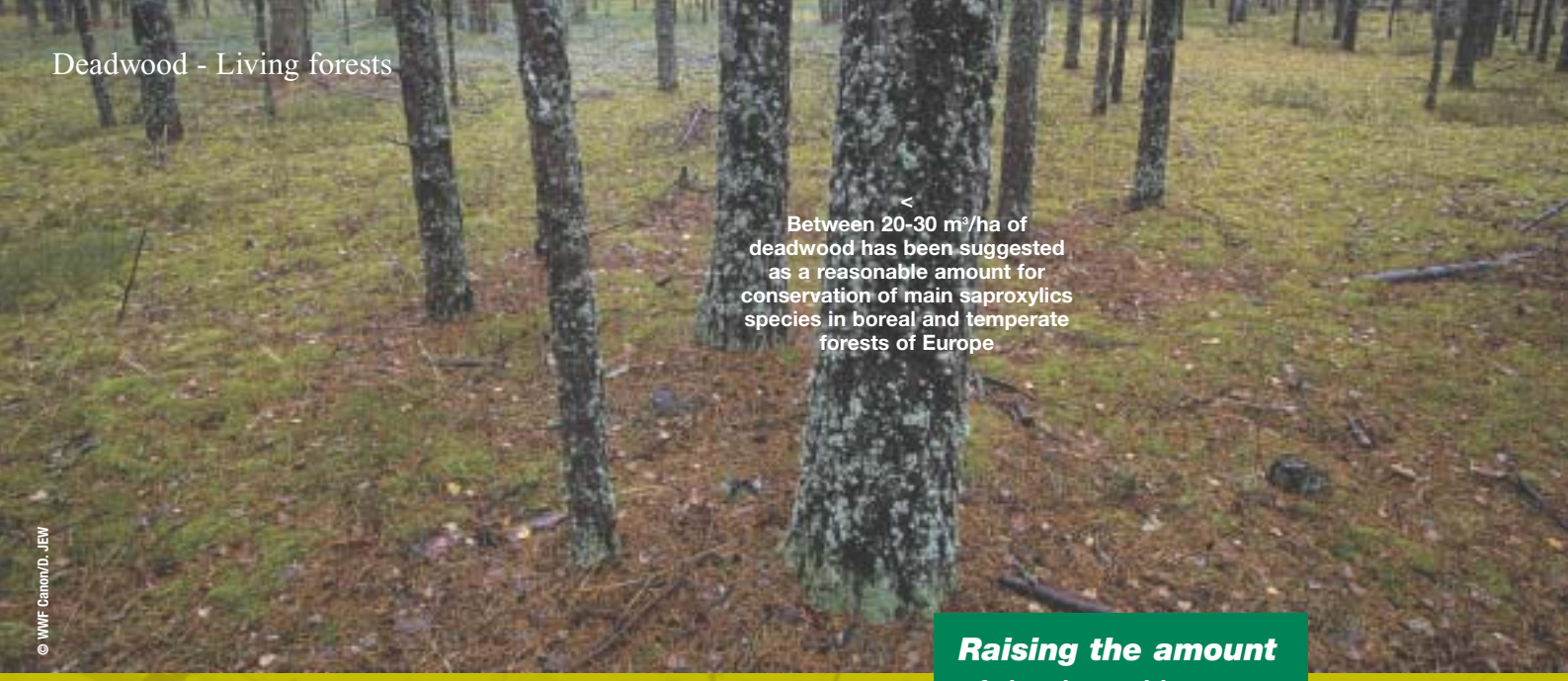
■ **Providing effective guidance within protected areas:** many forest reserves have been managed in ways that are bad for saproxylic species. There is a general need to stop logging within IUCN Category I-IV protected areas. Guidance is needed for protected area managers on the importance of deadwood and on habitat requirements. Some common management actions, such as coppicing, while valuable for a proportion of species may be harmful to saproxylic species if carried out in the wrong way[49]. Most guidance in Europe is still at a very general level compared with North America. In British Columbia a government manual gives habitat requirements for over 130 vertebrate species using a typology of deadwood and details of decay, sap conditions etc[50].

