Four Highlights from Natura 2000 Forests

NGO recommendations on management

Four Highlights from Natura 2000 Forests: NGO recommendations on management

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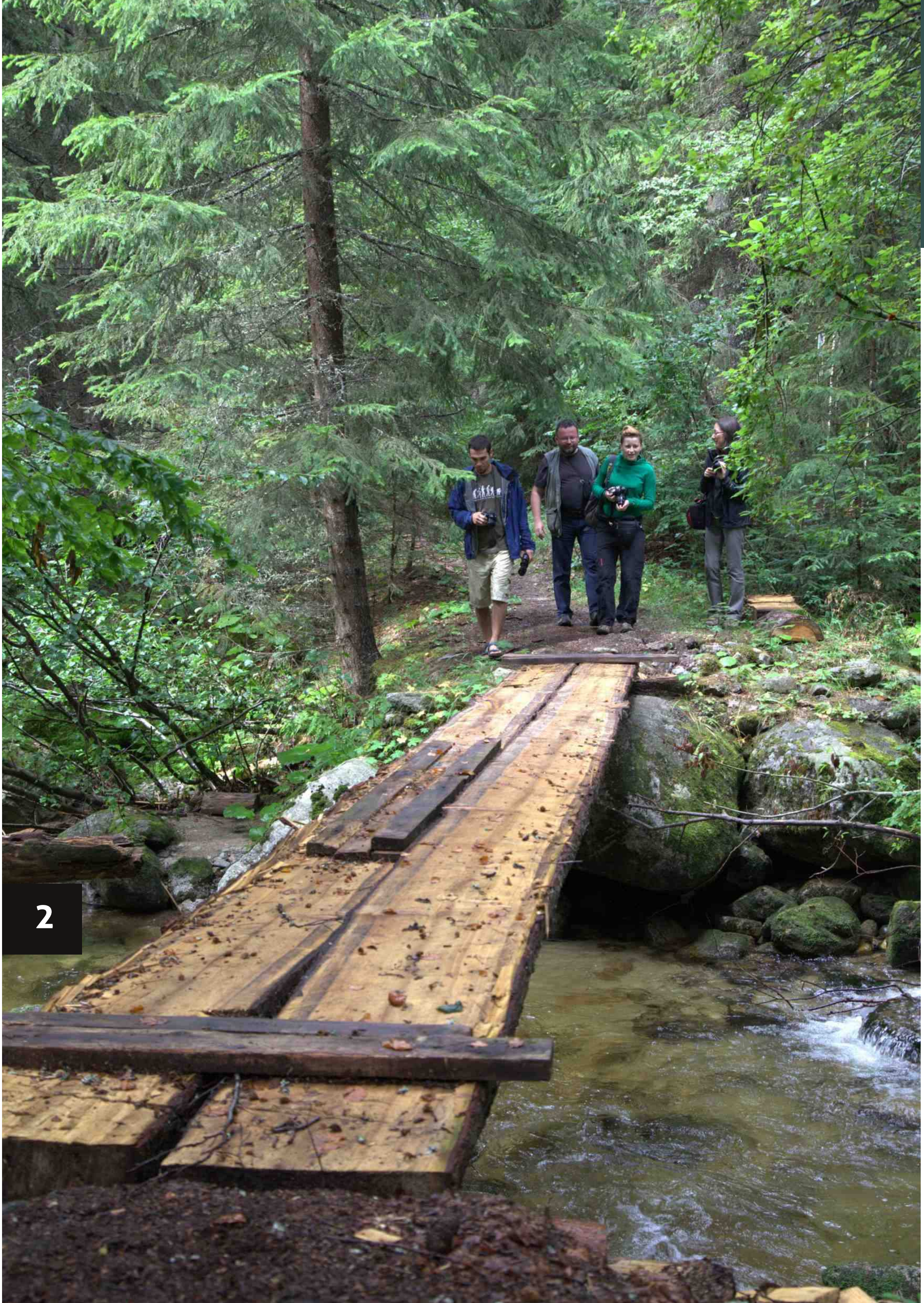

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Introduction

In 2010 forests and other wooded land covered 177.8 million hectares which is more than 40% of the EU's land area. This number has been growing throughout the last twenty years. The majority of wooded land is covered by semi-natural forests or woody plantations, whereas around 20.4 million hectares (equivalent to 13% of the total area) of forests were in protected areas in the EU in 2010.[1] European forests are among the most important ecosystems providing necessary services for Europe's citizens, including a number or provisioning, cultural, supporting and regulating services.

Despite their growing area European forests are exposed to a number of pressures such as climate change, habitat fragmentation, invasive alien species or the intensification of forest management. At the same time resilience and adaptation capacity of forests to these pressures depends on their biodiversity and ecological coherence. This was already recognized by the EU's 2006 Forest Action Plan which states *maintaining and enhancing forest biodiversity* as one of its aims.[2] Maintaining biodiversity, sustaining ecological health and functioning in forests depends largely on their management. This was acknowledged by the EU Biodiversity Strategy to 2020 by adopting its Target 3: *Increase the contribution of agriculture and forestry to maintaining and enhancing biodiversity* and its Action 12: *Integrate biodiversity measures in forest management plans.*[3] These plans should include important measures such as maintaining optimal levels of deadwood, preserving wilderness areas, applying ecosystem-based measures to increase the resilience of forests against fires and adopting specific measures developed for Natura 2000 forest sites. There are several ongoing EU processes to support the implementation of this target and action along with the Strategy's other provisions, such as the Biogeographic Process where forestry management is a highlighted issue or the preparation of the *Guidance on the management of forests in Natura 2000.*

However, it is often unclear for planners and managers alike how the above provisions should be integrated into actual management practice. Therefore, it is crucial to share experience and knowledge on different forest management options and their role in achieving favourable conservation status of forests. It is also crucial to enhance cooperation between countries and stakeholders. These are some of the goals expected from the ongoing EU processes.

With this brochure NGOs wish to contribute to this knowledge by sharing their field-based experiences. We have decided to highlight four selected issues of forest management and to provide a list of good examples. These issues are relevant across most biogeographical regions and forest habitat types and are important for achieving favourable conservation status of Natura 2000 forest habitats and the target species they host. Non-intervention management is one of the management options for all zonal climax forests with large coverage across Europe, especially those in the Boreal and Alpine regions. Ecological coherence is key to ensuring forest resilience against climate change and other environmental pressures, and important for emblematic species such as large carnivores. Management for deadwood retention is a rather technical modification of current practices with significant benefits for structural and biological diversity of the forest. In the context of this brochure light forests are created and sustained by management practice which opens the canopy and allows light to penetrate to the understorey thus enabling a diverse mosaic of forest and grassland patches and favouring traditional land use practices at the same time.

We especially invite forest planners and managers, land use planners, conservation professionals and other interested readers to explore, learn and disseminate our findings.

Wilderness and non-intervention management

According to the definition given in the EU Guidelines on Wilderness in Natura 2000,[4] a **wilderness** *is an area governed by natural processes. It is composed of native habitats and species, and large enough for the effective ecological functioning of natural processes. It is unmodified or only slightly modified and without intrusive or extractive human activity, settlements, infrastructure or visual disturbance.* Wilderness areas are typically national parks or reserves of IUCN category I covering thousands of hectares and with a history of strict protection. The term **'wild area'** is used for sites (...) *where only some of the wilderness qualities are found, where the conservation objectives aim at achieving only part of the wilderness qualities, or where the objective is to fully restore natural processes and features with the aim to extend the wilderness core zone.* Wild areas can have various statuses, for example core zones of nationally protected or Natura 2000 sites or entire smaller nature reserves under strict protection. Wild areas do not necessarily have a long history of being undisturbed but they need to have the potential of restoring and sustaining natural processes.

Wilderness and wild areas are generally subject to **non-intervention management**: all kinds of human intervention are avoided that could have negative effects. (Exceptions are scientific investigation and in some cases guided tourism.) In other cases a **minimum intervention**[5] approach is applied which limits active management to non-extractive and preventive measures such as eradication of invasive alien species, maintaining touristic paths, etc. While in each case the guiding principle is to enable natural processes, there is a continuum

Above: The Three-toed Woodpecker occurs only in old-growth forests

Right: The highest spruce tree of Bulgaria is in the non-intervention forest of Parangalitsa reserve, Rila Mountains

between minimum intervention and non-intervention along which the level of intervention decreases even in case of naturally occurring disturbances (e.g. bark beetles or forest fires).

