10 messages for 2010
Forest ecosystems

European Environment Agency

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This document is the 5th in a series of assessments under the title '10 messages for 2010'. Each message provides a short assessment focusing on a specific ecosystem or issue related to biodiversity in Europe. The remaining messages will be published at various intervals throughout 2010. More detailed information on the published and forthcoming messages can be found at www.eea.europa.eu/publications/10-messages-for-2010.

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Forest ecosystems

Key messages

- Forests cover a large part of Europe but the distribution of such ecosystems varies significantly across the continent. They fulfil multiple functions for society, providing economic, social and environmental benefits, including serving as a key reservoir of biodiversity.
- Old growth natural and semi-natural forests are the most valuable forest type in terms of storing biodiversity (including genetic variety) and carbon.
- Unsustainable forest management, fragmentation, airborne pollution and climate change are major threats to Europe's forest biodiversity. Interacting pressures on forest ecosystems are threatening species and habitats of European interest.
- Using protected areas and other management measures, European countries are protecting and restoring their forest biodiversity. In addition, citizens are increasingly recognised as key stewards of Europe's forests.
- Ensuring that actions in 2011, the International Year of Forests, are consistent with and support actions in 2010, the International Year of Biodiversity, will be a challenge.

1 Forests cover a large part of Europe and fulfil multiple functions for society, providing economic, social and environmental benefits, including serving as a key reservoir of biodiversity

As Map 1 illustrates, the distribution and extent of forests ([1]) varies significantly in different regions of the EU.

The area of forest increased slightly in most MCPFE countries between 1990 and 2005, mainly on former agricultural land (MCPFE, 2007). About 50 % of European forests in the MCPFE countries are predominantly coniferous, 25 % are broadleaved and 25 % are mixed (MCPFE, 2007). Seventy per cent of the forests in MCPFE countries are mixed forests of two or several tree species, with the remaining 30 % consisting of a single tree species (MCPFE, 2007).

Forests provide a wide range of services. They protect soils from erosion, and regulate watersheds and local hydrological systems by reducing variations in water flows. They regulate the local, regional and global climate, store carbon, and purify air and freshwater. Forests are important biodiversity repositories with the greatest assemblage of species found in any terrestrial ecosystem. Forest ecosystems also supply numerous social and cultural services. They are part of our cultural and historical heritage, and wooded lands represent a privileged place for outdoor recreation and leisure. Forest goods include wood (such as harvested timber, deadwood, bark and cork) and non-wood products (including berries, mushrooms and game) (Stenger *et al.*, 2008).

Soil biodiversity in forests plays a crucial role in ecosystem regulating services. In addition to

([1]) UN-ECE/FAO (2000) defines forests as 'Land with tree crown cover (or equivalent stocking level) of more than 10 percent and area of more than 0.5 ha. The trees should be able to reach a minimum height of 5 m at maturity *in situ*'.

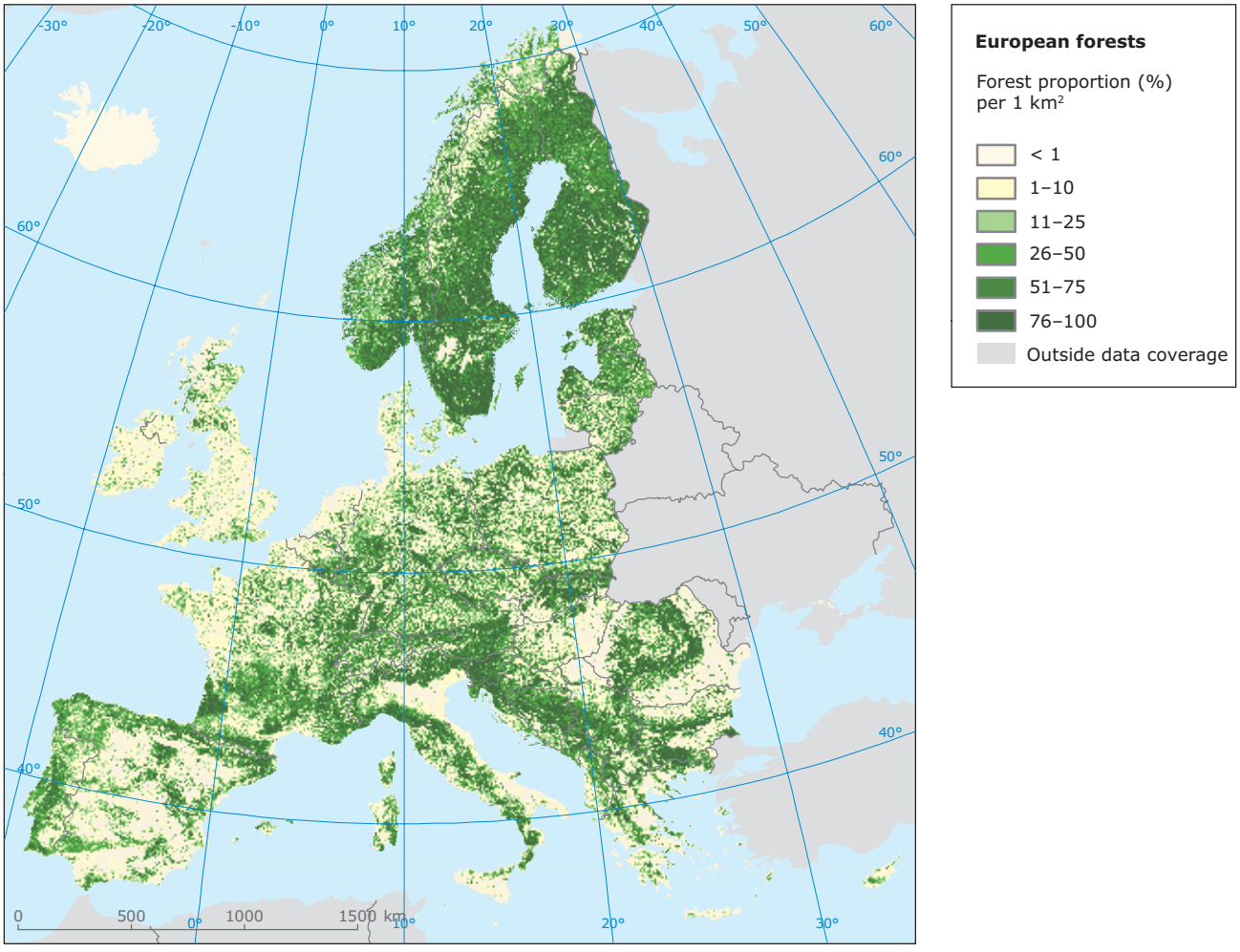
Forests in Europe — some facts and figures

