THE EUROPEAN ENVIRONMENT

STATE AND OUTLOOK 2010

BIODIVERSITY

European Environment Agency

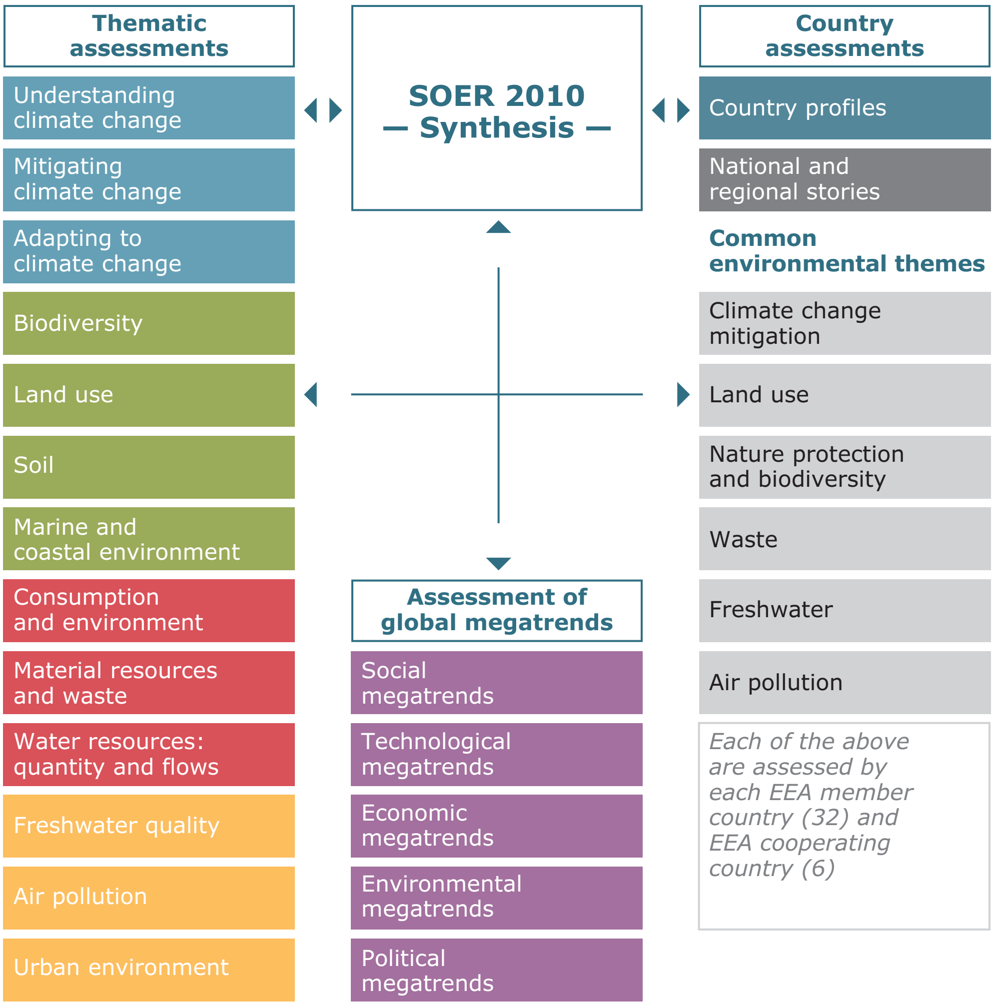
What is the SOER 2010?

The European environment — state and outlook 2010 (SOER 2010) is aimed primarily at policymakers, in Europe and beyond, involved with framing and implementing policies that could support environmental improvements in Europe. The information also helps European citizens to better understand, care for and improve Europe's environment.

The SOER 2010 'umbrella' includes four key assessments:

1. a set of 13 Europe-wide **thematic assessments** of key environmental themes;
2. an exploratory assessment of **global megatrends** relevant for the European environment;
3. a set of 38 **country assessments** of the environment in individual European countries;
4. a **synthesis** — an integrated assessment based on the above assessments and other EEA activities.

SOER 2010 assessments



All SOER 2010 outputs are available on the **SOER 2010 website**: www.eea.europa.eu/soer. The website also provides key facts and messages, summaries in non-technical language and audio-visuals, as well as media, launch and event information.

THE EUROPEAN ENVIRONMENT

STATE AND OUTLOOK 2010

BIODIVERSITY

Cover design: EEA/Rosendahl-Schultz Grafisk
Layout: EEA/Pia Schmidt

Information about the European Union is available on the Internet. It can be accessed through the Europa server (www.europa.eu).

Luxembourg: Publications Office of the European Union, 2010

ISBN 978-92-9213-153-1
doi:10.2800/58023

Acknowledgements

EEA lead author
Rania Spyropoulou.

EEA contributors
Ivone Pereira Martins, Gordon McInnes, Ronan Uhel, Ahmed Uludag, Josef Herkendell, Elena Cebrian Calvo, Carlos Romao, Alex R. Oulton, Jean-Louis Weber, Katarzyna Biala, Mette Palitzsch Lund, Karina Makarewicz, Ybele Hogeveen, Paul Csagoly, Jan-Erik Petersen, Frederik Schutyser, Ana Nieto (IUCN Regional Office for Pan-Europe under contract with EEA).

EEA's European Topic Centre on Biological Diversity (ETC/BD)
Marcus Zisensis, Dominique Richard, Brian McSharry, Doug Evans.

European Environment Agency
Kongens Nytorv 6
1050 Copenhagen K
Denmark
Tel.: +45 33 36 71 00
Fax: +45 33 36 71 99
Web: eea.europa.eu
Enquiries: eea.europa.eu/enquiries

Biodiversity

Summary

Biodiversity — the variety of ecosystems, species and genes — is essential to human wellbeing, delivering services that sustain our economies and societies. Its huge importance makes biodiversity loss all the more troubling. European species are threatened with extinction and over-exploitation. Natural habitats continue to be lost and fragmented, and degraded by pollution and climate change. Despite actions taken and progress made, these threats continue to impact biodiversity in Europe. The new global and EU targets to halt and reverse biodiversity loss by 2020 are ambitious but achieving them will require better policy implementation, coordination across sectors, ecosystem management approaches and a wider understanding of biodiversity's value.

The status of biodiversity is worrying

Monitoring the status and trends of the enormous diversity of ecosystems, species and genes clearly presents challenges. There are significant gaps in our understanding, particularly with respect to the marine environment. But there is little doubt that humans are having a massive impact on the natural world.

Although the threat of the extinction of species is slower than elsewhere, current trends in Europe are a concern. Moreover, the fact that a species is not threatened by extinction does not mean that its status is favourable. Detailed bio-geographical evaluations of the 1 182 species listed in the EU Habitats Directive showed a favourable conservation status in only 17 % of cases, an unfavourable status in 52 %, and in 31 % of the cases the status was unknown. Similarly, just 17 % of the assessments of 216 European habitat types were favourable.

Biodiversity underpins our wellbeing

Biodiversity plays a crucial role in supporting human life and wellbeing by providing a range of 'ecosystem services' of enormous value.