■ **Legislative needs:** in many European countries forest laws and environmental legislation need to be reformulated to distinguish between forest management in protected areas and commercially used sites. Sanitary felling based on legal requirements should not apply to protected forest areas IUCN I-IV.

■ **Educating users:** a lack of understanding about the importance of dead timber means that much is removed, even from "protected" forests, by people who do not realise that they are causing damage. An effective educational campaign, explaining the role of deadwood through nature trails, leaflets and exhibitions, can help protect the habitat within protected areas and also encourage people to manage their own land in a more ecological manner.

■ **Enforcing controls:** illegal timber extraction remains a serious problem in many protected areas and where education and information are insufficient, disincentives are also needed.

■ **Using surrogates:** in protected areas with a serious lack of dead timber, active restoration may be needed [see page 11]. As an interim measure surrogate habitats may help to preserve a few keystone species: the most common examples include nest boxes and bat boxes, but this is costly and only partially successful. The recovery of the pied flycatcher (*Ficedula hypoleuca*) in parts of the UK has been ascribed to use of nest boxes. Such surrogates only support a tiny fraction of the biodiversity associated with deadwood and are therefore not a viable long-term solution. ■



< Between 20-30 m³/ha of deadwood has been suggested as a reasonable amount for conservation of main saproxylics species in boreal and temperate forests of Europe

How to **manage** deadwood

Raising the amount of deadwood in *managed forests to 20-30 m³/ha by 2030 would be a major step towards the goal of good forest management in Europe.*

> Responsible forest management requires sufficient amounts of deadwood. The compensation for leaving veteran trees and not removing valuable deadwood in commercial forests is increased forest stability and resilience. Deadwood management does not threaten tree health and does not cost a lot if done wisely.

Protected areas will only ever cover a small fraction of European forests and much of the managed forest estate can and should play a role in biodiversity conservation. This can often include retention and management of deadwood within production forestry. Actions depend on forest types and situations, but some general principles are emerging:

■ **Including veteran trees and deadwood in management plans:** plans can identify likely interventions that can support saproxylic species – as described below – and where to apply them. Retaining deadwood in exotic plantations may have few benefits if species are not adapted to these habitats.

■ **Retaining examples of key habitat components:** likely to support saproxylic species within managed forests, including particularly:
> Existing large, veteran, dying or dead trees, pollarding senescent trees if necessary to prolong the existence of this particular habitat
> A proportion of middle-aged trees to ensure the future
> Key habitat areas where stands are allowed to mature in a natural manner
> Fallen deadwood including brash from thinnings (possibly a mixture of cleared and uncleared areas[51]) and even more importantly large logs