- The 46 European countries participating in the Ministerial Conference on the Protection of Forests in Europe (MCPFE) contain 25 % of the world's forests.
- 80 % of European forests are located in the Russian Federation (MCPFE, 2007).
- In EEA member and collaborating countries, forests today cover 33 % of the land area, which corresponds to 185 million ha (EEA, 2008).
- In the EU-27, forests and other wooded land covered 177 million hectares, or 42 % of the land area in 2005 (Eurostat, 2008).
- The largest forest areas are found in Sweden (31 million ha, equivalent to 75 % of the territory), Spain (28 million ha), Finland (23 million ha, 77 % of the territory) and France (17 million ha). The biggest providers of forest timber are Sweden (65 million m^3 annually), Germany and France (62 million m^3 each), Finland (51 million m^3) and Poland (32 million m^3) (Eurostat, 2008).

Data on forests in Europe can be accessed through the European Forest Data Centre at http://efdac.jrc.ec.europa.eu/.

filtering water and pollutants, it decomposes organic material into humus, which stores water and provides nutrients for forest plant growth that also stabilises the ground. A lively forest soil biodiversity becomes even more important for the forest water household and carbon storage in the face of global

Map 1 Forest distribution in Europe based on Corine Land Cover 2000



Source: EC, 2007.

warming and climate change (EEA, 2008; Turbé *et al*., 2010).

Factors such as forest ownership structures and the importance of forestry to national economies can significantly influence forest ecosystem management targets, thereby affecting biodiversity. This is especially the case if either private or public ownership is oriented towards the long-term sustainability of forest utilisation. Overall, about 40 % of forests are publicly owned and around 60 % are in private hands in the EEA region (MCPFE, 2007).

Almost three-quarters of the growing population in the EEA region lives in urban areas and this is expected to rise to 80 % by 2020 (EEA, 2009c). Forests are thus becoming more and more important for delivering essential ecosystem goods and services to urban agglomerations. Forests surrounding and within cities are necessary to provide fresh air and fresh water, and reduce dust and noise. Among other functions, they serve as a micro-climatic buffer around concrete urban heat islands, provide habitats for species and also have recreational purposes (EEA, 2008; EEA, 2009c).

Perceptions of the role of forests and their use depends largely on the national environmental and social conditions — the extent of forests, population density and economic development. According to Abellanas Oar (2009), European forestry falls into three mains types, as presented in Table 1.

The multifunctional role of forests is increasingly recognised, as addressed in the 'Green Paper on Forest Protection and Information in the EU: Preparing forests for climate change', adopted by the European Commission on 1 March 2010 (EC, 2010). The Green Paper highlights the importance of European forests as providers of jobs, income, raw materials for industry and renewable energy. It further specifies that forests protect settlements and infrastructures, thereby improving quality of life.

Recognising these multifunctional roles of forests in Europe may also draw attention to potential tension between different demands. For instance, current bio-energy targets and increased harvesting of biomass in forests are not compatible with the goals of storing carbon and enriching biodiversity by accumulating organic material in forests (Liski and Fritze, 2010; Verkerk *et al*., 2010).