- Provisioning services: managed ecosystems such as farmed land, forests, lakes and rivers provide resources such as food, wood and freshwater. Agro-ecosystems in Europe have a total annual economic value of around EUR 150 bn. Ecosystem goods include the 50 000–70 000 plant species estimated to be used in medicine globally.
- Regulating services: over 75 % of the world's crop plants rely on pollination by animals and in the EU the annual economic value of insect pollinated crops is about EUR 15 bn. Europe's terrestrial ecosystems also play a major role in regulating the climate, controlling floods and purifying water, often at much lower cost than man-made substitutes.
- Cultural services: humans treasure the natural environment for the leisure opportunities it offers, and ascribe to it huge cultural importance. Indeed, much of Europe's landscape is the product of the interaction of natural and cultural forces over centuries.

The cost of biodiversity loss is thus not limited to the disappearance of iconic species. Rather, it means foregoing services essential to our societies, our economies and our way of life. Tellingly, The Economics of Ecosystems and Biodiversity (TEEB) study (a major international initiative) puts the annual cost of continuing with business as usual in the face of global biodiversity loss at EUR 50 bn.

Key pressures continue

In the EU-27, habitat changes — including loss, fragmentation and degradation — impose the greatest impacts on species. Grasslands and wetlands are in decline, urban sprawl and infrastructure fragment the landscape, and agro-ecosystems are characterised by agricultural intensification and land abandonment. And only a tiny proportion of Europe's forests are undisturbed while large forest areas are managed intensively, with little regard for biodiversity.

Agricultural intensification means decreased crop diversity, simplified cropping methods, fertiliser and pesticide use, and homogenised landscapes. Introducing biofuel crops may intensify fertiliser and pesticide use, exacerbating biodiversity loss. Industrial chemicals, metals and pharmaceutical products likewise end up in the soil or in water. Although nitrate and phosphorus pollution of rivers and lakes has declined, excess atmospheric nitrogen deposition is still an issue across the EU.

Accelerated biological invasions and climate change are also increasing threats. More than 10 000 non-native species are now present in Europe, 10–15 % of which have negative economic or ecological effects. Meanwhile, climate change is affecting species distribution and range, the timing of life stages and the ecological interactions of predator and prey.

Limited information on outlooks

Computer modelling indicates that changing land use, exploitation of marine and forest resources, increasing atmospheric CO_2, climate change and eutrophication will significantly change the distribution and abundance of species, species groups and biomes globally.

Most land-use projections in Europe forecast reduced grassland cover with overall agricultural land likewise decreasing. Coupled with intensified farming and urban sprawl, these developments are likely to affect biodiversity.

Climate change projections show a marked variation across Europe, with more pronounced impacts in the Mediterranean basin, north-western Europe and the Arctic. Biodiversity loss is among the main expected consequences as species struggle to migrate and adapt to new conditions.

Slow EU policy response

Implementation of EU environmental legislation and actions in related policy areas have had some positive effects. But progress has been slow and threats have grown both within Europe and globally. The EU has therefore failed to achieve its objective of halting biodiversity loss by 2010.

The success in extending Natura 2000 — the only supranational network of protected areas worldwide, now covering 18 % of EU land — is overshadowed by the fact that biodiversity protection has not been adequately integrated into sectoral policies. Other existing legal instruments and policies have not been fully implemented or are insufficient, and communication of the value of biodiversity has been inadequate. The EU is developing a new biodiversity strategy and has endorsed the new global target to halt, and where possible reverse, biodiversity loss and the degradation of ecosystem services by 2020. Future progress will depend on success in four key areas: enhanced implementation of measures to conserve biodiversity; policy coherence with other sectors; a more integrated ecosystem management approach; and public awareness of the relevance and value of biodiversity — and the consequences of its loss at all scales.

1 Introduction

This biodiversity assessment is integrating our knowledge on species, habitats and protected areas into the complex issues of ecosystem management, ecosystem services, human health and wellbeing. Chapter 2 includes an overview of the state of biodiversity in the EU and EEA member countries and an analysis on pressures with a more specific focus on terrestrial ecosystems. Biodiversity loss and ecosystem services are discussed in Chapter 3. Chapter 4 considers outlooks, responses, next steps and knowledge gaps.

Most of the information on which this assessment is based, derives from assessments of the SEBI 2010 indicator set, the EU Biodiversity Baseline (EEA, 2010a) and the 2010 biodiversity assessment report (EEA, 2010b).

1.1 Global biodiversity loss

Biodiversity includes all living organisms found in the atmosphere, on land, in the soil and in water, their genes, their communities and the habitats and ecosystems of which they are part.

All species have a role and provide the fabric of life on which humanity depends: from the smallest bacteria in the soil to the largest mammal in the ocean. The dynamics of species and habitats are interrelated with the water cycle, the mineral cycle and the energy flow. These processes together determine the state of ecosystems that people manage and on which they depend.

A decade ago, more than 80 % of the global land surface was estimated to be influenced by human presence and activities such as cultivation, urbanisation and transport (Sanderson et al., 2002). The fragility of global food, water and energy systems has become apparent over recent years. For example, arable land per person declined globally from 0.43 ha in 1962 to 0.26 ha in 1998. The Food and Agricultural Organization of the United Nations (FAO) expects this value to fall further by 1.5 % per year between now and 2030, if no major policy changes are initiated (FAO, 2009).

Environmental pressures such as habitat change, pollution, overexploitation, biological invasions and climate change are accelerating the global species extinction rate, making it perhaps a thousand times more rapid than the estimated natural rate of one in a million species a year. Natural habitat loss continues at an alarming rate: even though the net loss in forest area is slowing at the global scale, about 13 million ha of natural forests were converted to agriculture between 2000 and 2005 (FAO, 2006). Rapid changes in the Arctic exemplify the interconnectedness of the planet and how policies in one part of the world can severely affect the environment, biodiversity and livelihoods in another (Johnsen et al., 2010).

The loss of biodiversity is an issue of global, regional and local concern. The Convention of Biological Diversity (CBD) was signed together with the Climate Change and the Desertification Conventions at the Rio Summit in 1992. The CBD supports sustainable development by promoting nature and human wellbeing, recognising that biodiversity underpins the delivery of all ecosystem services, most of which have been degraded at the global level (MA, 2005). Examples of ecosystem services are the provision of food, energy, fibres and medicines, and regulatory mechanisms such as nutrient and water cycling, climate regulation, soil formation and retention, pollination, and control of agricultural pests and diseases.

The global target of reducing biodiversity loss by 2010 was endorsed in 2002 (see Section 1.2). The study on The Economics of Ecosystems and Biodiversity (TEEB, 2009) has further linked ecological and economic considerations into discussing natural capital. It also showed that the cost of inaction in the face of global biodiversity loss in a business-as-usual scenario is estimated at around an untenable EUR 50 billion per year.

1.2 European policies and the 2010 target

The cooperation of European countries on nature conservation policies started in the 1970s, especially aimed at species and habitats conservation and site designations within the frame of global agreements such as the Ramsar Convention on wetlands (1971), the Bonn Convention on migratory species (1979), the Convention on International Trade in Endangered Species (CITES, 1973) and the more specific Bern Convention on the Conservation of European Wildlife and Natural Habitats (1980).

A broader approach to biodiversity conservation was initiated in the 1990's with the Pan European Biodiversity and Landscape Diversity Strategy (1995), aimed at supporting the implementation of the CBD in Europe. Forest Europe — the Ministerial Conference on the Protection of Forests in Europe (MCPFE), was initiated in 1991 to build cooperation for the sustainable management of the continent's forests. Cooperation within the framework of the regional seas conventions of Barcelona (1982), Helsinki (1992), OSPAR (1998) and Bucharest (2002) provides common policies for safeguarding marine species, habitats and sites. The more recent Alpine (1991) and Carpathian (2003) Conventions are aimed at an integrated approach in managing those important mountain ecosystems for sustainability and conservation.