In Municipal Parks and Private Gardens

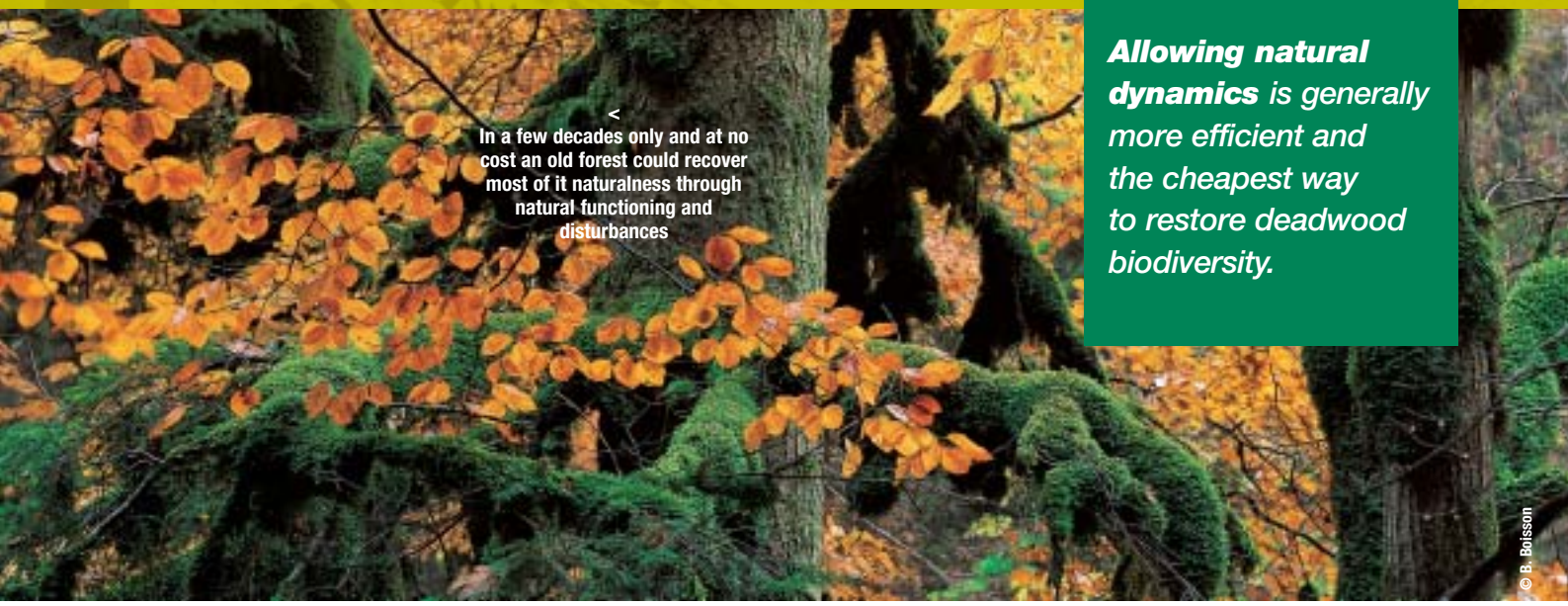
> In some areas veteran trees often exist outside forests, in parks, hunting reserves and even public or private gardens; such trees can provide important refuges for threatened species. Conserving and where necessary enhancing existing veteran or dead trees helps life return to our doorstep. It would help raising public awareness on forest ecology too.

© D. Vallauri

■ **Using other management interventions:** either in designated areas or more generally including:
> Prescribed burning in boreal forest
> After a storm, while granting salvage logging, balancing the ecological and economic benefit of leaving deadwood on the ground (without perverse subsidies the economy will often support a near-to-nature form of management).
> Creation of artificial snags by leaving a proportion of some trunks standing after felling. Such techniques work. Research by Anders Lindhe of WWF Sweden found that hundreds of beetle species, including many red-list species, utilise high stumps left after cutting, making high stumps in logging areas and other open sites valuable tools for conservation of saproxylic beetles[52]. Studies have shown that around half the artificial deadwood snags created are likely to be used by cavity nesting birds[53].

The amount of dead timber retained within managed forests is open to debate and management decisions will require detailed knowledge of local conditions[54]. A general rule will probably be the more the better, although the quantity will be a trade off against the value of timber and the practical inconvenience of large amounts of deadwood in production forests. For European boreal and temperate forests, between 20-30 m³/ha of deadwood or 3 to 8 per cent of total volume of wood could be suggested as a reasonable amount, divided between standing dead trees and down logs[55]. ■

Restoring deadwood and **naturalness**



< In a few decades only and at no cost an old forest could recover most of it naturalness through natural functioning and disturbances

***Allowing natural dynamics** is generally more efficient and the cheapest way to restore deadwood biodiversity.*

> In today's damaged forest ecosystems, strategies for restoring deadwood are also urgently required… But as deadwood is an indicator of naturalness, restoration needs to be carefully planned and rely wherever possible on natural functioning.

A medium term aim of a landscape-scale forest conservation strategy should be to encourage levels of deadwood high enough to retain healthy populations of naturally-occurring saproxylic species. Natural disturbances support deadwood recovery: for example storms in temperate forests or snow damage in mountain areas regularly provide dead trees, uprooted logs or snags. Studies in the Wye Valley in the UK found that deadwood volumes in mature stands that had not been managed for a century reached the level and variety of ancient forests in mainland Europe and eastern North America[56].