Natural dynamics enabled by non-intervention

Natural structural and functional diversity is a precondition for maintenance of high biodiversity in forests. There are different levels and scales of natural ecosystem dynamics. In case of forests it varies from small-scale gap dynamics (as in lowland beech forests) through "stand development phases" dynamics (as typical for montane mixed forests) to the large-scale disturbance dynamics (as in typical montane spruce forests). All manifestations of these dynamics should be accepted in wilderness and wild areas as manifestations of the natural processes maintaining the ecosystem. Even if natural processes are seemingly destructive for the forest stands (as massive wind throws or bark beetle outbreaks), non-intervention is often a good strategy and may bring along conservation benefits. Non-intervention is often less destructive for forest-related biodiversity than active intervention against the outbreaks; and forest recovery by natural succession is usually faster and cheaper than by artificial planting. A network of large non-intervention areas contributes to the ecological coherence of habitats and strengthens their resilience and adaptation capacity to climate change and other external pressures.

Conservation benefits

As visualized by the Wilderness Quality Index maps[6] of EEA, the highest values of wilderness quality in Europe may be found in the Alpine and Boreal biogeographical regions. According to experience from Central and Eastern Europe, national parks and reserves under non-intervention management often host the best-preserved natural forests and are hot-spots of forest-related biodiversity which can be considered as reference for other management options. Some species, considered as primeval forest relicts, can be found exclusively or almost exclusively there. It is the only possible measure for the protection of priority species related to old-growth forests, such as beetles *Rhysodes sulcatus* or *Boros schneideri*. Also some bird species prefer these areas, such as the Ural Owl *(Strix uralensis)*, the Tengmalm's Owl *(Aegolius funereus)*, the White-backed Woodpecker *(Dendrocopos leucotos)* and the Three-toed Woodpecker *(Picoides tridactylus)*. Non-intervention supports the structural and functional diversity of forests including a sufficient amount of deadwood, the importance of which is discussed in a separate chapter.

Applicability

Non-intervention management areas significantly contribute to the favourable conservation status of a large set of habitat types, especially primary habitats and dynamic complexes of habitats as well as the species they host. Examples of habitats that benefit from non-intervention management can be found in all habitat groups under Annex I to the Habitats Directive from aquatic to terrestrial and from closed canopy forests to open grasslands, dunes, peatlands or rocky habitats. Non-intervention management, however, is not appropriate for semi-natural habitats which have evolved as a result of human management and land use when their existence depends on human intervention.

Although non-intervention management is normally used for the best-preserved and primary natural habitats, this approach may be in some cases also useful for habitat restoration. There is a lot of conservation evidence (especially for forests) when natural processes restored natural structure and even species composition better and cheaper (although normally not faster) than active restoration measures, and important negative impacts of restoration measures were avoided by "restoration by natural processes". Especially natural stand vertical and spatial composition and deadwood resources can be restored by such non-intervention.

The non-intervention approach must always be considered on a site-specific, case-by-case basis. When planning for non-intervention management of a certain site, it is necessary to involve and get consent from all stakeholders. Several factors have to be considered carefully, e.g. sufficient size and zonation, presence of invasive species, legal provisions, potential conflicts and socio-economic benefits generated by introducing non-intervention management.

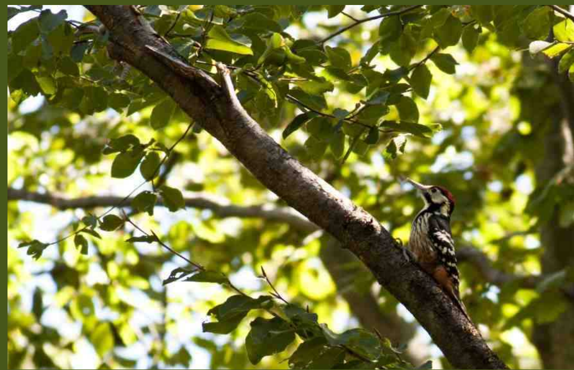
Example 1: Non-intervention management of forests in Bulgaria

Similarly to the European experience, Bulgarian national parks and reserves under non-intervention are the best-preserved parts of the Bulgarian Natura 2000 network. In the Bulgarian protected areas there is a long tradition of non-intervention management. The country has three national parks which are IUCN category II (total surface of 193047.9 hectares), 55 reserves which are IUCN category I (total surface 77083.9 hectares) and many protected sites with non-intervention management. There is also a wide network of non-intervention areas throughout the network of Bulgarian Nature parks which are IUCN category V.

Non-intervention management on at least 10% of the area of forest habitats in Natura 2000 is already a legally adopted requirement within Natura 2000 network in Bulgaria. They are crucial for saving forest biodiversity in Natura 2000 and achieving the favorable status of the forest habitats.

SCI&SPA Central Balkan BG0000494

Central Balkan SCI&SPA BG0000494 overlaps with the National Park of the same name. It covers 72 021.07 hectares of wooded and treeless areas in the middle of Stara Planina Mountain. The site is famous for the best-preserved old-growth beech forests in Bulgaria. There are more than 25 000 hectares of beech forests aged between 100 and 300 years. They are mainly *Asperulo-Fagetum* forests (9130) and Moesian Beech forests (91W0) but there are also *Luzulo-Fagetum* (9110) and *Cephalanthero-Fagion* beech forests (9150).



Map of the Central Balkan National Park, SCI and SPA; old-growth beech forest in the Central Balkan National Park; White-backed Woodpecker.

About 28% of the site's territory (20 019 hectares) belong to 9 reserves where all human activities are forbidden except for scientific investigations and crossing the reserves on marked footpaths. The whole surface of the site is public state property.

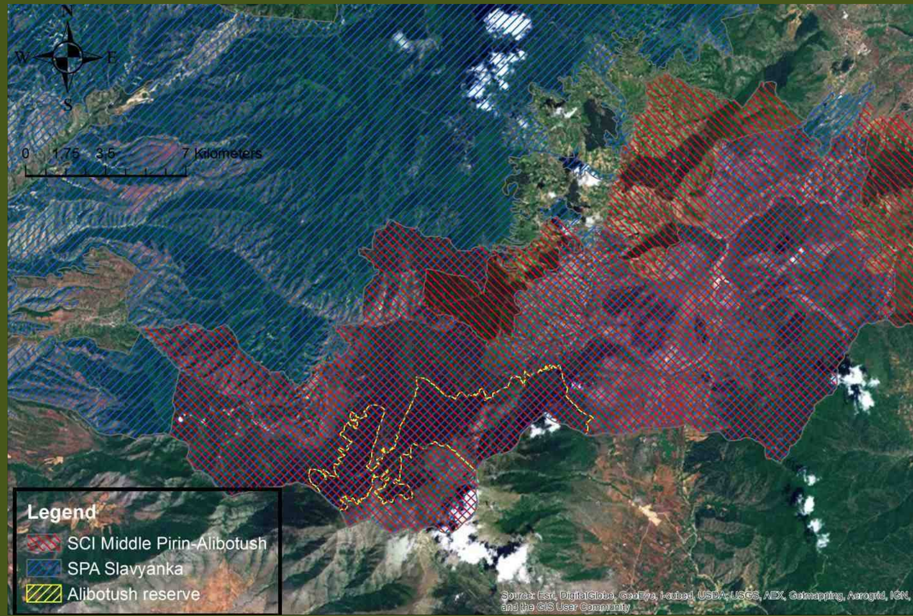
The National Park is IUCN category II. It is also PAN Park certified and 21 019 hectares (29.57% of total area) of its territory is declared as wilderness area. Outside the wilderness area almost all forest activities are forbidden except small quantities of fuel wood harvesting by the local population from coppices and plantations. Hunting is totally forbidden on the territory of the whole park.

The park protects important Bulgarian populations of the Brown Bear *(Ursus arctos)*, the Wolf *(Canis lupus)*, the Balkan Chamois *(Rupicapra rupicapra balcanica)* and other mammals. Non-intervention managed forests in the Park are one of the most important Bulgarian stronghold for the White-backed Woodpecker *(Dendrocopos leucotos)*, the Pygmy Owl *(Glaucidium passerinum)*, the Hasel Grouse *(Bonasa bonasia)*, the Tengmalm's Owl *(Aegolius funereus)*, the Semicollared Flycatcher *(Ficedula semitorquata)*, the Ural Owl *(Strix uralensis)*, the Black Woodpecker *(Dryocopus martius)* and many other bird species.

SPA Slavyanka BG0002078, SCI Middle Pirin-Alibotush BG0001028 and Alibotush reserve

SPA Slavyanka protects the most important parts of Slavyanka Mountain in Bulgaria. It covers 19433 hectares. The majority of the lands and forests belong to the state (57%) and municipalities (34%), only 9% is private property. The SPA Slavyanka BG0002078 partially overlaps with SCI Middle Pirin-Alibotush BG0001028. SCI Middle Pirin-Alibotush BG0001028 protects Natura 2000 habitats in South Pirin and Slavyanka Mountains. It covers 68934 hectares. It includes two reserves: Alibotush (1 638 hectares) and Orelyak (785.1 hectares). Both reserves are public state property and are managed by the Bulgarian Ministry of Environment and Waters.