Despite the above initiatives, however, drivers of change continued to affect Europe's biodiversity and in 2001–2002 a set of global, pan-European and EU commitments to *formally set a target to effectively reduce or halt biodiversity decline as a contribution to poverty alleviation and to the benefit of all life on earth by 2010* was endorsed (EEA, 2006a). In line with these international policy targets and the European commitment of halting biodiversity loss by 2010, nature and biodiversity is one of the four priority areas of the EU's 6th Environment Action Programme (EC, 2002) alongside climate change, health and the quality of life, and natural resources and waste.

A number of EU directives on the environment have a significant influence on the state of biodiversity. The two EU nature directives for birds (EC, 2009a) and habitats (EC, 1992) aim to ensure a favourable conservation status for birds and their habitats as well as for other selected animal and plant species and habitat types in need of conservation. The Environmental Impact Assessment and the Strategic Environmental Assessment Directives require consideration of the potential impacts on protected species and sites of certain regional and territorial developments. The Environmental Liability Directive (EC, 2004) implements the polluter pays principle and covers damage to protected natural habitats. The Water Framework Directive (EC, 2000), in which the Nitrates Directive (EC, 1991) was integrated, has established a framework for the protection of all water bodies in order to prevent and reduce pollution, promote sustainable water use, protect the aquatic environment, improve the status of aquatic ecosystems, and mitigate the effects of floods and droughts. The Renewable Energy Directive (EC, 2009b) includes some precautionary measures for the preservation of biodiversity. The National Emission Ceiling Directive (EC, 2001), one of the main EU instruments for reducing nitrogen and sulphur emissions, binds EU Member States to respect emission ceilings. The Marine Strategy

Table 1.1 An overview of pan-European and EU targets and objectives for halting biodiversity loss and sustaining ecosystem service endorsed in 2003–2006

Target/objective
Pan-European Commitments (Kiev Resolution on Biodiversity, 2003) 'to halt the loss of biological diversity at all levels by the year 2010' according to seven key targets in the areas of: forests and biodiversity; agriculture and biodiversity; a pan-European ecological network; invasive alien species; financing biodiversity; biodiversity monitoring and indicators; public participation and awareness (UNECE, 2003).
In the European Union protecting, conserving, restoring and developing the functioning of natural systems, natural habitats, wild flora and fauna with the aim of halting desertification and the loss of biodiversity by 2010, including diversity of genetic resources, both in the EU and on a global scale; and, to encourage and promote effective and sustainable use and management of land and sea taking account of environmental concerns (EC, 2002).
The 10 priority objectives of the EU Biodiversity Action Plan (EC, 2006a) 1. to safeguard the EU's most important habitats and species; 2. to conserve and restore biodiversity and ecosystem services in the wider EU countryside; 3. to conserve and restore biodiversity and ecosystem services in the wider EU marine environment; 4. to reinforce compatibility of regional and territorial development with biodiversity in the EU; 5. to substantially reduce the impact on EU biodiversity of invasive alien species (IAS) and alien genotypes; 6. to substantially strengthen effectiveness of international governance for biodiversity and ecosystem services; 7. to substantially strengthen support for biodiversity and ecosystem services in EU external assistance; 8. to substantially reduce the impact of international trade on global biodiversity and ecosystem services; 9. to support biodiversity adaptation to climate change; 10. to substantially strengthen the knowledge base for conservation and sustainable use of biodiversity, in the EU and globally.

Framework Directive (EC, 2008a) brings about the obligation to manage human activities at sea sustainably through an ecosystem-based approach and links to the envisioned Integrated Maritime Policy.

In response to the commitments made, the European Commission published the Biodiversity Action Plan (BAP; EC, 2006a), which sets out ten objectives for action for halting biodiversity loss (Table 1.1). Most of the objectives of the BAP require a high level of integration of biodiversity and ecosystem services considerations in sectoral policies, such as the Common Agricultural and Common Fisheries Policies, but also into national policies for regional development.

The existence of the 2010 target has stimulated a number of important actions to safeguard biodiversity. Recent reports (EEA, 2009a; EC, 2009c) have acknowledged that the 2010 target has neither been met in Europe nor the rest of the world, even though some progress has been made in meeting the first three objectives.

In March 2010 the European Council endorsed the long-term biodiversity vision and the EU post-2010 headline target (Box 1.1; EC, 2010a). A new ten-year Strategic Plan was adopted at the global level at the 10th Conference of the Parties to the CBD in Nagoya, Japan in October 2010. Its mission is to *take effective and urgent action to halt the loss of biodiversity in order to ensure that by 2020 ecosystems are resilient and continue to provide essential services, thereby securing the planet's variety of life, and contributing to human well-being, and poverty eradication*. In line with these developments a new EU biodiversity strategy will be discussed further in 2010 and 2011, based on the EU 2010 Biodiversity Baseline, outlining the criteria against which achievements are to be assessed.

Box 1.1 The EU post-2010 biodiversity vision and headline target

The vision

By 2050 EU biodiversity and the ecosystem services it provides — its natural capital — are protected, valued and appropriately restored for biodiversity's intrinsic value and for their essential contribution to human wellbeing and economic prosperity, and so that catastrophic changes caused by the loss of biodiversity are avoided.

The headline target

Halting the loss of biodiversity and the degradation of ecosystem services in the EU by 2020, and restoring them in so far as is feasible, while stepping up the EU contribution to averting global biodiversity loss.

2 State and trends of biodiversity

2.1 Biodiversity at stake in Europe

The distribution of terrestrial plant and animal species in Europe has been shaped since the last glaciations. Species distribution and abundance both on land and in the seas continue to change in response to environmental change, mostly induced by human activities ever since. Measuring biodiversity change has always been based on choices which are time and space related. For instance, the selection of species and habitats to monitor and/or protect, is dependent on the specific countries and communities involved and the conditions of nature and landscapes under discussion.

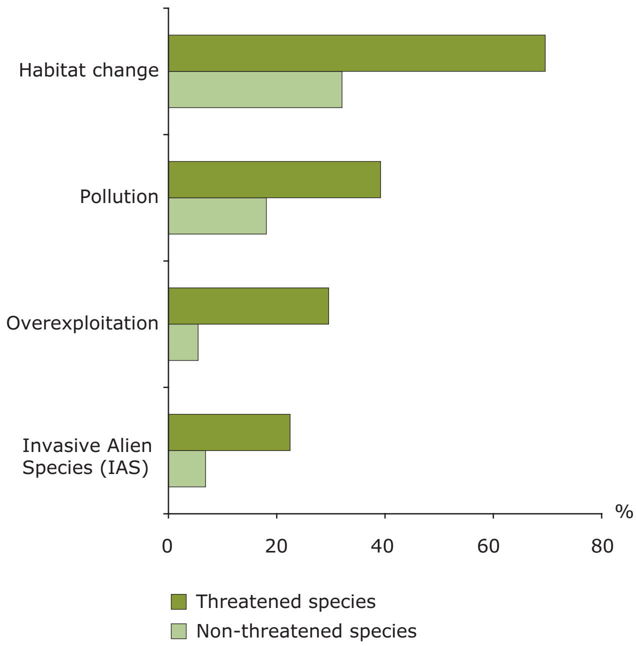
European countries have been concerned with observed changes in species and habitats since the second half of the 20th century. First to be targeted by conservation policies at the European and international level were birds and their habitats, wetlands and migratory species in the 1970s ([1]). International trade was also understood as a major threat to the survival of several species, thus regulating global trade of endangered species was initiated in the same period ([2]). The species approach evolved further in the 1980's with the development of Red Lists of endangered species and more emphasis on the need for establishing protected areas. The 1990's saw more species and habitat types ([3]) listed for action at the European level and the establishment of the Natura 2000 network for safeguarding them. Policies to protect coastal and marine species and designate protected areas have been gradually introduced, since the 1990's for all regional seas ([4]).