While natural retention of deadwood could be the rule for deadwood management, particularly in managed forest, in specific locations when threats to critically endangered species are well documented or where recovery is very slow, conservationists and foresters may wish to speed up the process of recovery. In a crisis, where deadwood is in such short supply that dependent species face extinction, short term restoration methods may be justifiable, whereby deadwood is created through artificial disturbance. Several restoration strategies have been tested in Europe, for instance in a Life project in the Bosca della Fontana (Pô plain, Italy)[57].

They can include the deliberate creation of standing or fallen snags; uprooted trees; leaning dead trees; standing dead trees; hastening senescence; and creating habitat trees: drilling, for example, nest holes of different sizes so that species using secondary nest holes have instantly created habitat.

In southern Finland, 10,500 hectares of forests are being restored through the artificial creation of dead and decaying trees as part of a more general restoration programme which also includes prescribed burning and peatland restoration[58].

In general artificial methods are expensive and only likely to create limited benefits, and passive restoration will create better habitats although the process will take longer. More important is the development of a comprehensive spatial approach to ensure connectivity of deadwood habitats (as habitat fragmentation is currently the major problem facing saproxylic beetles). Encouraging the philosophy of non-intervention, which is still against the instincts of many foresters, is also very important.

Expert knowledge of the ecological needs of particular species is required to create the right kinds of habitat – for instance in Sweden efforts at protecting the white-backed woodpecker include focusing principally on retention and increase of broadleaved tree species[59].

The limited research suggests that recreated habitat can certainly be useful but it is probably not providing the complete habitat range expected; for instance data indicate that trees killed by bark beetles provide richer snag, from a biodiversity perspective, than one created by ring-barking[60]. Artificial methods can however certainly provide an emergency bridge while longer-term management changes can have an impact. ■

A landscape approach to deadwood

> Protection, management and restoration all have a role to play in conserving saproxylic species and ecoregional or landscape approaches to forest conservation will utilise all three. Planning at a broader scale helps to determine where particular interventions are most useful, for instance by focusing management changes in places that can link existing protected areas or provide stepping stones for saproxylic species to migrate.

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Deadwood - **Policy needs**

***European governments** are becoming increasingly aware of the importance of deadwood. To make deadwood again a common sight additional measures are needed.*

> Governments are committed to several international processes to conserve forest biodiversity. They must act now to include veteran trees and deadwood in national biodiversity strategies, remove perverse subsidies, introduce supportive legislation and raise awareness of their importance.

Deadwood and certification

> FSC certification already favours deadwood retention to preserve biodiversity. Any certification scheme should add some requirements for deadwood management. The national standard for the FSC in Germany provides an example: "A strategy is developed for the maintenance and proliferation of biotype (habitat) trees and deadwood; it is integrated into the management plan…Trees with woodpecker holes and other natural cavities are exempt from forestry use and left to age and decay naturally… solitary trees that have been split or broken apart by storms or lightning strikes, as well as dead trees that have split or fallen due to advanced decomposition, remain in the forest…"[70]. The Swedish FSC standards encourage deadwood management aiming for an increase of deadwood stores in a typical Swedish spruce forest to slightly more than 20 m^3/ha, compared with the current levels that often are below 5 m^3/ha. Natural levels commonly exceed 60 – 80 m^3/ha[71].

Policy changes and legal changes can help to protect deadwood components at various scales, from initiatives that affect the whole continent to actions within individual countries.

■ **Region and nation-wide initiatives:** the Ministerial Conference on the Protection of Forests in Europe – a cross-country initiative to promote and measure good forest management – has agreed a series of criteria and indicators of good management, which member states are obliged to report on. Recently a new indicator was added specifically related to deadwood[2]: "Maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems: Indicator 4.5: Deadwood - Volume of standing deadwood and of lying deadwood on forest and other wooded land classified by forest type[63]". As yet, data are sparse because the indicator was added late in the assessment, but future surveys will have to include deadwood. Some countries have already incorporated deadwood into national assessments[64], as in the case of Finland which includes an indicator: "Decayed and wildlife trees in commercial forests and conservation areas (m^3/ha)[65]".