Table 1 Current trends in forestry

Forestry type	Typical context	Perception of the forest	Use	Characteristics
Monofunctional forestry	• Lowland countries mostly in northern Europe, with large forest resources and low population density • Countries with little forest area and mostly artificial forests targeted to production	• Forests considered as primary production units	• Wood production	• Intensive forestry • Minimised exploitation costs • Development and use of heavy engineering • Homogeneous and standardised primary material • Large-scale fellings
Multifunctional forestry	• Countries with limited forest resources and high population density (west and central Europe)	• Forests as a natural ecosystem with multiple productive and social functions	• Gross products (wood) • Protection function (air, soil, water) • Recreation and leisure • Landscape and aesthetic functions • Biodiversity conservation	• 'Close to nature' forestry • Importance given to the ecological implications of interventions • Trade-offs to fulfil several services • Direct production as financial source for forestry
Conservation forestry	• Countries with very little forest areas, highly industrialised and with a high population density	• Forests as a nature reserve with a social function to serve urban population needs	• Environmental benefits (protection and purification) • Biodiversity conservation • Landscape and aesthetical functions • Recreation and leisure	• Conservation forestry • The main objective is to preserve the ecological stability • Direct production is marginal

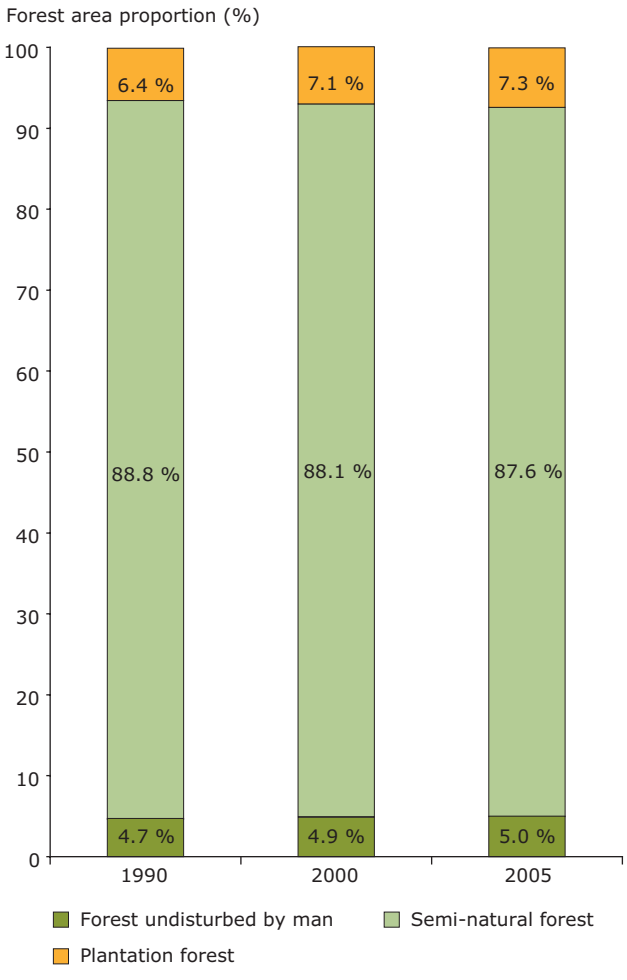
Source: Adapted from Schutz, 1990.

2 Old growth natural and semi-natural forests are the most valuable forest type in terms of storing biodiversity (including genetic variety) and carbon

Throughout Europe, forests can be found of all ages and at all development stages. Some old forests with little recent human impact exist within Europe's often intensively used cultural landscapes. The largest areas of old growth forests in the EU are found in Bulgaria and Romania (Veen *et al.*, 2010).

In the EEA region, about 5 % of forests are undisturbed by man. In the wider MCPFE region, the share of forests undisturbed by man is 23.3 %. The Russian Federation contributes more than half of undisturbed forest in the MCPFE region, i.e. 255 million ha or about 32 % of the country's total forest area (MCPFE, 2007).

Figure 1 Extent of human intervention in Europe's forest ecosystems — data from the 38 EEA member and cooperating countries



Source: EEA, 2008.

Old growth forests are a key repository of biodiversity. Many fungi, lichens, and bryophytes live on dead wood. Similarly, arthropod, mammal and bird species use dead wood as food source and habitat (Verkerk *et al.*, 2010) For forest organisms dependant on dead wood, especially invertebrates, both the quantity and quality are essential. Quality is expressed in the variety of kinds of dead wood (stumps, snags, coarse woody debris), as well as the degree of decay. Many specialised plant and animal species are thus found in old-growth forests (Frank *et al.*, 2009).

Natural successive growth allows woodlands to develop a complex stratification structure of older and younger trees, which provides various niches for fauna and flora. By contrast, plantations are generally characterised by equal age structure and fewer ecological niches (EEA, 2008). Plants and animals that are old growth forest specialists are particularly unlikely to find appropriate conditions to colonise and to reproduce in those plantations with comparatively short rotations (Brockerhoff *et al.*, 2008).

The quantity of deadwood in natural and semi-natural forests depends on many factors. These include tree species composition and structure, development stage, the type and frequency of natural disturbance in the region, the management type, and soil and climate characteristics (EEA, 2008). The amount of deadwood in forests is thus relatively low in northern Europe (where forestry is more intensive) and in dry Mediterranean areas (where forest management techniques are geared towards fire prevention) and highest in central Europe (Verkerk *et al.*, 2010).

With 53 gigatonnes of carbon sequestered in forest biomass and dead wood, the forests of MCPFE countries in Europe are large stores of carbon. In the EU-27, 73 % of carbon stock biomass is above the ground, 20 % is below ground and 7 % resides in dead wood (MCPFE, 2007). With growing age, the total carbon stock of forests increases (Luyssaert *et al.*, 2008).