Recent assessments of taxonomic groups of species in the pan-European region ([5]) and EU reporting on the conservation status of habitats and species (Article 17, EU Habitats Directive) allows a quantitative assessment of species, habitat types and protected areas in the SOER for Europe for the first time.

Based on the above, it is now clear that habitat changes including loss, fragmentation and degradation, have been shown to have the greatest impact on all mammals, reptiles, amphibians, butterflies and dragonflies in the pan-European region. Pollution, overexploitation, spread of invasive alien species are the other key pressures assessed (Figure 2.1).

Alongside these threats, climate change is increasingly driving biodiversity change in Europe and in the rest of the world. A significant number of species and habitat types protected by the Habitats Directive are

Figure 2.1 Main impacts on threatened and non-threatened species at EU level (%)



Source: IUCN, 2010.

([1]) Ramsar Convention (1971), EU Birds Directive (1979), Bonn Convention (1979).
([2]) CITES Convention (1973).
([3]) Bern Convention (1980), EU Habitats Directive (1992).
([4]) Barcelona Convention for the Mediterranean Sea (1982), Helsinki Convention for the Baltic Sea (1992), OSPAR Convention for the North Atlantic Ocean (1998), Bucharest Convention for the Black Sea (2002).
([5]) 52 countries and four territories (Gibraltar, Svalbard and Jan Mayen Islands, San Marino, Faroe Islands) making up EEA member countries, EEA collaborating countries, and some EECCA countries (Annabelle Cuttelod, IUCN, 2010, personal communication).

also potentially threatened by climate change over their natural European range. Bogs, mires and fens are the most vulnerable, which is a cause of concern because they are extremely important carbon stores and their degradation releases greenhouse gases to the atmosphere. Of the species groups, amphibians are worst affected with 45 % of species negatively affected by climate change (Table 2.1) (EEA, 2010d).

Assessments of the threat of species extinction in the pan-European region

As a result of the threats mentioned above, the current extinction risk of species in Europe is a cause of concern. Given that humans are thought to be increasing the rate of extinctions by 100–1 000 times the historical background rate and even though species extinction is not occurring in Europe as rapidly as in other areas of the world, many species with a restricted range are especially vulnerable.

Approximately 14 % of all terrestrial mammals are threatened with extinction. Human-induced habitat loss, in particular by agricultural practices and pollution, is directly affecting most terrestrial mammal species. Accidental mortality (e.g. entanglement in fishing gear and ship strikes) and pollution are the main threats to marine mammal species of which 22 % are threatened with extinction (Temple and Terry, 2007).

Reptiles are showing a worse condition, with 19 % of all the terrestrial and aquatic species threatened with extinction. Habitat loss is affecting all reptile species, in particular to the result of harmful farming practices. A high number of the threatened reptiles are also affected by direct collection for consumption, trade, science and disturbance from leisure activities. Atmospheric pollution is also causing declines in non-threatened reptiles (Cox and Temple, 2009).

Amphibians show the worst decline of all taxonomic groups assessed so far, as 23 % of the species are threatened. Habitat loss or degradation and water pollution are the major threats affecting amphibian species. Significant is also the threat posed by farming practices and biological invasions (Temple and Cox, 2009).

Closely related to habitat loss due to changes in agricultural practice are the declines in butterfly species, of which 9 % are considered threatened (van Swaay et al., 2010).

Approximately 15 % of all dragonfly species are threatened in Europe mainly because of the drying out of their habitat. This is due to the increasingly hot and dry summers combined with the intensified water extraction for drinking and irrigation (Kalkman et al., 2010).

Table 2.1 Habitat types and species of the EU Habitats Directive negatively affected by climate change in at least one EU Member State *

Habitat type group	% of habitat types noted as affected by climate change	Out of (number of habitat types)	Species group	% of species noted as affected by climate change	Out of (number of species)
Bogs, mires and fens	50	12	Amphibians	45	51
Dunes	29	21	Arthropods	29	118
Forests	22	72	Mammals	26	125
Heaths	20	10	Non-vascular plants	21	38
Sclerophyllous scrub	15	13	Molluscs	17	35
Coastal	14	28	Reptiles	13	87
Rocky habitats	14	14	Fish	4	100
Grasslands	10	29	Vascular plants	3	602
Freshwater	5	19			
All habitats	19	218	All species	12	1 158 **

Note: (*) The table sets out the proportion of habitat types and species groups listed in the Habitat Directive for which at least one Member State identified climate change as a reason for unfavourable trends in the area covered or the natural range.

(**) In addition to these species groups, two species from the 'others' category were noted as affected by climate change: the red coral (*Corallium rubrum*) and the medicinal leech (*Hirudo medicinalis*).

Source: ETC/BD, 2009.

A selection of species of saproxylic beetles were also assessed and nearly 11 % of these are threatened by habitat loss and degradation due to logging and wood harvesting, agricultural expansion and intensification, urban sprawl, forest fires and climate change. The loss of older trees is a cause of considerable concern (Nieto and Alexander, 2010).

As for birds, the group for which the best information is available, 13 % of the species in Europe are considered to be threatened (BirdLife International, 2004a). While the status of some threatened species has improved due to conservation action, many more have deteriorated because of worsening threats and/or declining populations. A stabilisation of populations of common bird species at low levels has been observed during the last decades. Forest birds have declined by around 15 % since 1990, but from 2000 onwards numbers appear to be stable. Farmland bird populations declined dramatically in the 1980's but their populations have been stable since the mid 1990's (SEBI indicator 01). Overall, the risk of extinction among Europe's birds has been on the rise over the last decade (SEBI indicator 02).

Assessments of the conservation status of species and habitat types in the EU

The fact that a species or a habitat type is not threatened by extinction does not mean that it enjoys a favourable conservation status. According to the EU Habitats Directive and the Article 17 reporting (EC, 2009c), the 'favourable' status implies that the habitat type or species can be expected to prosper without any change to existing management or policies. 'Unfavourable — inadequate' status implies that a change in management or policy is required but the danger of extinction is not high, while 'unfavourable — bad' implies that the habitat type or species is in serious danger of becoming extinct (at least locally). Finally, 'unknown' status implies that there is no or insufficient information is available.

The above definitions take into account parameters affecting long-term distribution. For habitat types, that includes the extent and surface of the habitat, its structure and functions. For species parameters include range, population size, age structure, mortality and reproduction. This forms the basis for developing a common assessment method across biogeographical regions (Box 2.1) and

Box 2.1 Biogeographical regions

From an ecological perspective, Europe can be divided into nine land and four marine biogeographical regions — areas with similar climate, altitude and geology, where certain habitats and species are typically found together. The conservation status of the species and habitat types listed in the EU Habitats Directive has been assessed not the territory of that State but in each biogeographical region it occurs within that Member State (EC, 2009c).