Alibotush reserve covers 8.4% of the surface of the SPA (1 638 hectares). It protects the most important old-growth High oro-Mediterranean pine forests 95A0 in the region. All human activities are strictly forbidden except for scientific investigations and crossing the reserve using marked footpaths. The reserve is a territory of Brown Bears *(Ursus arctos)*. It is inhabited by wolves (*Canis lupus)* and the Balkan Chamois *(Rupicapra rupicapra balcanica)*.



Map of SPA Slavyanka, SCI Middle Pirin-Alibotush and Alibotush reserve

Non-intervention managed forests of the reserve are an important Bulgarian stronghold for the White-backed Woodpecker *(Dendrocopos leucotos)*, the Pygmy owl *(Glaucidium passerinum)*, the Hasel Grouse *(Bonasa bonasia)*, the Tengmalm's Owl *(Aegolius funereus)*, the Semicollared Flycatcher *(Ficedulase mitorquata)* and many other bird species. The unmanaged forests of the reserve are home of the densest Bulgarian Capercaillie *(Tetrao urogallus)* population.

SCI Middle Pirin-Alibotush BG0001028 is outside of the reserves Alibotush and Orelyak and it is managed by the state forest company. 10% of the Natura 2000 forests habitats in this site should be declared as non-intervention forests according the new guidance on management of the forests in Natura 2000 in Bulgaria.

Example 2: Non-intervention management of forests in Poland

Białowieża Great Forest, Poland

Białowieża Great Forest is probably the most famous Polish forest, located in north-eastern Poland (Continental biogeographical region) on the Polish-Byelorussian border. This big forest complex (1 500 km^2 from which ca 630 km^2 is presently in Poland) was used as royal game area and was not intensively managed for centuries. The forest is composed of a mosaic of mixed oak-hornbeam forests (9170 habitat), alluvial alder forests (91E0), bog birch, pine and spruce forests (91D0 habitat), bog alder forests and spruce-pine forests (non Natura 2000 habitats). In the beginning of the 20th century the idea to create the forest reserve emerged. In 1923 it was implemented by the designation of ca 45 km^2 of the best-preserved forest area in the centre of Białowieża Great Forest as non-intervention zone. This was subsequently named Białowieża National Park.[7]

This core area of the present Białowieża National Park now has almost 100 years tradition of non-intervention management, and is commonly understood as the best-preserved lowland oak-hornbeam forest in Europe, the reference for forest dynamics and ecology of this habitat. There is wide scientific evidence of biodiversity, forest ecology and forest dynamics of this site. This is probably the most often examined forest in Poland. The results clearly show that non-intervention is crucial for forest biodiversity. For a lot of species, especially small animals like insects and cryptogamous plants (mosses, lichens, fungi), this is the only place in Poland where they are presently noted. Biodiversity is very rich, with a long list of Red List species finding refugia here. This zone is also crucial for Natura

Non intervention oak-hornbeam forest in Bialowieza Forest, Poland

2000 species like *Cucujus cinnaberinus, Rhysodes sulcatus, Osmoderma eremita, Boros schneideri, Buprestis splendens, Mesosa myops, Pytho colvensis and Phryganophilous ruficolis* – for most of them this is the most important Natura 2000 site in Poland. The non-intervention approach has also created a unique opportunity to study forest ecology because the ecological processes and ecological relationships are still natural here.[8]

The non-intervention zone in Białowieża Forest is also an important reference for natural composition, dynamics and status of natural habitats. Spontaneous ecological processes were released here, including succession and fluctuation in forest stands. As a result of bark beetle outbreaks the occurrence of spruce has been reduced creating extensive deadwood-rich areas in a place of former spruce forests. In the mixed oak-hornbeam forests there are fluctuations in stands composition with expansion of lime and hornbeam and reduction of pine, spruce and oak. There are various regimes of natural disturbances: form small-scale gap dynamics to the most extensive collapse of spruce stands and subsequent regeneration. These processes should be considered as part of natural dynamics of natural habitats, and are assessed as part of "favourable structure and function" of them.

In 2004, with the Polish accession to the EU, the entire Białowieża Forest was designated as Natura 2000 site Puszcza Białowieska PLC200004 (compact bird & habitats site, SPA & SCI). The pilot management plan was prepared in 2004 and the plan of conservation measures was prepared in 2012. Both plans confirmed non-intervention approach as an appropriate way also for conservation of the crucial Natura 2000 values in this particular forest complex.[9]

The non-intervention approach is currently being expanded. In 1996 the national park was enlarged to ca 100 km² and – after some discussions – non-intervention approach was subsequently expanded to the majority of the area. In 2003 another 85 km² were designated as nature reserve "Natural Forests of Białowieża" with non-intervention predominating. In 2012 – although the national park was not enlarged – the new forest management plan for the Białowieża Forest assumed a non-intervention approach for all >100-year-old forest stands, i.e. for the next 240 km². Thus presently ca 440 km² of forest is under non-intervention management.

Natural regeneration of spruce and rowan in the non intervention zone in Gorce Mts, after bark beetle outbreak

Gorce Mountains, Poland

In Gorce National Park (southern Poland, Gorce mountain range of the Carpathians, Alpine biogeographic region; Natura 2000 bird Special Protection Area Gorce PLB120001, as well as part of bigger Site of Community Importance Ostoja Gorczanska PLH120018) non-intervention management approach is applied to almost 5 000 hectares of 7 030 hectares of the national park. 3 600 hectares are formally designed as "strictly protected as continuous core zone". Another 1 000 hectares are under non-intervention management without a formal "strict protection" status. These management decisions have helped to create an important wilderness area for mountain forests in the Polish Carpathians.

Non-intervention management was found very suitable for forest ecosystems[10] in the site. In *Asperulo-Fagetum* beech forests (habitat code 9130) it is followed by high biodiversity and natural values of forests. In the habitat '*Acidophilous Picea* forests of the montane to alpine levels (*Vaccinio-Piceetea*)' (habitat code 9410) even in case of bark beetle or sawfly outbreak it seems to be the best possible choice.

The Gorce case provides evidence for the conservation advantages of different bark beetle outbreak strategies. The pressure of bark beetles *(Ips typographus)* on the spruce forests in Gorce Mountains is permanent with an important outbreak period between 2006 and 2010. Only 52% of spruce trees survived the 1997–2011 period. Generally a non-intervention approach was applied while in some areas active protection (removing infected trees and artificial regeneration) was used. The original spruce stand was destroyed either by bark beetles or by tree cutting as a measure against bark beetles. Active protection in fact did not slow the process down. On non-intervention areas, however, vivid tree regeneration started: succession with birch and rowan as well as spruce. The outbreak episode did not destroy the forest cover or the spruce forest permanently; it caused only a "deep fluctuation" in the forest structure. If dead trees are not removed, montane spruce forests regenerate rather easily after disturbance over a large area. Biodiversity definitely benefits from the non-intervention strategy. The Three-toed Woodpecker *(Picoides tridactylus)*, the Capercaillie *(Tetrao urogallus)*, the Pygmy Owl *(Glaucidium passerinum)* find perfect biotopes in the dead, partially-dead and regenerating spruce forests. The Gorce Mountains have also become a unique tourist area with "wilderness impression" as the impression of "massive tree-cutting in a protected area" was avoided. A lot of negative impacts of cutting and transporting of trees (disturbance of birds and large carnivores, destroying of *Bombina variegata* reproduction pools, risk of destroying tree holes and other microbiotopes crucial for biodiversity) were avoided by the non-intervention approach. Naturally regenerated areas are very suitable for the Capercaillie. The Golden Eagle *(Aquilla chrysatetos)*, the Lynx *(Lynx lynx)* and the Brown Bear *(Ursus arctos)* also seem to prefer the non-intervention zone and return to Gorce Mountains.

In higher mountains bark beetle outbreaks should be considered as part of natural disturbance regime typical for the habitat '*Acidophilous Picea* forests of the montane to alpine levels *(Vaccinio-Piceetea)*' (habitat code 9410). In lower locations, in mixed spruce-fir-beech forests non-intervention management involves natural fluctuation of species abundances, but still maintains the habitat in terms of its typical species composition. In the upper zone of forests spruce stays dominant. These changes should be considered as natural regeneration and fluctuation and should be assessed as being in line with Natura 2000 objectives.

Example 3: Non-intervention management in German National Parks

One of the assumptions of the German Biodiversity Strategy is: "By the year 2020, throughout 2% of Germany's territory, Mother Nature is once again able to develop undisturbed in accordance with her own laws, and areas of wilderness are able to evolve". Accordingly to this assumption the non-intervention approach is widely used in forests in German national parks and other protected areas.