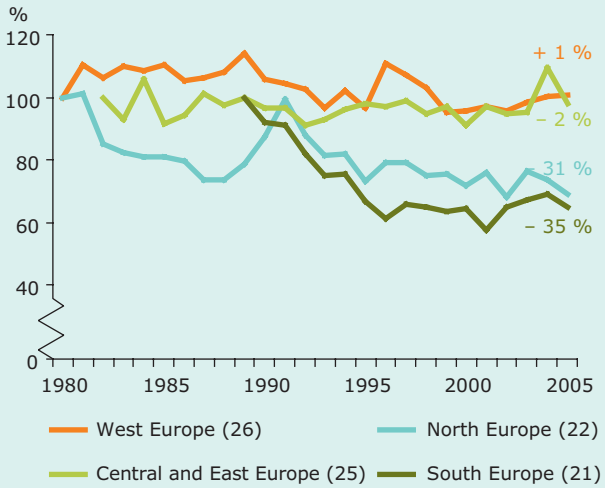
Forests' natural, regionally adapted genetic variety is important for adapting to new environmental conditions such as climate change. The need to increase renewable energy use and carbon sequestration might be arguments for using high production genotypes to increase timber volume but

Common woodland bird species as an indicator of forest diversity trends in Europe

As Figure 2 illustrates, between 1980 and 2005, the population size of common forest bird species declined by 31 % in northern Europe and 35 % in southern Europe while remaining relatively stable in western and eastern Europe.

As a particular example, populations of Lesser-spotted Woodpecker (*Dendrocopos minor*) and the Willow Tit (*Parus montanus*) declined more steeply in western Europe than in central and eastern Europe. Both depend on deciduous forests with old trees and deadwood (EEA, 2008).

Figure 2 Populations of common forest bird species in four European regions



Note: Number of species per indicator in brackets.

Source: PECBM, 2007.

it may lower adaptability to future climate change impacts (Larsson *et al.*, 2007; MCPFE, 2007).

In its fourth Assessment Report, the Intergovernmental Panel on Climate Change (IPCC), states that 'in the longer term, a sustainable forest management strategy aimed at maintaining or increasing forest carbon stocks, while producing an annual sustained yield of timber, fibre or energy from the forest, will generate the largest sustained mitigation benefit' (Metz *et al.*, 2007).

However, as recognised by Luyssaert *et al.* (2008) and addressed by the EU-funded CarboEurope Integrated Project ([2]), old unspoiled forests still absorb carbon. As such, protecting these forests should be a high priority in order to protect the large carbon stocks (EC, 2002).

In mostly semi-natural forests in Europe, efforts to promote carbon sequestration and biodiversity are mutually supportive. The policies can be combined, using long rotation cycles continuously to favour late succession stages and deadwood (EEA, 2008).

3 Unsustainable forest management, fragmentation, airborne pollution and climate change are major threats to Europe's forest biodiversity

Unsustainable forest management

Intensifying forestry by draining wet forests and peatlands, fertilising and introducing forest tree species with differing genotypes negatively affects forest biodiversity in Europe. In addition, it suppresses natural ecosystem processes such as limited fires (EEA, 2008) and natural succession (Kuuluvainen, 2009).

About half of the Europe's peatlands, which hold large carbon stocks and have significant biodiversity value, are the focus of human land use, often combined with drainage. In addition to harming unique peatland habitats and species, this causes peat mineralisation and deterioration of the carbon storage function. Most peatlands in the EU-27 are found in Germany, Ireland, Poland, Scandinavia

([2]) The CarboEurope Integrated Project (www.carboeurope.org) is the world's first research project that coherently and comprehensively integrates terrestrial and atmospheric carbon sciences at the continental scale.

and the United Kingdom. Approximately 20 % are drained for forestry mainly in Scandinavia and the United Kingdom. About half of all European peatlands are located in Russia (Drösler *et al*., 2008).

Abandoning land use management combined with other influences such as air pollution can degrade or destroy culturally and historically important ancient woodlands and associated species. For instance, ancient oak trees, which were pollarded for centuries for wood pasture in England or in the Sierra Grazalema in southern Spain, are habitats for lichen, bryophytes and invertebrate species, sometimes rare and endemic (Rackham, 2008).

Fires can be an important natural disturbance favouring biodiversity, as in the case of boreal forests (Kuuluvainen, 2009). However, their frequency and intensity for short periods of time can also have devastating effects. In some cases, such events can result from deliberate human interventions. In the Mediterranean, for example, forest fires are not only used for traditional management of farmland but for speculative reasons, such as clearing rural land so that it can serve other purposes such as conversion to urban use (WWF/IUCN, 2007).

Fragmentation

Changes in forest coverage and connectivity (area and inter-patch distance) affect biodiversity (e.g. birds, mammals, plants), wildlife migration, seeds dispersal and other ecological factors such as pest propagation. In Europe, the main causes of fragmentation include transport network development, changing land use, logging operations and fires.