For the purpose of the Article 17 assessments of conservation status, nine terrestrial regions were considered:

- Alpine: mountain chains with high altitudes and cold, harsh climates, forests and rock peaks, including the Alps, Apennine, Carpathian, Pyrenees and Scandinavian mountains.
- Atlantic: Europe's western coastal areas, with flat lands and cliffs, plus major river estuaries.
- Black Sea: the western and southern shores of the Black Sea, extending through Bulgaria and Romania.
- Boreal: Europe's far north, extending into the Arctic Circle.
- Continental: the heartland of Europe — much of it agricultural — spanning 11 countries from France to Poland. Hot summers contrast with cold winters.
- Macaronesian: made up of Europe's volcanic islands in the Atlantic Ocean: the Azores, Madeira and the Canaries. Covering only 0.3 % of EU territory, this region is home to 19 % of habitat types of EU concern.
- Mediterranean: Europe's hot, dry, southern countries, with mountains, grasslands, islands and extensive coastlines.
- Pannonian: the steppes of Hungary and southern Slovakia, the dry grasslands of the Carpathian basin.
- Steppic: stretching from Bucharest (Romania) in the west, across the lower section of the flood plain of the Danube and to the north of the Black Sea, with low-lying plains and wetlands.

Similarly, four marine regions were considered:

- Atlantic: northern and western Atlantic, from the Straits of Gibraltar to the Kattegat, including the North Sea.
- Baltic: east of the Kattegat, including the Gulf of Finland and the Gulf of Bothnia.
- Macaronesian: exclusive economic zones of the Azores, Madeira and Canary Archipelagos.
- Mediterranean: east of the Straits of Gibraltar.

These marine regions are based on reported exclusive economic zones or other territorial claims. They were prepared purely for reporting under Article 17 and have no legal status.

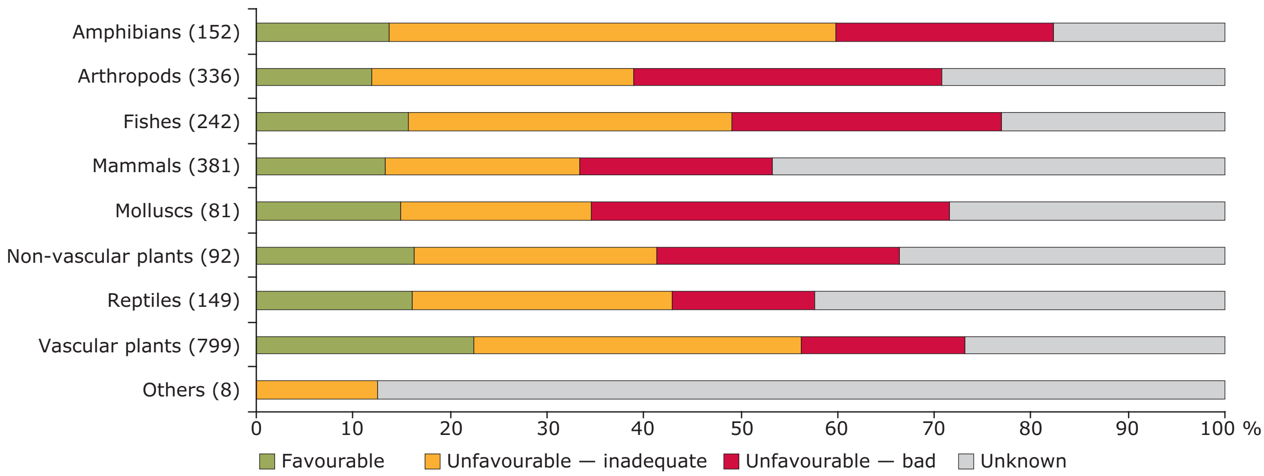
Source: ETC/BD, 2009.

a common reporting format for the Member States (EC, 2009c).

Article 17 of the Habitats Directive (EC, 1992) requires Member States to report every six years on progress in implementation. For the reporting period 2001–2006, 25 EU Member States (Romania and Bulgaria were not included) provided the first detailed assessments of the conservation status of the 216 habitat types and 1 182 species listed on the directive and found within their territory. The scale of this reporting exercise is unparalleled in Europe and provides a first overview and point of reference for assessing future trends.

The detailed assessments of the conservation status of species, except birds, revealed that only 17 % of the assessments in EU-25 show a favourable conservation status, 52 % an unfavourable status, and the status is unknown for 31 % of them. Amphibians are in the worst state with fish and arthropods coming second, while the group with the highest percentage of favourable assessments was vascular plants (Figure 2.2).

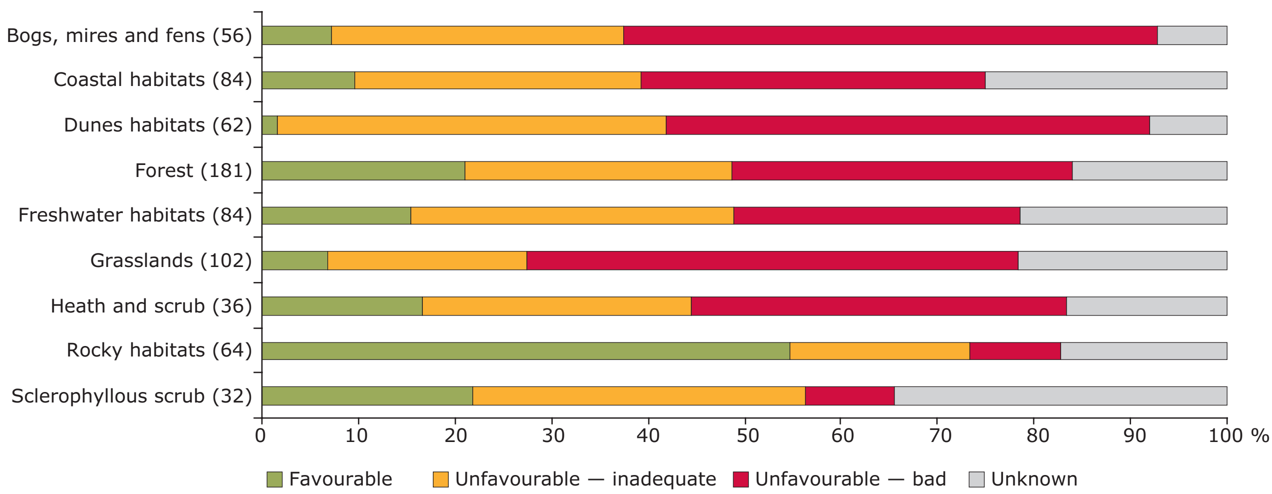
Figure 2.2 Conservation status of assessed species in EU-25, by taxonomic group



Note: Number of assessments in brackets.

Source: ETC/BD, 2008.

Figure 2.3 Conservation status of assessed habitats in EU-25



Note: Number of assessments in brackets.