In the montane spruce forests the strategy to not fight against bark beetle outbreaks is widely applied as such outbreaks are considered a part of the natural disturbance regime. The most well-known example is probably the Bayerische Wald national park (Natura 2000

Bayerischer Wald National Park DE6946301 (SPA&SCI))[11] where this approach is applied on thousands of hectares on which the spruce stands. Although the spruce was destroyed by bark beetle, it now regenerates vividly. This creates a positive contrast with the adjacent areas in Šumava National Park on the Czech side of the border where the forests were destroyed by the fight against bark beetle much more than by bark beetle itself. Nevertheless, the same approach is also applied in other national parks. In Harz National Park (Natura 2000 sites Nationalpark Harz DE4129302 (SCI) & 4229402 (SPA)), the Quitschenberg study area provides knowledge on the ecological results: although many of the spruce trees are destroyed by the bark beetle, there is intensive regeneration of rowan and birch which seem to be the succession phase before spruce forest recovery. In fact, it is the process of re-naturalization of the spruce forests of the High Harz: a natural transition of the former cultivated forest to the forest with a much more natural structure. There is even scientific evidence for spruce forest regeneration after bark beetle outbreaks showing that "doing nothing", as happened in the German national parks, is in many cases the best conservation strategy.[12]

The non-intervention approach is predominantly used for deciduous forests in German national parks and nature reserves, especially for beech forests, as the best way to maintain natural features of the forest structure and biodiversity, or to restore these structures in formerly managed forests. The most famous are the beech forests in the Hainich, Kellerwald-Edersee, Jasmund and Müritz national parks (Continental biogeographic region, respective Natura 2000 sites: Hainich DE4828301 (SCI & SPA), Kellerwald DE4819301 (SCI) & DE4920401, (SPA); Jasmund DE1447302 (SCI); Serrahn DE2645301 (SCI) & Wald- und Seenlandschaft Lieps-Serrahn DE2645402 (SPA)), designated, as example of natural Central European beech forests with typical biodiversity and natural features, as a UNESCO World Natural Heritage site.[13] The most important reasons justifying the designation were the non-intervention approach and naturalness of the structure.

Even such artificial pine stands are sometimes treated by non-intervention, achieving conservation benefits

Even in the strongly transformed, artificial forests the idea "Let nature be nature" is the guiding principle in most of German national parks. In Müritz National Park (northern Germany, Continental biogeographic region; Natura 2000 site Seen, Moore und Wälder Des Müritz gebiete DE2543301 (SCI) & Müritz-Seenland und Neustrelitzer DE2642401 (SPA)) – also an artificial pine forests plantation – in 1998 the forest was split into three categories regardless of its condition. Category A included deciduous trees, older coniferous forests and the forests which developed by themselves on the former military training ground. Management was stopped here in 1998. Category B included forests which were treated between 1998 and 2008, e.g. middle-aged coniferous forests. These forests now belong to category A and are also no longer treated. Category C included younger coniferous trees which will continue to be cleared until 2018. By then forest treatment in the Müritz National Park should be completed and it is assumed that non-intervention will be the only approach used in the future.[14] The potential influence of this assumption on biodiversity is still discussed.[15]

Why is deadwood crucial in forests?

By deadwood we mean standing trees (snag), trees broken by a storm or the fall of another tree (volis), laying logs, dead branches, down dead trees with only one extremity touching the ground and coarse woody debris (portion of decayed trunks).[16] There is a saying that "the dead tree is more alive than the living tree". It is also said that this lifecycle stage in forests is necessary for the continuation of a healthy ecosystem. When we consider biodiversity richness created by deadwood, these sayings are actually already proven scientific fact.

Deadwood is a source of a number of forest ecosystem services. The most important is creating habitat for other organisms such as carnivores (place for hunting and digging), smaller mammals, rodents, bats (magazines for seeds, hiding and reproduction places), reptiles and amphibians (place for hiding, hibernation in winter, resting, feeding or reproduction) and, most obviously, birds. Nearly half of forest bird species occurring in Austria, for example, are classified as vulnerable or nearly-threatened according to the Austrian Red List. These species can be found in a wide range of habitats; however, most are especially adapted to specific "old-growth conditions" that have become very rare in commercial forests.[17] Woodpeckers are good examples. The biggest group benefiting from deadwood is invertebrates (mostly insects). Only in Central Europe there are about 1 500 species of saproxylic beetles. Deadwood-dependent beetles are a crucial part of forest biodiversity and almost all of these species are strongly threatened; most of them are included in the Red Lists, and some *(Osmoderma eremita, Cucujus cinnaberinus, Rhysodes sultactus, Limoniscus violaceus)* also in the Habitat Directive Annexes. Besides animals, plants also benefit from deadwood as habitat e.g. bryophytes. In Białowieża Forest, in a 100-hectare compartment 75 species of moss and 24 species of liverworts were found, most of them related to deadwood. Last but not least, fungi are the most visible element on decaying wood. Dead trunks often play the role of a cradle for new generation of forests, providing seedlings with a perfect habitat with great amounts of water and all kinds of biogenic substances. In the forests of Babia Góra National Park in Poland 50% of new generation of the Norway Spruce was found on deadwood covering only 5% of the surface! The comprehensive review of biodiversity in deadwood was published by Bobiec at al.[18] and recently by Stockland, Siitonen and Jonsson.[19]

Deadwood in the forest is definitely crucial for maintaining forest biodiversity. For Natura 2000 habitats maintaining the full variety of habitat-related biodiversity is one of the objectives: to achieve and maintain favourable conservation status, the deadwood resources are one of the crucial features considered among "structure and function" of the forest.

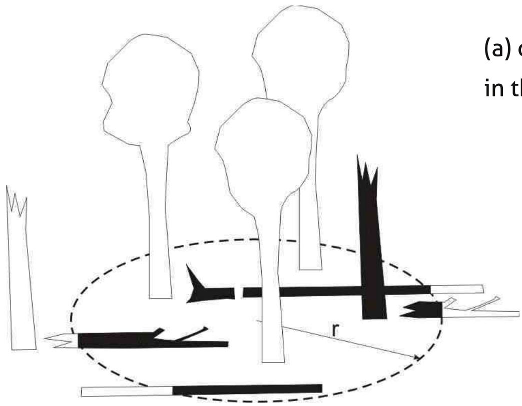
Deadwood in the forest provides several cultural ecosystem services too such as improving the quality of the landscape, attracting tourism and education as well as providing spiritual values such as feeling of remoteness, being in the wild and a general closeness to nature. As for regulating services deadwood is also a great magazine of water and humidity, creating a specific microclimate. It also helps water retention by slowing down water flow on the surface and in the ground. The same happens on steep slopes vulnerable to soil erosion: deadwood stops avalanches and soil movement. Deadwood accumulates not only water but also great amounts of organic matter, biogens, carbon, nitrogen and other elements.

How to assess deadwood resources?

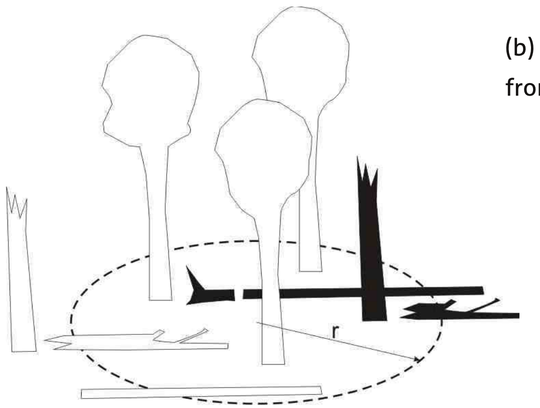
Deadwood provides relevant habitat for thousands of European forest organisms, several of which are threatened. Data on deadwood can be collected at relatively low cost in national forest inventories and the indicator is reported by countries according to agreed definitions. Therefore deadwood volume was selected as one of the crucial indicators of sustainability of forest management as one of the 25 Streamlining European Biodiversity Indicators monitored by the European Environmental Agency.[20]

There are different methodologies but most are based on the detailed counting of deadwood on sampling plots, which is then extrapolated to the whole forest area. Sampling plots may be random points or a regular network of points covering the forest area in which circle or square plots are designated. In Polish studies, for example, a regular network of 0.05 circle hectare (12.62 m radius) plots was used. Because deadwood volume in the forest is highly variable, normally at least 20 to 40 plots are necessary to get reliable assessment for the assessment unit. Using more plots allows for assessment and comparison of resources for internal units, as nature reserves and managed forests, particular Natura 2000 habitats in the site, etc. Only coarse deadwood elements are counted. EEA recommends the counting of only elements with >2 m in length and >10 cm mean diameter (lying), or >10 cm diameter at breast height (standing). In some countries, according to the local forestry tradition, the diameter threshold of 7 cm is applied. Stumps of the fallen trees are normally not taken into consideration.

There are two possible approaches of considering particular elements: (a) count what is inside the plot; (b) count what originates from the plot (have original roots inside the plot). The second approach is a bit more difficult in practical application but gives the additional possibility to assess the variation of element size.



(a) counting what is in the plot



(b) counting what originates from the plot

How much deadwood should there be in the forest?