■ **Changing or implementing legislation:** legislative options also need to be retained, including where necessary minimum requirements for deadwood retention. For instance forest regulations in Washington require at least 2 logs per acre (roughly 4 per hectare), both at least 30 cm diameter at the small end, with a minimum length of 6 metres[66].
Changes are needed to national laws that insist on harvesting and therefore make deadwood retention illegal; a change to Latvian law allowing retention of deadwood is an excellent recent example. Better enforcement of regulations against illegal felling is often needed and sometimes changes in rules that enforce unnecessary sanitary felling within protected areas.

■ **Removal of perverse subsidies:** several countries still provide subsidies that act against deadwood retention, particularly clearing after storms. For instance the French government will pay €900-1800/hectare for salvage felling after storms without any requirements for deadwood retention, although up to half of those felled trees are yet not sold four years after the storm.

■ **Quantifying the extent of the challenge:** it is important to include deadwood species in national Red Lists of endangered species and on international agreements like the Bern Convention, both to quantify and publicise their conservation problems.

■ **Raising awareness on the importance of deadwood:** should be a key aspect of policy, with a number of outputs.

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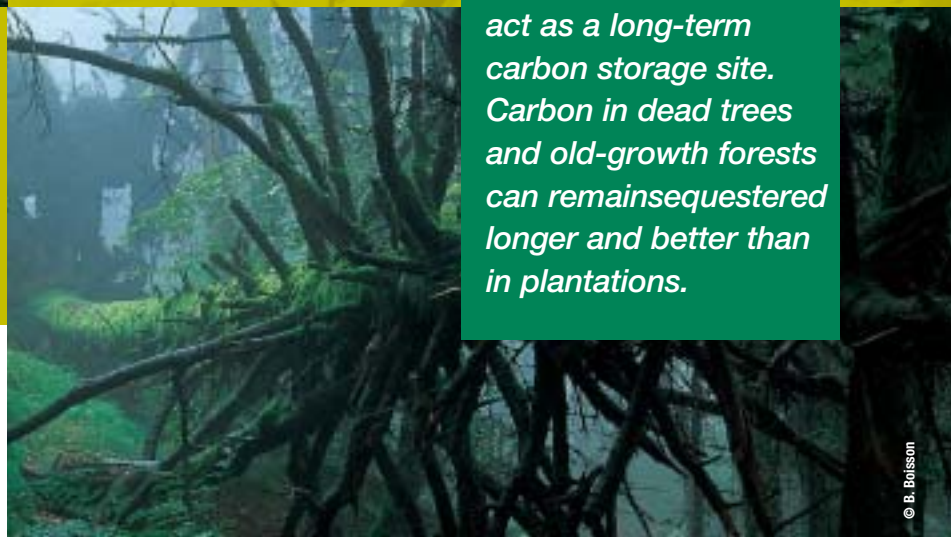
Deadwood and **climate change**

In temperate forest, *deadwood tends to act as a long-term carbon storage site. Carbon in dead trees and old-growth forests can remainsequestered longer and better than in plantations.*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> Deadwood plays a wider role by storing carbon to mitigate global warming as efficiently as many young timber plantations.

As the reality of climate change is widely recognised, carbon sequestration (the storing of carbon in ecosystems) is gaining attention as one way of reducing greenhouses gases.

Major forest carbon pools include trees, under-storey vegetation, deadwood, litter, and soil. Deadwood is important as it is both a store and source of carbon but is generally the least studied of the carbon pools. This will now change because national carbon inventories are required under the Kyoto Protocol of the 1992 United Nations Framework Convention on Climate Change[72].
Initial discussion on carbon storage focused on fast-growing rotations of exotic plantations. However, while these can quickly accumulate carbon, storage is very temporary: average retention time of carbon in plantation trees is only a few years because most of the fibre is used in paper and other short life products that are either burned or degrade quickly in landfill.