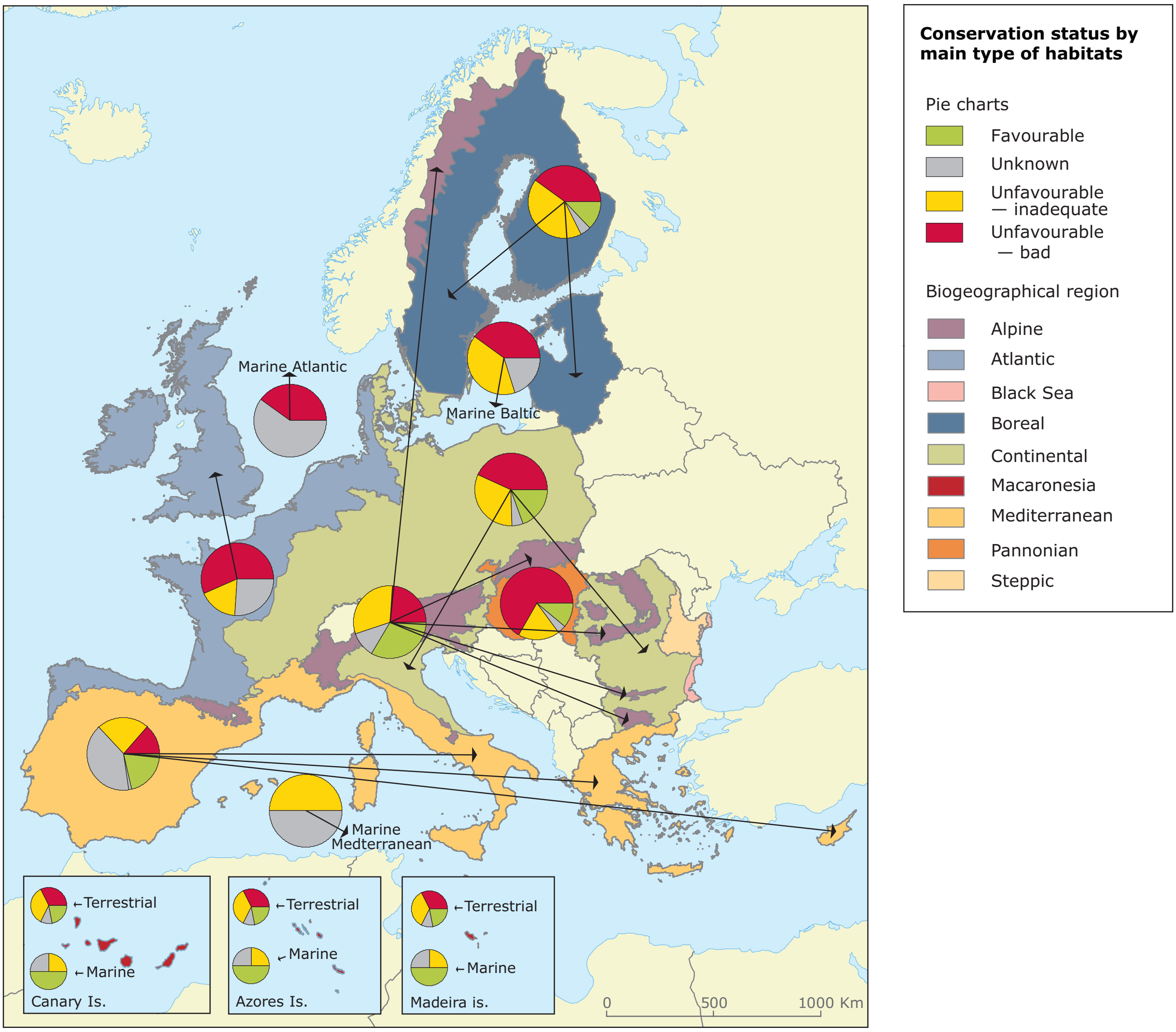
Source: ETC/BD, 2008.

The assessment for the habitat types, which are listed in the EU Habitats Directive, was also made available for the same period. Grouped into nine categories, these habitat types are mostly defined on the basis of plant communities, although some are landscapes. They show varied degrees of inherent variability, from habitat types as broad as reefs to narrowly defined ones corresponding to a single plant association (Evans, 2006).

Amongst these groups, only 17 % of habitat type assessments are favourable while most were reported to have an unfavourable conservation status (Figure 2.3).

Dunes habitats, grasslands and bogs, mires and fens seem to be the most threatened. In grasslands, negative changes in the species composition and other structural features are due to a change of land use, intensification of agricultural practices or abandonment of traditional management. Bogs, mires and fens require specific regimes so they are sensitive to changes in hydrological conditions and also eutrophication, due, for example, to the atmospheric deposition of nitrogenous compounds. All dune habitat types have been assessed as unfavourable, mostly connected to urban development and tourism, as shown in the SOER 2010 marine and

Map 2.1 Conservation status of assessed habitats in EU-25, by biogeographical region



Note: How to read the map: in the Mediterranean biogeographical region (see Box 2.1 for an explanation of biogeograhical regions) about 21 % of habitats have a favourable conservation status but 37 % have an unfavourable (bad/inadequate) status.

Source: ETC/BD, 2008; SEBI 2010 Indicator 05.

coastal environment assessment (ETC/BD, 2008; EEA, 2010e).

The conservation status of species and habitat types differs considerably across the terrestrial and marine biogeographical regions (Map 2.1). Looking into biogeographical regions, the proportion of the habitat assessments as 'unfavourable — bad' exceeds 40 % in most of the biogeographical and marine regions while the proportion of the habitats assessed as 'unfavourable' is more than 70 % in most of the terrestrial biogeographical regions. In the Atlantic and Pannonian biogeographical regions, more than 50 % of the habitats are assessed as 'unfavourable — bad'; this percentage slightly exceeds the percentage in the other biogeographical regions.