The reference should be the "natural" amount: For the natural forests of Europe, amount >50-100 m^3/hectare is typical, with the recorded maximum up to 250 m^3/hectare, in single cases even up to 500 m^3/hectare.[21] The typical amounts are higher in the temperate zone (UK, central Europe, Alps, all mountains), a bit lower in boreal forests and significantly lower in the Mediterranean. Such amounts are achievable in non-intervention zones, nature reserves, national parks etc. in which the target definitely should be "as much as possible and as given by the natural processes". The crucial conservation question is "How much is enough?" for maintaining biodiversity. There are some scientific research and reviews on this issue. In Scandinavian forests it was assessed[22] that full deadwood-related biodiversity needs at least some forest parts with >100 m^3/hectare, the less-demanding xylobionthic species need still 20 m^3/hectare; resources with <20 m^3/hectare are not useful for biodiversity. In German oak-beech forests it was assessed[23] that 40 m^3/hectare is necessary for the favourable status of xylobionthic biodiversity. The Polish guidance for birds habitat assessment[24] estimates that one pair of the White-backed Woodpecker *(Dendrocopos leucotos)* needs, for favourable status, approximately 100 hectare of forest with >50 m^3/hectare deadwood, and one pair of the Three-toed Woodpecker *(Picoides tridactylus)* needs approximately 200 hectares with >35 m^3/hectare deadwood. There are a lot of similar estimations, with similar results.

The most comprehensive European review by Müllerand Bütler[25] provides the values critical for biodiversity (different groups of deadwood-related plants and animals) with ranges of 10–80 m^3/hectare for boreal and lowland forests and 10–150 m^3/hectare for mixed-montane forests, with peak values of 20–30 m^3/hectare for boreal coniferous forests, 30–40 m^3/hectare for mixed montane forests, and 30–50 m^3/hectare for lowland oak-beech forests. With the above average uneven spatial distribution (including islands with huge amounts of deadwood) is better for the biodiversity than the homogenous distribution.

In the typical managed European lowland forests the deadwood amount is usually 1–10 m^3/hectare which is definitely not enough for forest biodiversity. It is a bit more in the mountains where there are some difficult-to-access places. The amounts of 20–40 m^3/hectare were recorded in some managed forests (for example Carpathians, Poland) which means such amount is still possible to achieve even under normal forest management.

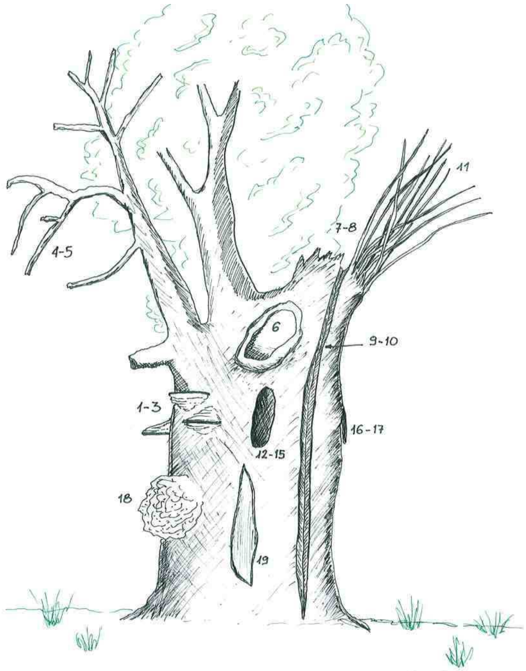
Not only the quantity, but also the quality of deadwood is important. The biggest elements are normally more valuable for biodiversity (some species do not explore small pieces, requiring for example 40 cm as minimum dead log diameter). Maintaining the variation of deadwood form (standing vs. lying, broken vs. uprooted, etc.) is important because some related species have very specific demands. Continuity of different decay stages is necessary because most of related species prefer a particular stage.

How to restore and protect deadwood?

To allow for deadwood retention dead trees obviously should not be removed from the forests. But it may not be enough: trees must have the opportunity to age and die. Not only dead, but also dying trees must not be removed, which is sometimes in conflict with the foresters wish "to fight against forest pests". In order to become deadwood, especially coarse deadwood (which is crucial for biodiversity) trees must also have an opportunity to age. In a long-term perspective, retention of groups of trees (5–10% of each stand) saved untouched in the forest during all forest cuttings, and then saved till natural death and decay is a way to restore and sustain deadwood resources. Normally, natural processes of tree aging and dieback in central European forests can provide 0.2–2 m^3/hectare of deadwood yearly. In cases of insect or fungi-caused stand dieback it is more, which from the point of view of biodiversity is not necessarily a natural disaster, but may also be a deadwood restoration opportunity. In some protected sites fast restoration of deadwood resources is sometimes achieved by implementing conservation measures such as cutting the trees and abandoning them on the ground.

Microhabitats

Although rather coarse woody debris (dead logs, trunks or their fragments) are considered under the name of ‘deadwood’, small ‘microdeadwood’ structures on living trees (such as cavities, dead branches, scars, cracks, etc.) are also important for forest biodiversity. The number of such structures per forest hectare may be a useful indicator for monitoring.[26] In natural forests thousands of such structures per hectare are typical. In managed forests their number is dramatically reduced. In order to save forest biodiversity the amount of such structures must be restored. For this all trees with such structures must be consistently saved.



„Biodiversity tree" – examples of different microhabitats on the single tree, most of them are „microdeadwood“ elements

Photos above: A fallen tree serves as a microhabitat in Bialowieza National Park

Above: a broken tree would become a microhabitat

Top left: Buxbaumia viridis, Annex II moss, growing on deadwood logs

Slonne Mountains and Przemyśl Foothill, Poland

In the Carpathian Foothills of Poland, Natura 2000 sites Ostoja Przemyska PLH1800012 and Gory Slonne PLH180013 are dominated by managed beech forests with a few nature reserves. The deadwood volume in the beech forests (habitat type *Asperulo-Fagetum* beech forests, 9130) was assessed as approximately 30 m^3/hectare: an average which is very high in comparison with other Polish managed forests. Nevertheless, in nature reserves after about 20 years of non-intervention management, the amount has doubled (ca 60 m^3/hectare) which meets biodiversity conservation needs much better.

Generally, good deadwood resources are correlated with extremely rich biodiversity of beech forests, e.g. a lot of Red List species, some having there their last localities within the entire Poland (relicts of primeval forests: *Tachyusida gracilis, Ampedus melanurus, Peltis grossa, Lacon lepidopterus, Eurythyrea austriaca, Sternodea baudii, Euplectus frivaldszkyi* and others), and the biggest Polish populations of the following Natura 2000 listed insect species: *Cucujus cinnaberinus, Rhysodes sulcatus, Boros schneideri* and moss *Buxbaumia viridis*. The species are distributed not only in present nature reserves but also in some parts of managed forests. However, a more detailed assessment shows that the situation is not safe. The huge amount of deadwood in managed forests may only be a relict of less intensive management in the past, not the stable element of present management. In the managed forests the first decay stage is almost absent, which is an indicator of intensification of deadwood removing during recent years. This is an important threat for *Cucujus cinnaberinus* and *Boros schneideri*, Natura 2000 conservation targets there, because they require dead trees in an early stage. Creating more nature reserves with a non-intervention approach and saving more fresh deadwood, especially in the streams' valley zones

Rhysodes sculcatus, Cucujus cinnaberinus and *Boros schneideri* in relic Carpathian forest Natura 2000 Gory Slonne

(30 m from the stream on each side) also in the managed forests, are still necessary as Natura 2000 site conservation measures there.

Drawa Great Forest and Drawa National Park, Poland

This is a big forest complex (ca 1 000 km^2 from which 744 km^2 is designated as Natura 2000 Site of Community Importance Uroczyska Puszczy Drawskiej PLH320046) in north-western Poland (Continental biogeographic region), strongly transformed by previous forest management which still contains significant areas of beech forests (habitat code 9130). Most of the beech forests are also transformed by the former 300 years of forest management: age structure is simplified, and deadwood volume is reduced to an average of 2.5 m^3/hectare. Nevertheless, in the central part of the complex a small fragment (ca 40 hectares) of beech forest was saved as nature reserve Radecin (Heilige Hale) almost without active management during the last ca 100 years. A much bigger core part of the beech forests was designated (together with the complex of lakes and rivers) as Drawa National Park in 1990. Under the national park status the intensity of intervention strongly decreased and after many discussions the non-intervention approach was expanded to ca 300 hectares of beech forests in the national park in 2000.