Deadwood itself releases carbon to the atmosphere – becoming a carbon source – during microbial respiration from decomposer organisms. But in ecosystems in cool climates, microbial activity is restricted and decomposition very slow, so that deadwood tends to act as a long-term storage site. Much of the carbon in long-lived and slow decaying trees, such as Scots pine, can remain sequestered for over a thousand years. Dead trees and old-growth forests are therefore usually better carbon stores than the new forests which replace them. In British Columbia, research found that at a rotation age of 80 years, regenerating stands stored approximately half the wood carbon of nearby old-growth forests (predominant age 500 years), indicating that conversion of old-growth forests to younger managed forests results in a significant net release of carbon[73]. On the other hand, in impoverished forests, restoring deadwood by retention can store carbon for many decades or centuries. Calculations in France suggest that creation of new protected areas (with no logging) can store the same amount of carbon as afforestation[74]. ■

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■ **Educating users:** a lack of understanding about the importance of deadwood means that much is removed, even from "protected" forests. An effective educational campaign, using nature trails, leaflets and exhibitions, can help protect habitat and encourage people to manage their own land more sympathetically.

■ **Informing managers and public:** for instance both the French[67] and British[68] state forest bodies have published guides to managing deadwood.

■ **Informing forest owners:** in Sweden the state forestry body created a highly successful self-education package, Rikare Skog, which forest owners use to learn about ecology[69].

■ **Informing within protected areas:** trails, sign boards etc (e.g. as is currently the case in Poland and Slovenia).

■ **Courses and training:** the inclusion of deadwood management in short courses and in standard forestry training will help to cement understanding of its importance. ■

Deadwood: unravelling some **myths**

***Debunking the myths** about the negative impacts of deadwood is crucial. Anyone interested can help to address them at many levels (political, communications, management) and scales.*


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> When many Europeans see a natural forest they often think that something is wrong, that the forest is sick. Unfounded myths about old trees and deadwood have developed over centuries.

■ Myth 1:

A "clean" forest is a healthy forest

"Clean" forests are not healthy forests. The few natural forests remaining in Europe are far more stable, healthy and resistant to disease, pests and climate change. As a result, natural forest are more diverse and complex than their managed counterparts.

■ Myth 2:

Over-aged forests are a problem

Veteran trees are often regarded as a sign that a forest is being poorly managed. As a result, we have many forests where only young trees remain and people have lost a sense of what a natural forest with uneven age structure looks like. For example in a typical central European forest we rarely find trees older than 100 years whereas many tree species could easily reach an age of 300 years and more. We might imagine a human population where everyone past their early thirties is quietly removed…

■ Myth 3:

Dead trees harbour diseases

The most threatening pest for forest managers is the bark beetle and deadwood is often blamed for allowing the bark beetle to infest forests. In fact the evidence suggests that reasonable levels of dead trees are no danger for the forest. On the contrary, several studies seem to show that they shelter a significant group of parasitoids and predators, which more or less control the populations of pests[61]. Although bark beetle numbers increase near significant numbers of fallen logs, research found little evidence for increased tree death as a result[62], mainly because the species attracted are already highly specialised to dead timber.

■ Myth 4:

Only young is beautiful!

A central problem in managing for deadwood is a matter of human culture. Veteran and dead trees are not attractive in a culture obsessed with youth: foresters themselves have been obsessed for decades by the question of regeneration of forest for example. Species such as fungi and beetles are not renowned for their beauty and charisma and are not well promoted by nature conservationists. Making space for dead timber is not simply a question of telling people about a few management techniques, but also involves changing the perception of what high quality management might look like and about forest ecology.

■ Myth 5:

Deadwood brings fire

A frequent argument for the removal of deadwood is as an insurance against fire. Yet well-managed deadwood components can be integrated into existing fire management policies (and for instance can still be removed from fire breaks). Most fires start in dry weather when living trees burn readily and most fires in Europe are started by people, so a few snags and down logs will not significantly increase the risk of fire.