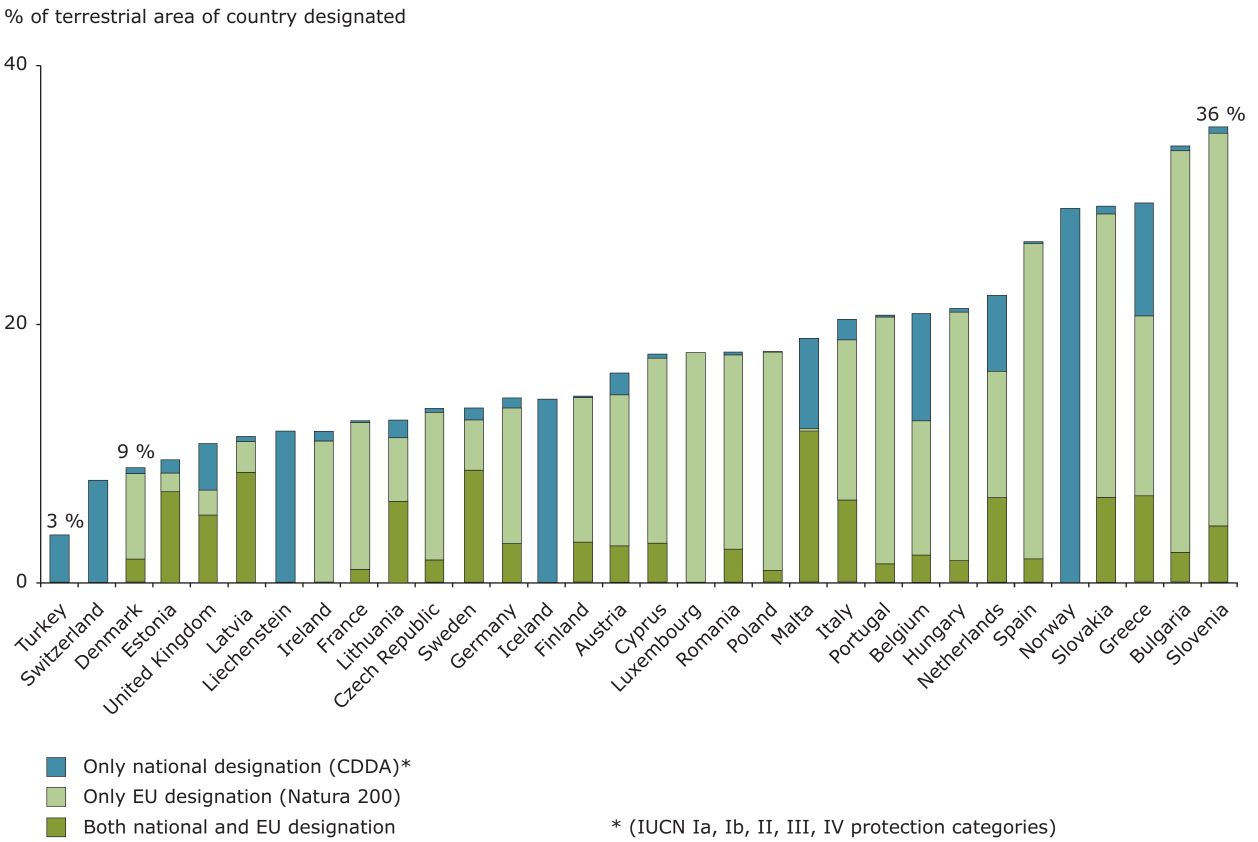
Assessment of protected areas

Protected areas have long been the only way of preserving remarkable natural assets from adverse land use. The number and coverage of nationally designated protected sites has increased, reaching more than 100 000 sites across 54 countries (EEA, 2010c). The size of protected areas varies greatly; however, 90 % of sites are less than 1 000 ha. To some extent this reflects the high pressure on land use arising from agriculture, transport and urban development (EEA, 2010c).

A variety of national designations exists and the IUCN management categories are used to allow comparisons and data aggregations across countries (IUCN, 1994). Strict nature reserves, IUCN category I, are mostly situated in northern European countries, principally Scandinavia. Most nationally designated sites in Europe are classified as IUCN category V, Protected Landscape/Seascape, and VI, Managed Resource Protected Area (EEA, 2010c). Increasingly areas listed in IUCN categories IV, V and VI, are valued as areas where sustainable resource use and rural development practices can be tested in partnership with a wide range of stakeholders (Dudley, 2008).

Multiple designations of the same site under national, European (mainly Natura 2000) and/or international processes (e.g Ramsar wetlands) are quite common in many countries. The Natura 2000 site network established by the EU Birds and Habitats Directives is aiming to assure the long-term survival of Europe's most valuable and threatened species and habitats. It has steadily developed over the last 15 years, now reaching 18 % of

Figure 2.4 Percentage of terrestrial protected areas in EU-27



Source: ETC/BD based on CDDA, 2009; Natura 2000, 2009; IUCN, 1994.

the terrestrial area of EU Member States. All types of ecosystems are represented within the network, with 38 % of it approximately covered by agro-ecosystems including 11 % that are grasslands, 34 % covered by forests, 16 % by heath and scrub, and 11 % by wetlands. Progress has been also noted in establishing marine Natura 2000 sites, now reaching 167 561 ha in EU-27, however, it is significantly lagging behind. The main land uses in Natura 2000 sites and the degree of their similarity to their surrounding areas vary significantly (EC, 2009d).

The percentages of national territories designated for conservation, including national designations and the EU Natura 2000 sites, vary greatly amongst EEA member countries (Figure 2.4). Removing spatial overlaps, their total area, including nationally designated sites within all IUCN

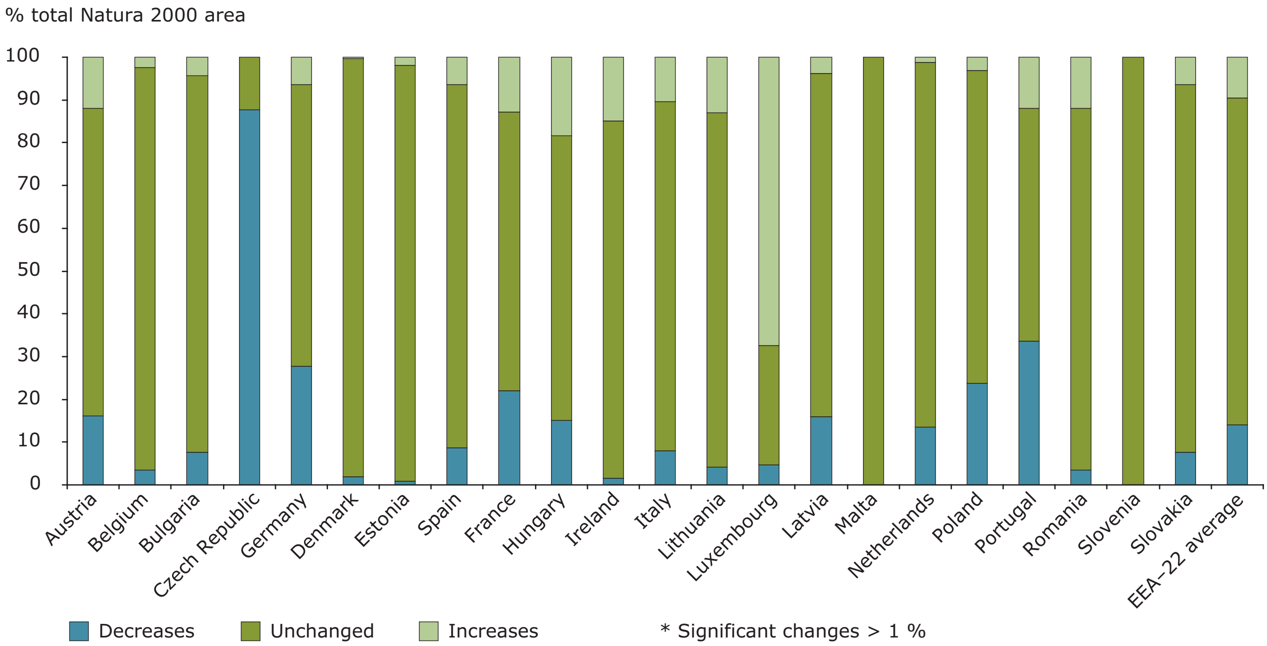
Box 2.2 Coverage of habitat types and species of the Habitats Directive by the Natura 2000 network

The distribution data provided by the Member States as part of the Article 17 reports allow a verification of the Natura 2000 network and will be invaluable for assessing new proposals made to complete gaps identified by the biogeographic seminars and associated bilateral meetings. For many habitat types and species the Article 17 distribution maps are more recent than those used during the biogeographic seminars, particularly for the EU-15 Member States, and would also permit a re-evaluation of the network.

The area of distribution of terrestrial habitat types of Annex I of the Habitats Directive to be found within the Natura 2000 network is generally between 20–60 %. In the Continental region, however, a 100 % coverage of the distribution within the sites is most frequent, with 40–50 % coverage just behind in other regions. A higher coverage of the habitat types within the sites is found in the Mediterranean region, which probably is due to the different approaches of Member States in preparing the distribution maps for Article 17.