The conservation status assessment and biodiversity survey in 2013 showed the following:[27]

- Radecin reserve, after ca 100 years of non-intervention with ca 67 m^3/hectare deadwood is definitely a biodiversity hot-spot, important not only on the local, but also on the regional and national scale. In the whole 1 000 km^2 forest complex Radecin reserve is the crucial habitat of the Hermit Beetle *(Osmoderma eremite)*, hosting >80% of the local beetle population on 0.05% of the local oak-beech forest area. The site, although very small, is hosting a long list of Red List beetles with primeval forest relicts as *Stenagostus rombeus, Platycis cosnardi, Triplax elongata* and *Kiklioacalles navieresi*. The same is true for other biodiversity components: the site is an extremely important hot-spot also for rare and endangered species of epiphytic mosses, lichens and fungi. Some species have the only regional (north-western Polish) localities there. The local conservation status of the habitat Asperulo-Fagetum beech forests (9130) was assessed as perfect, with all structures and functions typical for beech forest present. There is a natural 'small-scale' disturbance regime of forest dynamics. This is based on small canopy gaps after death or breaking of single trees, resulting mosaic of oak-beech stands of different development phases.

- The beech forests have become significantly more valuable after 10 to 20 years of non-intervention management. Ca 30 m^3/hectare of deadwood was accumulated. There is evident and significant expansion of some species typical for natural forests in these stands. The biodiversity of beetles and fungi, even after so short a time, is 2–3 times higher than in the adjacent commercial beech forests.

- The beech forests outside the national park, for which "management as usual" was applied till now, are biodiversity poor, although they still have the potential to restore their original biodiversity. Key structural elements (old trees, deadwood and broken trees) are almost absent here and the average amount of deadwood is 2.5 m^3/hectare. Nevertheless, if a single element of deadwood exists, it is usually used by rare species. The biodiversity regeneration potential in the forest complex is probably maintained by the existence of such refugia as Radecin reserve.



Beech forest in Drawa Great Forest, Poland. *Left to right:* after ca 100 years of non intervention: biodiversity hot-spot; after 15 years of non intervention: biodiversity recovering; managed beech forest: poor with biodiversity

In the new management plan, which is in preparation in 2013, the non-intervention approach will be extended for the whole beech and oak forest area in the Drawa National Park (ca 1 800 hectares) as probably the best way to the restoration of this habitat's original biodiversity. For the managed forests around the national park some other conservation measures will be proposed such as saving the retention tree biogroupes, small biodiversity refuges and no-take belts along the streams, rivers and lake banks (micro non-intervention areas covering 5–10% of the managed forest area). Nevertheless, although the state ownership of almost all forests creates a good opportunity to improve conservation status, and the scientific justification of the conservation needs seems to be strong, the opposition of state foresters against each change of the usual management is significant and the final solutions are still discussed.

The Drawa beech forests are also designated as Lasy Puszczy and Drawa PLB320016 Special Protection Area for birds. The non-intervention approach creates a perfect habitat for most of forest birds protected here, such as woodpeckers, the Red-breasted Flycatcher, the Eagle Owl, the Black Stork and others.

Light Forests

A light forest is characterized by sparse stands of trees so sunshine penetrates the forest down to the ground level over large parts of the day. As a result there is a well-developed grass and herb layer. Additionally, there is a layer of shrubs and young trees; this may be sparse or rather dense. All layers (including mature trees) are influenced by direct sunshine, which makes these forests unique habitats. As this main feature of light forests is neither reflected by phyto-sociological units nor by habitats of the Habitats Directive, light forests may belong to several of the units of these classification systems.

Importance for biodiversity

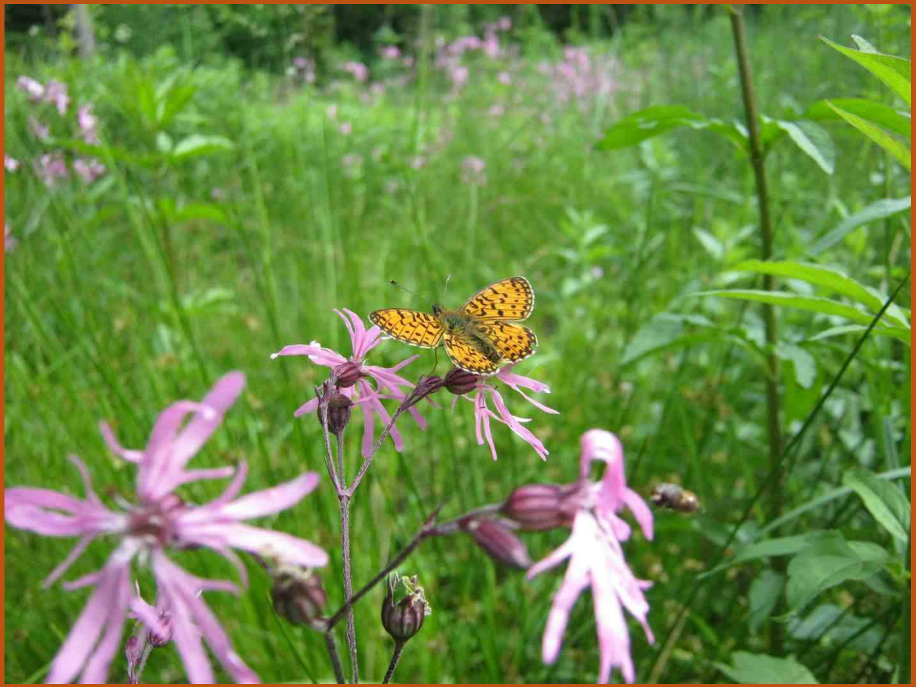
Light forests and their importance for biodiversity are well-known from Central and North-Western Europe. Several publications summarize clear results supporting this.[28] In light forests unique habitat conditions are found which harbour large numbers of specialized species not found elsewhere. Examples include xylobiontic (saproxylic) beetles, butterflies, moths and ants. These are usually forest-dwelling species which need the combination of some typical forest features with sunshine and warm conditions. It is most obvious with xylobiontic beetles which need wood of their host tree under warm and sunny conditions for their reproduction. Light forests are species-rich and rich in species of regional and national Red Data books. A study in Germany, for example, revealed more than 400 species of xylobiontic beetles and almost 300 species of moths including a high percentage of species listed in Red Data

Books. Studies of butterflies and ants produced similar results. Moreover, in all groups large numbers of endangered and specialized species were included. Light forests present clearly a unique habitat quality that harbours a good proportion of European biodiversity.

Management options

Light forests may be formed by natural dynamics (e.g. river dynamics, pest outbreaks, grazing of ungulates), abiotic conditions (e.g. steep slopes, surplus or lack of water, local late frosts) and human influences. This brochure focuses on the last option. Human influences are mainly different land use practices which have to be supported and maintained adequately to preserve the specific biodiversity of light forests. Two important traditional land use practices that maintain light forests are coppicing and forest grazing. These kinds of traditional management systems are often labeled as "not sustainable", as their productivity of timber may be low, but they may produce some secondary forest and agricultural products and, most importantly, unique habitats.

Even under normal forestry, patches of light forest may be integrated in the economic system, e.g. along forest roads, at forest edges or along rivers as part of an ecological management. Light forests supplement strategies that highlight the importance of old-growth forests. Both strategies are important and are beneficial for contrasting sets of species. Both strategies form habitats that harbour large numbers of endangered and specialized parts of European biodiversity.



Boloria euphrosyne,
a butterfly species of light forests

Coppicing with standards, few years after the cut of firewood

Zygaena osterodensis is a brightly coloured and day-flying species of light forests, which systematically belongs to the micro-moths

Example 1: Coppice with Standards in Bavaria, Germany

The Bavarian Conservation Programme for Forests started the project 'action plan for light-penetrated forests' with open canopies, e.g. managed as coppice with standards. The action plan was established by the Bavarian Environmental Protection Agency (Bayerisches Landesamt für Umwelt, LfU), Augsburg. The aim of the action plan was to identify the habitat requirements of rare and endangered species of the studied light-penetrated forests (coppice with standards) and to establish a standard procedure to detect and conserve these species and their habitats.

The steps of species action plan:

1. Identifying ecological requirements of endangered species in coppice with standards
2. Generating a list of important habitat types
3. Identification of indicator species
4. Development of a standard procedure for rapid evaluation of individual forests
5. Application of the standard procedure

With the emphasis of conservation efforts to forests used as coppice with standards, a type of forest use was chosen which has declined at an immense rate in Bavaria. In contrast to this decline in Bavaria (and elsewhere), efforts have been undertaken to re-establish coppice with standards, e.g. in southwest Germany near Freiburg, and the conservation value of this forest type has been recognized. As an ancient form of forest use with traditional regulations, coppice with standards also attracts interest in its historical and sociological value.[29]

Coppice with standards, after cutting the undergrowth for fire-wood. Thin twigs are visible, which remain on the site.