As Maps 2 and 3 illustrate, fragmentation (loss of connectivity) in the period 1990–2006 occurred most in south-western and north-eastern Europe. Elsewhere, the connectivity change assessments at province level (Map 2) and at the more local landscape scale (Map 3) both indicated that the connectivity of European forests was generally stable or improved slightly in the period 1990–2006. This is mostly explained by the correlated increase in forest cover and in the permeability of the landscape matrix, resulting from agricultural land abandonment, afforestation, natural vegetation succession and conservation policies across Europe (Estreguil and Mouton, 2009; Estreguil and Caudullo, 2010; Saura *et al*., 2010).

Fragmentation can reduce the habitat size and quality below the levels that forest species require for feeding, breeding, resting and other aspects of their life cycles (EEA, 2009b). Genetic variability also suffers due to reduced migration options (Keller and Largiadèr, 2003).

Large, unfragmented forest areas connect viable meta-populations (interconnected subpopulations of species) and reduce the wood-edge effect of pollutants, noise, predators and micro-climate changes (sunlight, wind, moisture, etc.). This reduces the vulnerability of forest species populations and habitats. It also protects forest ecosystem goods and services from the impacts of natural and unnatural external occurrences, such as fires, windthrow or droughts (EEA, 2008).

In open landscapes such as agricultural fields, a scattered mixture of forest patches combined with hedges as linear elements structures the landscape pleasantly, connects and provides habitats for wood edge species, and protects the open ground from erosion and other deteriorating influences (EEA, 2008).

Air pollution

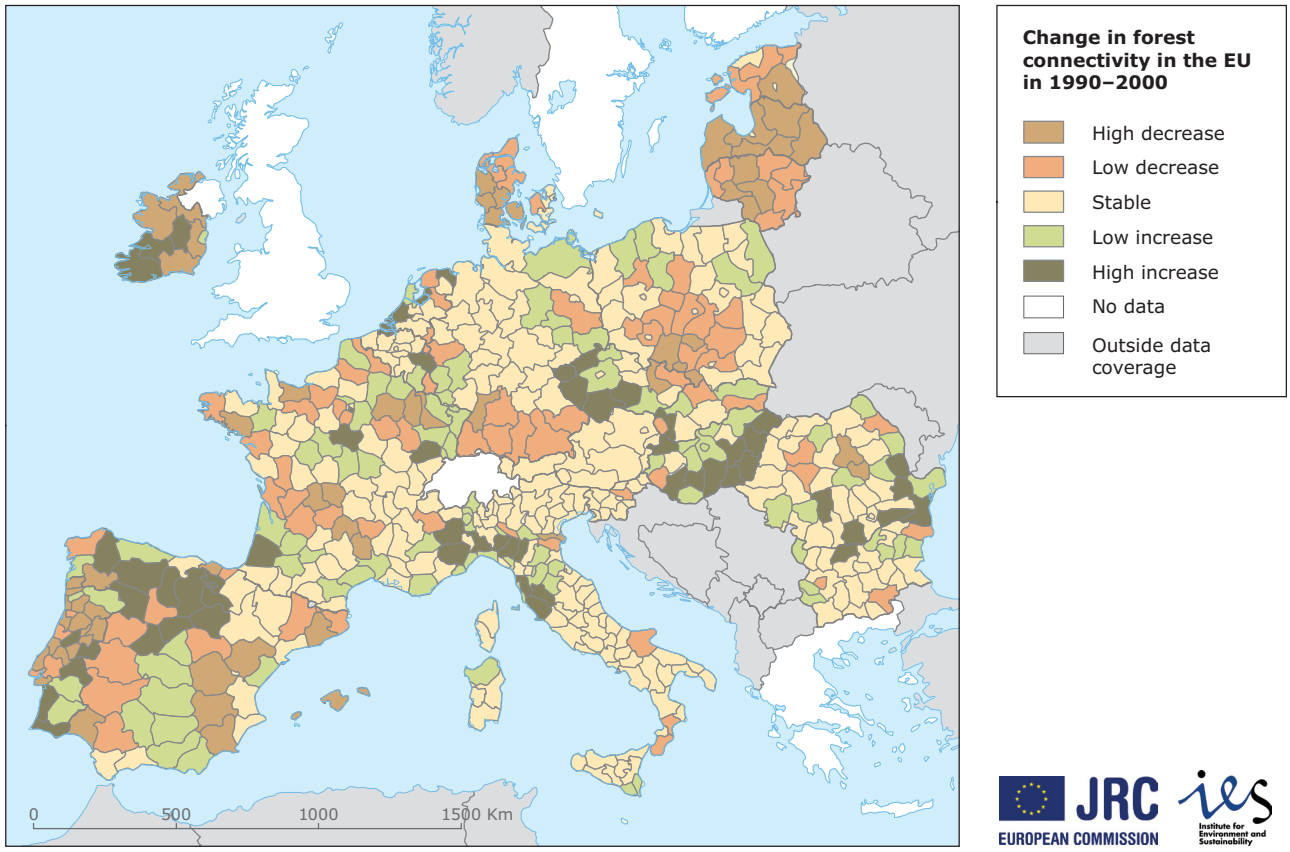
Air pollution and depositions, particularly those of sulphur, have declined in recent years in the 46 MCPFE countries (MCPFE, 2007). However, nitrogen depositions that can lead to eutrophication and acidification (MCPFE, 2007) have overall little changed since 2001. The highest nitrogen levels are measured in central Europe and originate especially from fossil fuel combustion and intensive animal husbandry. Ammonium and nitrate are the main compounds deposited from the air (ICP Forests, 2009).