■ Myth 6:

Deadwood is a health and safety risk to visitors

The greatest risk in forests is from commercial timber operations, particularly the felling operations. Deadwood is already successfully retained in many reserves and protected areas, or even city parks (like for instance in the parks around Vienna), and can be managed for instance by retaining dead trees some distance from public paths. Germany recently changed its laws to remove responsibility for accidents from forest owners, so that visitors wander off paths and through old forests at their own risk; similar changes elsewhere would make it easier private forest owners whose forest are open to public access. ■

A **WWF** Call for Action

WWF is working on a series of initiatives to promote this positive process of change:

> Development of guidelines for deadwood management as technical publications with partners aimed at (1) protected area managers and (2) commercial or community forest managers (3) Natura 2000 sites

> Development of a portfolio of model restoration strategies and practices at landscape level in Europe

> Lobbying for the removal of perverse subsidies and laws that are undermining the preservation and good management of deadwood and old forests

> Engagement with national standards reviews for certification schemes to encourage greater acknowledgment of the importance of veteran trees and deadwood

> Inclusion of deadwood options within Kyoto initiatives and more generally as a sequestration option reported by governments

> Support and collaboration on key research projects aimed at quantifying the biodiversity values of deadwood

Deadwood is practical indicator demonstrating the health and biological diversity of forests. WWF believes that the silvicultural, economical, social and ecological questions linked to veteran trees and deadwood could help us very practically to start improving European forest management towards a more natural ecosystem approach that would favour saproxylic species, along with many others. These questions represent a considerable challenge for sustainable management and conservation, considering the very high number of fungi, vertebrates and invertebrates and key functional processes involved.
WWF notes that, within Europe, there is significant variation in scientific knowledge and awareness on saproxylic species and deadwood, as well as in management approaches. WWF believes that the understanding of veteran trees and deadwood and theirmanagement must be strengthened as a matter of urgency.

Policy

Governments and the European Union should develop policy level actions in favour of deadwood to meet their obligations under the Convention on Biological Diversity by:
> including deadwood in national biodiversity strategies and national forest programmes
> developing guidelines for deadwood monitoring and management including minimum thresholds for deadwood as an indicator for biodiversity and naturalness
> increasing the list of saproxylic species mentioned in the Habitats Directive
> introducing supportive legislation that restricts salvage, sanitary, legal or illegal logging in IUCN categories I to IV protected areas and removes perverse subsidies and laws undermining deadwood management
> exempting forest owners from responsibility for accidents to visitors entering in their forests (as was recently achieved in Germany)
> including deadwood options within Kyoto initiatives and more generally as a sequestration option reported by governments

Protected areas

Protected area managers can support veteran trees and deadwood in Europe by:
> identifying and protecting key sites to maintain essential reference forests for deadwood species
> developing effective strategies for deadwood management within protected areas and Natura 2000 sites
> stopping removal of veteran trees and deadwood within IUCN categories I-IV protected areas
> strengthening prevention, information and education
> using active restoration measures where needed

Managed forests

Forest companies and forest managers can help to build a healthy deadwood habitat by:
> including veteran trees and deadwood (and other key microhabitats) in management plans to increase their number and volume: WWF suggests a target of 20-30 m^3/ha by 2030 in boreal and temperate forests
> balancing deadwood retention with fire risk management
> using existing certification scheme national standards as a reference for appropriate deadwood management
> considering retention of deadwood on the ground after a storm ■

Twenty-thirty by twenty thirty!

Up to 30 per cent of forest species depend on veteran trees and deadwood. WWF calls on European governments, forest owners and the forest industry to commit now to conserve biodiversity by increasing the number of veteran trees and restoring 20-30 cubic metres of deadwood per hectare by 2030.

WWF contact in Europe

To find an office of WWF and forest contacts in Europe-Middle East
- http://www.panda.org/wwf-offices

For more information on WWF's forest work go to
- http://www.panda.org/forests4life

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