The action plan has been successful in defining conservation needs and priorities and translating them into measures to improve the situation in the forest. An extremely light canopy cover of 5–30% in parts of the forest plays a key role for specific biodiversity; some additional structures such as nectar sources, shrub diversity and distribution, gaps, old trees, etc. add to habitat quality.
A close cooperation with the forest users was established so that future developments in the forests will happen in accordance with conservation authorities. As a result of the action plan a financial support tool within the Bavarian Support Programme for Nature Conservation by Contract for forests (Vertragsnaturschutz-Programm Wald, abbreviated to 'VNP Wald') was developed and is applied now. It helps to maintain coppicing and strengthens the contact of villagers with conservation authorities and forestry. In some cases (e.g. coppice with standards in the "Steigerwald" region) close contacts and joint willingness to overcome difficulties together already form a new pride of local people in species richness and occurrence of rare species in their forests.

Example 2: Forest grazing in Bükki National Park, Hungary

Grazed forests in Hungary were developed by traditional agriculture typically on foothills and slopes originally covered with zonal forests. Solitary trees do not form a closed canopy, allowing for the development of light-penetrated patches with dense herbaceous vegetation between the trees. These grassland patches are sustained by grazing. This system allows for a longer grazing period throughout the year because unlike open grasslands, these grassland patches, being protected by the shades of trees, are less vulnerable to the summer droughts, staying fresh and green until much later.

Managed for centuries, grazed forests have developed a unique community of closed forest species coexisting with species of open grazed habitats and those now rare species which have been connected to traditional agriculture. Traditionally-grazed forests consist of old trees and thus provide habitats to rare beetle species *(Osmoderma eremita, Cucujus cinnabarinus)*. The combination of old trees and grazing animals favour the bird Hoopoe *(Upupa epops)*. The habitat is preferred by grassland species too, such as the Suslik *(Spermophilus citellus)*, several species of scarab beetles *(Scarabaeidae)* feeding on dung, the larvae of which serves as prey of rare species of rove beetles *(Staphylinidae)*. Once the extensive grazing is abandoned, the grazed forest – having been created and maintained by management – undergoes natural succession of shrubs and trees. Within a few decades the habitat turns into closed canopy zonal forest, losing a significant part of its biodiversity along with the cultural heritage of a management system practiced for centuries. This process, adverse from a conservation point of view, can be reversed by habitat restoration and by maintaining traditional management systems.

Grazed 'Hidegkút-laposa' forest in Bükki National Park

The grazing forest 'Hidegkút-laposa' consists of Turkish Oaks *(Quercus cerris)* and Sessile Oaks *(Quercus petraea)* which are more than a hundred years old. The traditional management had been abandoned for decades resulting in succession of shrubs and Turkish Oaks overgrowing grassland patches. Habitat restoration has been performed on more than 200 hectares so far including an initial cutting of the young trees and shrubs and supporting the recovering herb layer with regular mowing. After strengthening the herb layer grazing with Hungarian Grey Cattle was reintroduced in 2005 with 60 animals (to be increased to approximately 100). Management is implemented by a local farmer under the supervision of the National Park Directorate. Information about the site is available on the website of the Bükki National Park Directorate and upon request.[30]

Ecological coherence

In the context of the Nature Directives and at the scale of the whole Natura 2000 network coherence is achieved when the full range of variation in valued features is represented; replication of specific features occurs at different sites over a wide geographic area; dispersal, migration and genetic exchange of individuals is possible between relevant sites; all critical areas for rare, highly-threatened and endemic species are included; and the network is resilient to disturbance or damage caused by natural and anthropogenic factors.[31]

Management for coherence

Aiming for ecological coherence involves protection of species and habitats of European importance within designated sites and outside, in the wider landscape. The quality of current sites can be improved by increasing the number or size of sites, improving habitat management and reducing pressures originating from the wider environment by designating buffer zones. In the wider landscape it is necessary to ensure ecological connectivity between sites. Aiming for connectivity of the landscape can have slightly different interpretations within Europe. In the highly fragmented landscapes of Central and Western Europe mostly the network approach is applied which enhances connections between sites by defining core areas and physical corridors or 'stepping stones'.[32]
This is reflected in Article 10 of the Habitats Directive,[33] provisioning that *Member States shall endeavour to improve the ecological coherence of Natura 2000 by maintaining, and where appropriate developing, features of the landscape which are of major importance for wild fauna and flora. Such features are those which, by virtue of their linear and continuous structure (such as rivers with their banks or the traditional systems for marking field boundaries) or their function as stepping stones (such as ponds or small woods), are essential for the migration, dispersal and genetic exchange of wild species.*

In Europe the network approach is applied through the Pan-European Ecological Network (PEEN),[34] as part of the Pan-European Biological and Landscape Diversity Strategy (PEBLDS) and the Natura 2000 network at EU scale. At regional, trans-boundary, national and local scales there are many examples for ecological corridors and networks throughout Europe. Regarding Central and Eastern Europe, CEEweb published the study Assessing Green Infrastructure Elements in the Visegrad Countries.[35]

Enhancing ecological coherence is one of the goals of the EU Biodiversity Strategy,[36] envisaging in its Target 2 *ecosystems and their services to be maintained and enhanced by establishing green infrastructure and restoring at least 15% of degraded ecosystems by 2020.* In 2013 the European Commission adopted its Green Infrastructure Strategy[37] *to promote the deployment of green infrastructure in the EU in urban and rural areas.* For the help of planners and managers, the related guidance is already available:

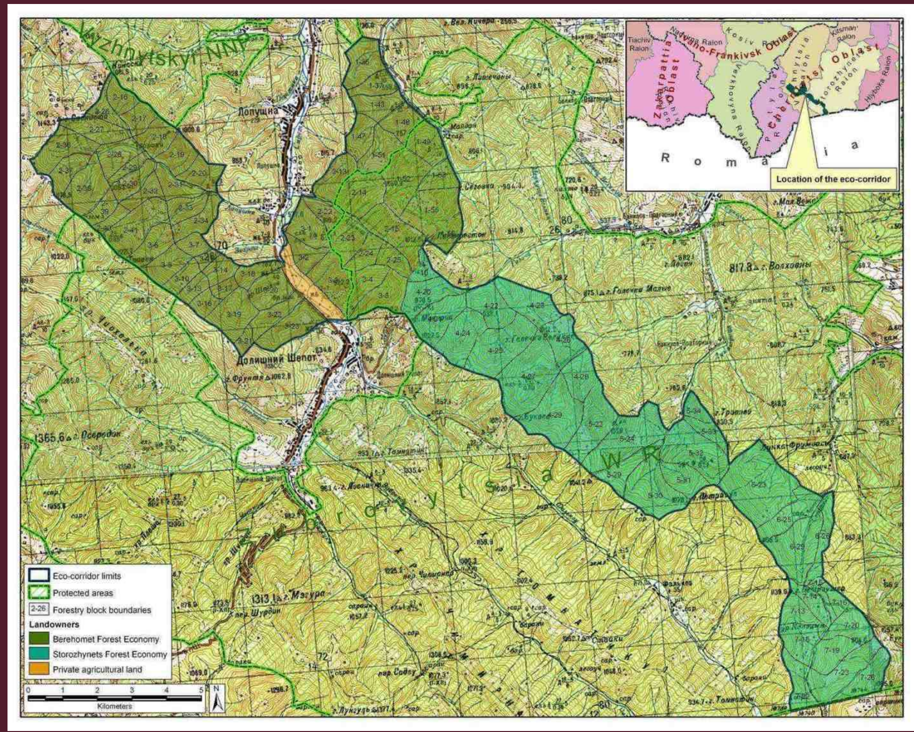
- Guidance on the maintenance of landscape connectivity features of major importance for wild flora and fauna[38]
- Note by DG Environment Towards Better Environmental Options for Flood risk management[39]
- Natural Water Retention Measures[40]
- Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment[41]
- Guide to Multi-Benefit Cohesion Policy Investments in Nature and Green Infrastructure[42]

Example 1: Realizing trans-boundary ecological connectivity in the Ukrainian Carpathians[43]

This example shows a design-led process for establishing trans-boundary ecological corridors intended to meet specific conservation goals through habitat suitability modeling, defining functionally-linked habitat patches and identifying management strategies. The purpose of the project was the development of practices for the establishment of trilateral trans-boundary ecological corridors for large mammals in two pilot exercises connecting Skoilivski Beskydy National Park and Vyzhnytskyi National Park in Ukraine with the nearest protected areas in Poland (East Carpathian Biosphere Reserve) and Romania (Muntii Rodnei NP or Vanatori NP) in order to enhance existing policy instrument and their implementation. Actions carried out by the project were the following.[44]

- Organize a kick-off meeting with key stakeholders on wildlife, protected areas, land use and spatial planning from all three sides of the border.
- Elaborate a work plan.
- Delineate a study area.
- Identify reference species (The Brown Bear, the European Bison, the Wild Cat and the Lynx).
- Identify habitat requirement parameters of reference species (through expert assessment) to be used for modeling and mapping of corridors.