Forest soil acidification is widespread in Europe, despite being now below critical loads in many countries. It is mainly caused by atmospheric depositions of pollutants that can affect tree roots and soil biodiversity, and impair the supply of nutrients to plants (ICP Forests, 2009). Higher levels of sulphate and nitrogen, and increased soil acidity still persist due to former emissions, making forests more vulnerable to environmental stresses such as climate change and other deteriorating influences (MCPFE, 2007).

Climate change

Climate change is first expected to impact tree species situated at latitudinal and altitudinal extremes in the boreal, Alpine and Mediterranean regions, with less intense effects in continental regions (Hemery, 2008). For instance, models predict that the tree limit of Arctic forests ([3]), will move northwards and towards higher altitudes during the next 100 years (Wolf *et al*.,

Map 2 Change in forest connectivity in the EU, 1990–2000



Note: Data from Corine Land Cover (CLC) for the years 1990 and 2000; results aggregated per provinces (Nuts 2/3).

Source: Estreguil and Mouton, 2009; Saura *et al.*, 2010.

2008). Habitat humidity changes are correlated with global environmental changes. Thus, forest wetlands are among the habitats most sensitive to climate change (Czerepko, 2008).

Increased storms, forest fires, flooding events and drought periods can be expected due to climate change, with a severe impact on European forests (Lindner *et al.*, 2010). Increased periods of drought and warmer winters are likely to weaken forests further and support invasive species. In addition to the climate change effects already mentioned, changes to forest growth and phenology, and species composition can be foreseen. Combined, these pressures will also alter the pattern of forest cover (EEA-JRC-WHO, 2008).

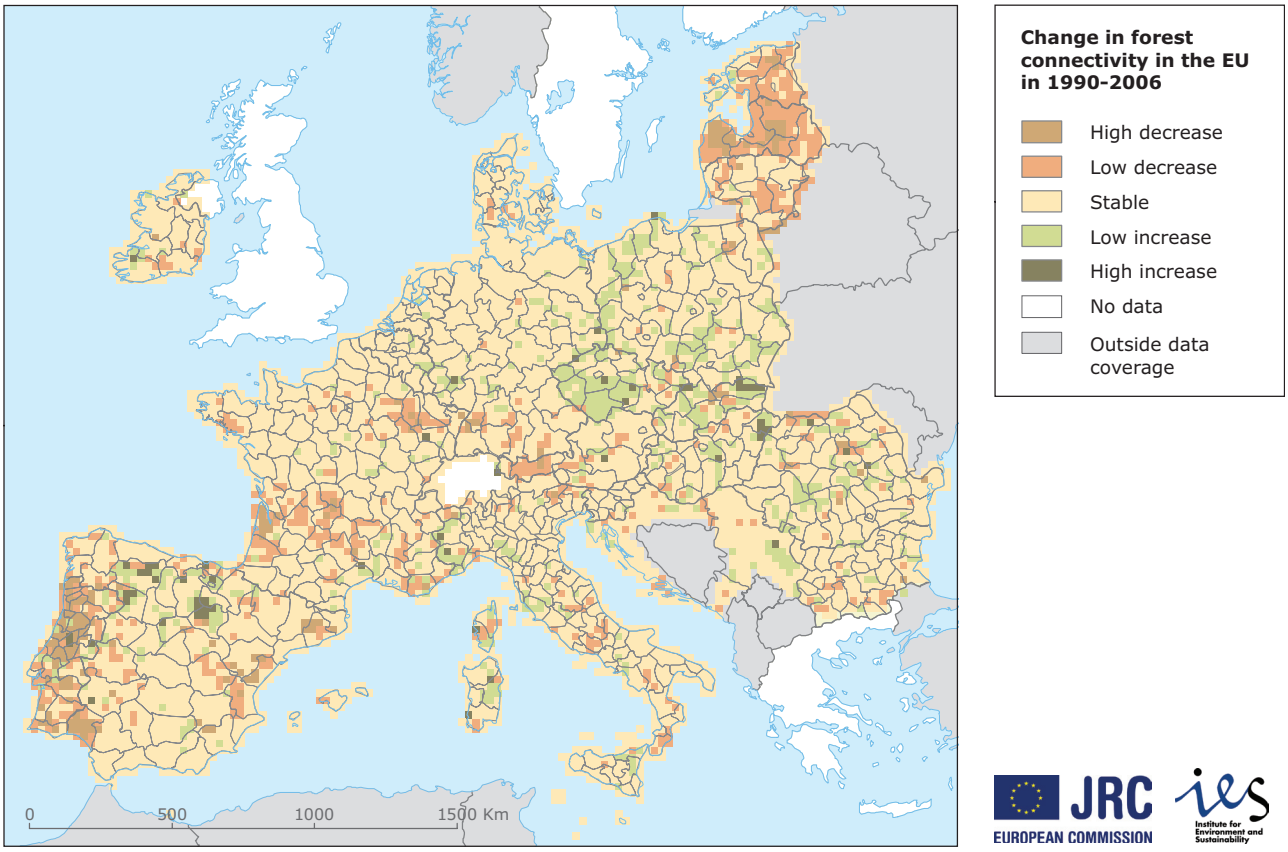
There is regional variation in the vulnerability of Europe's forests to climate change and expected changes in forest ecosystems (Lindner *et al.*, 2010). For instance, Alpine forests play an important role in protecting settlements and infrastructure, preventing floods and storing water following heavy rainfall. They are likely to be severely affected by changes in the Alpine hydrological cycle affecting precipitation and snow and glacier cover. Temperatures in the Alps have increased exceptionally rapidly, rising by around 2 °C between the late nineteenth and early twenty-first centuries (EEA, 2009a).