- Develop a model producing GIS (ArcGIS) habitat preference maps of the reference species based on their identified habitat requirements, using a landscape classification method provided by the Humboldt University of Berlin.
- Collect field and literature data for inputs into the model.
- Elaborate corridor scenarios using GIS (Corridor Designer) with GIS layers on habitat preference, settlement, infrastructure, land use, land status and ownership.
- Acquire additional information from consultations with relevant government agencies and other stakeholders.
- Review established corridor scenarios.
- Agree on location of final corridors during a meeting with experts and stakeholders.
- Identify corridor units, each characterized by specific land use and ownership issues requiring a specific management strategy.
- Elaborate needs and conditions for each unit to achieve a sustainable "conductivity" regime for wildlife, including:
  - new "stepping stone" protected areas,
  - memoranda of understanding with land users/owners,
  - special or adapted infrastructure,
  - compensation mechanisms.
- Estimate costs for the establishment and implementation of these regimes.
- Establish corridors and implement their management by local competent authorities, land users, owners and managers through



Map of the trilateral trans-boundary ecological corridor

instruments such as Memorandum of Understanding, funding mechanisms, management plans, ecological infrastructure design and fundraising.

- Evaluate carried-out measures and determine a strategy to complete the ecological corridors, including a follow-up.
- Compile policy recommendations and lessons learned and share them with policymakers concerned.

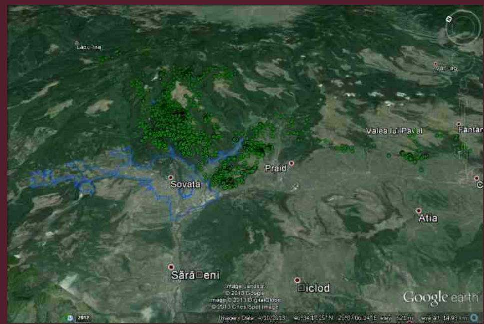
Example 2: Protecting movement corridor of large carnivores between Continental and Alpine SCIs by involving NGOs in local planning in Romania

This example shows how quantitative evaluation of species moving through a landscape can be used to assist landscape development planning at local and regional scales with the aim of securing connectivity between populations or important localities of that particular species.

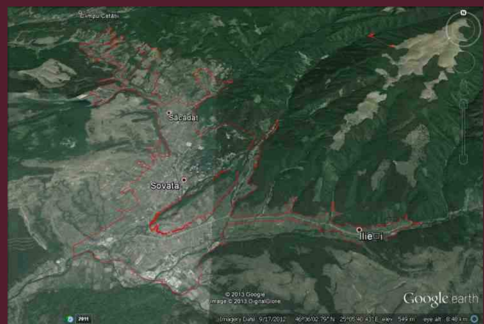
The SCI Dealurile Târnavei Mici–Biches (ROSCI0297) was designated as one of the most important Natura 2000 sites from the Continental bioregion in Romania for the protection of large carnivores (mainly that of the Brown Bear and the Wolf). For the long-term persistence of the two species in the site, it is essential that the site maintains a functional ecological connection to the neighboring mountainous area, most notably to the SCI Călimani-Gurghiu (ROSCI0019, part of Romania's Eastern Carpathians) located in the Alpine biogeographical region.

At the meeting point of the two areas there is a popular resort (the SPA town of Sovata) which is in continuous expansion.
To preserve functional connectivity between the two sites, during the revision of the Resettlement Plans of the localities Sovata and Eremitu, the NGO Milvus Group (the responsible body for the administration of SCI Târnavei Mici–Biches) asked for the most crucial movement corridors to be excluded from the Resettlement Plans. Arguments were based on concrete telemetry data from that specific area coming from brown bears fitted with GPS-GSM collars (VECTRONIC Aerospace, model GPS Pro Light 4) in 2013 in the frame of a project implemented by the Milvus Group.[45]

A Brown bear wearing a radio collar near the town of Sovata, Romania



The urban area of Sovata town and the movement of collared bears



The planned urban area of Sovata town, adjusted to Brown Bear movements

Recommendations and conclusions

In line with the provisions of the Habitats Directive, management of Natura 2000 sites should contribute to achieving the Favourable Conservation Status of the listed habitats across the biogeographic region and at national level. This is a rather wide scale which has to be downscaled to site level by setting specific conservation objectives for each site through the management planning process. The so-identified individual conservation objectives must be achieved by daily management practices. This brochure aims to provide cases for planners and managers as inspiring examples which may help define particular management options in relation to the conservation objectives of their forest sites. Recommendations along the four highlighted issues can be summarized as below:

1. Wilderness and non-intervention management

- Manifestations of natural ecosystem dynamics should be considered as part of the Favourable Conservation Status of natural habitats (including most of forest habitats) at the biogeographic region scale. For achieving and maintaining FCS, at least part of the habitat resources should be managed by natural processes. This is necessary for maintaining at least examples of natural dynamics typical for the habitat type (including natural disturbances) and in most cases it is useful for maintaining the full spectrum of habitat-related biodiversity.
- Non-intervention management provides, in most cases, important conservation advantages as well as societal benefits such as tourism and other cultural ecosystem services. Therefore, for natural habitats and especially for natural forest habitats, non-intervention management should be always considered as one of the management options. Application of the non-intervention approach should be decided locally at site level, taking into consideration ecological, social and economical requirements. In case of sites which are designated for nature conservation as a priority and where there are no conservation advantages of intervention and active management, non-intervention should be a priority option (such as in national parks, nature reserves and other protected areas of IUCN category I and II).
- Although non-intervention management is most relevant for the best-preserved primary natural habitats, this approach may also be in some cases useful for habitat restoration. In many cases, natural processes can restore natural structure and even species composition of forests, in a better and cheaper (although normally not faster) way than active restoration measures.

2. Management for deadwood retention

- Deadwood should be clearly expressed as an important structural feature of forest habitats necessary for maintaining the habitat-related biodiversity and as element of "structure and function". In Natura 2000 sites detailed assessment of deadwood resources should be carried out, estimating not only the average amount but also the spatial distribution and the quality of deadwood. Restoring or maintaining sufficient quantity and quality of deadwood should be part of the conservation objectives of forest habitats. To set a target for achieving sufficient quantity and quality of deadwood ecological requirements must be taken into account considering the scientifically-based thresholds.

- Restoring and maintaining sufficient deadwood resources in the forest requires not only leaving the actual dead trees on the site but also broken, uprooted and dying trees and saving retention trees and group of trees for ensuring the development of future old trees and future coarse deadwood production. Consistent saving of all trees providing "microdeadwood" microhabitats is also necessary. There is a need to change the attitude towards forest pests which at least in some cases should not be considered a natural disaster but an opportunity to restore deadwood and deadwood-related biodiversity.

3. Light forest

- Light forests are extremely important habitats of European biodiversity harbouring not only large numbers of species, but also specialized species. It has to be accepted that forests with few trees, many gaps and grass- and herb-rich undergrowth are valuable forests, even if they do not produce much timber and thus may be economically challenging. Traditional forest uses such as coppicing and forest grazing must be maintained and supported, especially if local communities still perform this land use or if species or habitats of light forests are still present.

4. Ecological coherence

- In Northern, Eastern and South Eastern Europe there are larger coherent natural areas which are still relatively intact but are coming under increasing pressure. In these regions landscape connectivity can be achieved by reducing the overall pressures on wildlife through improving their wider environment. The conservation goal there is to protect existing patterns of coherence of large ecosystems.[46] In these cases the goal of the network is to guide the region's development strategy so that conflicts with ecosystem processes and valuable concentrations of biodiversity are possibly avoided.[47] It is important to consider this, in order to ensure that significant funding is not diverted to enhance connections and create new sites before fundamental site management issues have been addressed in the core network areas. Protecting ecosystems at the landscape scale requires an integrated approach involving a number of key policy areas such as regional development, climate change, disaster prevention and resilience, agriculture, forestry, urban, water, and biodiversity protection and enhancement.

It is important to emphasize that in all cases there is a need for an economic framework which allows the implementation of these measures. Uptake of existing funding mechanisms, such as forest-environmental schemes, must be improved and new and innovative funding mechanisms must be explored. It is also important to highlight that conservation measures, along with their obvious conservation benefits, often provide economic opportunities and local livelihood. Therefore, a review of socio-economic costs and benefits of different management options, including the ecosystem services they provide, is recommended. Another important aspect is the good cooperation between the conservation sector and forestry, agriculture and other stakeholders at site level as well as across borders. Cross-border harmonization of conservation objectives and site-management is always recommended in case of forested landscapes reaching across national borders. There is vast amount of experience and knowledge at national and local level, often only available in national language. It is crucial to make this knowledge available for a wider audience. NGOs welcome recent EU processes such as the biogeographic process aiming, among other goals, to share such knowledge and they are ready to contribute to these processes by offering their national and local experiences.

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Wilderness and non-intervention management

Management for deadwood retention

Light forests

Ecological coherence

CEEweb for Biodiversity is an international network of non-governmental organizations in Central and Eastern Europe. The mission of the network is the conservation of biodiversity through the promotion of sustainable development.