4 Interacting pressures on forest ecosystems are threatening species and habitats of European interest

Nearly 170 species of European interest (indentified in the EC Habitats Directive) are linked to forest ecosystems. According to current knowledge, IUCN estimates that 27 % of mammals, 10 % of reptiles and 8 % of amphibians related to forests are threatened

([3]) Using the Arctic Monitoring and Assessment Programme definition of the Arctic (AMAP, 2003).

Map 3 Change in forest connectivity in the EU, 1990–2006



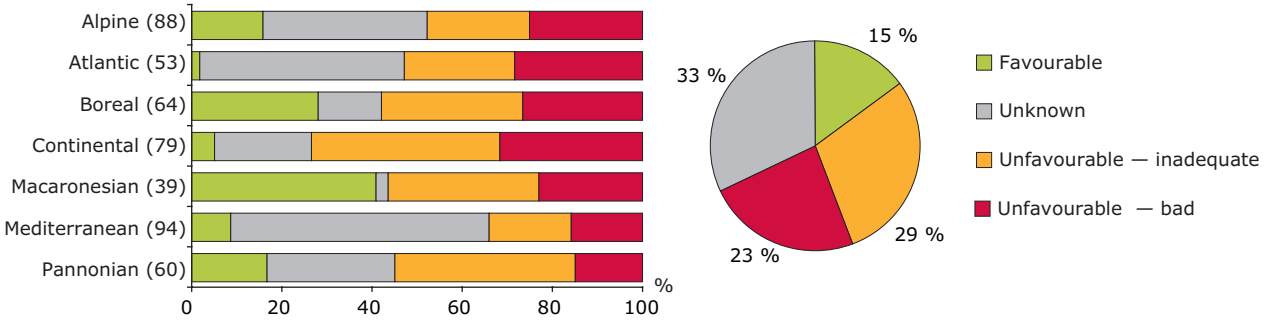
Note: Data from Corine Land Cover (CLC) for the years 1990 and 2006; results aggregated per landscape units of 25 x 25 km².

Source: Estreguil and Caudullo, 2010.

with extinction in the EU region (ETC/BD, 2010, based on IUCN, 2009).

EU Member State reporting pursuant to the Habitats Directive (EC, 2009) shows that 52 % of species of Community interest that prefer forest ecosystems are in 'unfavourable conservation status' (Figure 3). Only 15 % of the assessments report a favourable conservation status. The Macaronesian and Boreal regions report the highest percentage of favourable assessments (approximately one-third of all assessments).

Figure 3 Conservation status of species of Community interest that prefer forest ecosystems listed in the EU Habitats Directive in the EU-25



Note: The number of assessments is indicated in brackets. Only species of Annex II and Annex IV of the EU Habitats Directive are considered in this analysis.

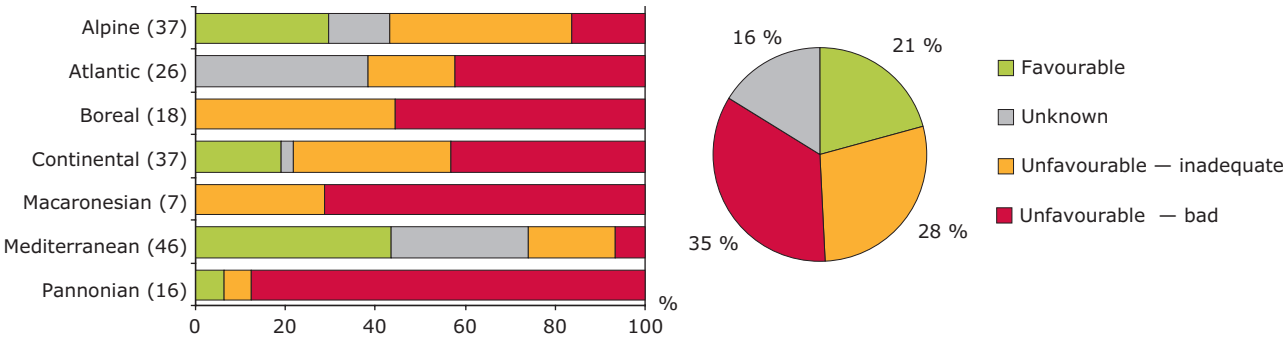
Source: ETC/BD, 2008.

The introduced pathogen species *Phytopthora ramorum* of woody plants in Europe

Nineteen EU Member States, as well as Norway and Switzerland, have reported and taken official measures to control the pathogen *Phytophthora ramorum* — an invasive alien species (RAPRA, 2009). Introduced into at least eight European countries by movement of plant stock, it can spread on rhododendrons and other shrubs in nurseries and woodland gardens.

Native oaks (Quercus and Lithocarpus spp.) have been affected by rapid mortality via stem bleeding cankers in California and Oregon, USA. It also causes leaf blights or dieback of many canopy trees, and understory shrubs (Brasier *et al*., 2004). Affected US states have a similar climate to Mediterranean countries, although other parts of Europe with less similar climates also appear to be at risk (RAPRA, 2009).

Figure 4 Conservation status of forest-related habitat types of Community interest listed in the EU Habitats Directive in the EU-25



Note: The number of assessments is indicated in brackets.

Source: ETC/BD, 2008.

Even more worrying, of the 73 forest habitat types listed in the EC Habitats Directive that were assessed, 63 % held 'unfavourable' conservation status, while just 21 % were 'favourable' (Figure 4). In contrast to the situation with respect to species, the highest percentage of favourable assessment was in the Mediterranean and the Alpine regions, with no favourable assessments reported in the Macaronesian, Boreal and Atlantic regions.

5 European countries have taken measures to protect and restore forest biodiversity in Europe

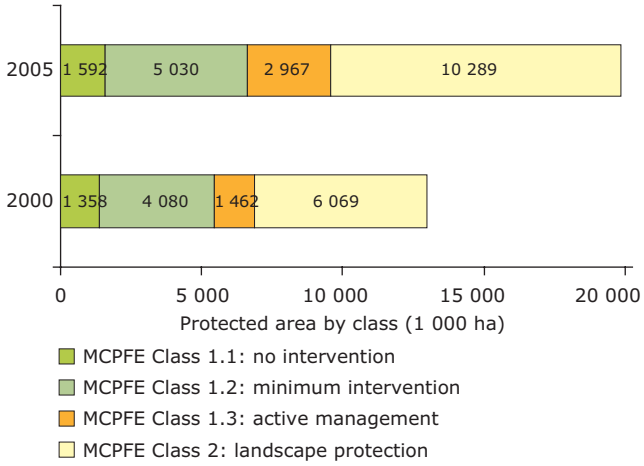
According to the Vienna Resolution 4, adopted at the Fourth Ministerial Conference on the Protection of Forests in Europe in 2003, 41 European countries and the European Community committed (among other things) to:

> 'promote, as appropriate, the restoration of forest biological diversity in degraded forests and forests established on former forestlands or other landscapes, including plantations, and enhance incentives to promote natural regeneration and regeneration with native tree species and provenances;
> 'prevent and to mitigate losses of forest biological diversity due to fragmentation and conversion to other land uses and maintain and establish ecological connectivity, where appropriate;
> 'promote forest management planning and practices and landscape planning that is specifically suited to maintain, conserve, restore and enhance forest biological diversity, making use of the natural processes of forests.'
> (MCPFE, 2003).

Countries have also afforded special protection to certain forests and other wooded land (Figure 5).

With about one third of the Natura 2000 network total land surface area covered with forests (ETC/BD, 2008), this network supported by the EC Birds and Habitats Directive Habitats Directives,

Figure 5 **Protected area and management strategies of forests and other wooded land for conserving biodiversity, landscapes, and specific natural elements in the 39 EEA member and cooperating countries, 2000 and 2005**



Source: MCPFE, 2007.

and by the Life instrument (Jones, 2006) provides a genuine opportunity to test and apply conservation and sustainable forest management measures within a large variety of forests types across the EU-27 Member States (e.g. Golob, 2007; EC, 2003).

The European Commission launched an EU Forest Action Plan in 2006, which has in particular the objective to 'maintain and appropriately enhance biodiversity, carbon sequestration, integrity, health and resilience of forest ecosystems at multiple geographical scales' (EC, 2006). It builds on the EU Forestry Strategy, adopted by the European Council in 1998, which highlights 'the importance of sustainable forest management for the conservation and enhancement of biological diversity, for the living conditions for animals and plants, and the fact that this sustainable forest management is one of many measures to combat climate change' (EC, 1998).

In 2010, the European Commission published the 'Green Paper on Forest Protection and Information in the EU: Preparing forests for climate change' to launch a debate on options for an EU forest protection and information approach in the framework of the EU Forest Action Plan. The Green Paper describes the general situation and global relevance of forests with special reference to the characteristics of EU forests and functions. It identifies the main challenges for EU forests arising from climate change. It also presents an overview of existing tools for forest protection and forest information systems that could be used to address challenges and monitor the environmental impacts of actions (EC, 2010). For instance, the EU BioSoil demonstration project was initiated to show how, on a large European scale, harmonised soil and biodiversity monitoring data can be provided for forest research and related policies (Hiederer and Durrant, 2010).

The European Forest Data Centre (EFDAC, 2010) now acts as a focal point for policy-relevant forest data. It hosts and provides links to forest information, including datasets, documents, services and other types of information such as maps and graphs, plots or statistical data. It also provides web-based tools for accessing EFDAC data and information. EFDAC is hosted by the Joint Research Center (JRC) of the European Commission.

At the global scale, the UN General Assembly has declared 2011 the International Year of Forests (UN, 2010). Ensuring that actions during 2011 are consistent with and supported by the actions taken for forest ecosystems during the International Year of Biodiversity in 2010 will pose a challenge.

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