In comparison with habitat types, there is a much higher number of species of Annex II of the Habitats Directive which are not reported outside the Natura 2000 network, reaching a maximum of 134 in the Mediterranean region. A large number of the species with 100 % distribution coverage within the sites are endemics or species with a very restricted distribution within the EU-25, which have been targeted when selecting sites such as the plant *Centaurea alba ssp*. princeps in Greece which only occurs within a single 10 km² cell (ETC/BD, 2008).

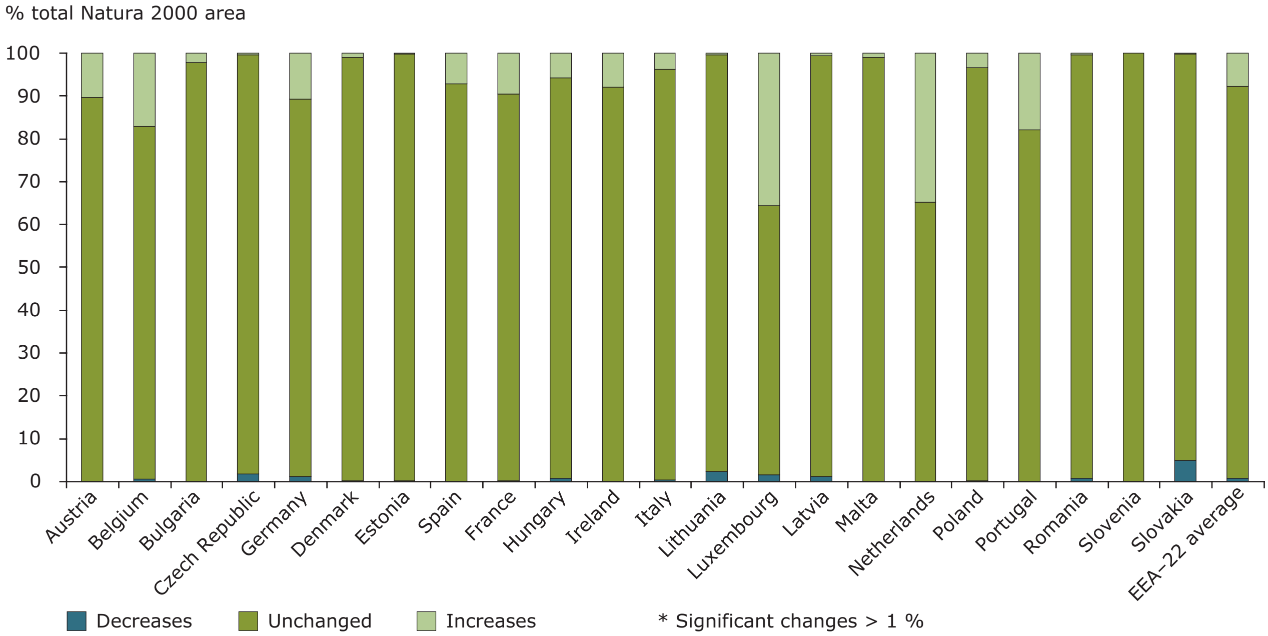
Figure 2.5 Changes in diffuse pressure from intensive agriculture in Natura 2000 sites, 1990–2006



Note: Corine land cover classes used for intensive agriculture include:
Arable land: non-irrigated arable land (211), permanently irrigated land (212), rice fields (213).
Permanent crops: vineyards (221), Fruit Trees and Berry Plantations (222), olive groves (223).
Heterogeneous agricultural areas: annual crops associated with permanent crops (241).

Source: EEA, 2010 — Land and ecosystem accounting.

Figure 2.6 Changes in diffuse pressure from urbanisation in Natura 2000 sites, 1990–2006



Note: Corine land cover classes used for urban diffuse pressure include:
Urban fabric: continuous urban fabric (111), discontinuous urban fabric (112).
Industrial, commercial and transport units: industrial or commercial units (121), Road and rail networks and associated land (122), port areas (123), airports (124).
Mines, dump and construction sites: mineral extraction sites (131), dump sites (132), construction sites (133).
Artificial non-agricultural vegetated areas: green urban areas (141), sports and leisure facilities (142).

Source: EEA, 2010 — Land and ecosystem accounting.

designation categories and Natura 2000 sites, has reached 121 702 551 ha or 22 % of the EEA area (ETC/BD based on CDDA, 2009; Natura 2000, 2009; IUCN, 1994). However, if sites with only IUCN categories Ia, Ib,II, III, IV — which correspond closer to conservation objectives — are included in the calculation, the total area under protection in EEA countries goes down to 90 922 576 ha or 16 % of the total area of these countries.

The pressure of urban and artificial land use within and in the neighbourhood of a given protected area ('urban temperature'), and the pressures from the broad pattern of arable land and permanent crops in the area ('intensive agriculture temperature') have been calculated on the basis of land cover in the context of land and ecosystems accounts (EEA, 2010j). The latest analysis of Natura 2000 sites based on land cover change 1990–2006, indicates that, while the vast majority of sites remained with no significant changes to their 1990 pressures from intensive agriculture and urbanisation, changes due to both intensification and withdrawal of agriculture, and urbanisation have taken place in a number of sites (Figures 2.5 and 2.6).

2.2 Analysis of pressures

The consolidation and assessment of the SEBI 2010 biodiversity indicator set and the EU Biodiversity baseline have provided valuable information inputs on the state and pressures of biodiversity in Europe. Below follows an analysis of threats and pressures, focusing on terrestrial ecosystems on land-use change, including habitat loss, degradation and fragmentation. Pollution, overexploitation, invasive alien species and climate change are also addressed in this section.

Land-use change and habitat loss

The main terrestrial ecosystems in the EU-25 plus Norway and Switzerland are croplands, 33 %; forests, 30 %; pastures, 16 %; and urban land, 2 %. Only 1 % of the wider European area can be considered as even relatively untouched by humans: larger wilderness ([6]) areas are mainly found in parts of Finland, Sweden, Norway, Ukraine and Western Russia together with bordering states; there are also some wilderness remnants in Central and Southern Europe.

([6]) Wilderness refers to relatively untouched natural areas that have not been significantly modified by human activity — core areas for nature on land or at sea where nature and wildlife thrive (Coleman and Aykroyd, 2009).

Table 2.2 Changes in ecosystems between 1990 and 2006

Ecosystem	Surface change (km²)	Change (%)
Agro-ecosystems (intensive and heterogeneous, agro-forest)	– 12 611	– 2.0
Agro-ecosystems (extensive)	– 4 476	– 2.6
Grasslands (pastures)	– 2 553	– 0.9
Grasslands (natural)	– 1 795	– 2.4
Heath and scrubs	+ 13 245	+ 5.9
Forests	+ 5 378	+ 0.6
Wetlands (marshes/bogs)	– 1 266	– 5.0

Note: The term 'agro-ecosystems' is based on the following Corine land cover categories:
Regularly cultivated land: non-irrigated arable land (211), permanently irrigated land (212), rice fields (213). vineyards (221), fruit trees and berry plantations (222), olive groves (223), pastures (231), and annual crops associated with permanent crops (241).
Mixed cultivated land: complex cultivation patterns (242), agricultural area with significant areas of natural vegetation (243), and agro-forestry areas (244).
Semi-natural areas with possible extensive agriculture practices: natural grasslands (321), moors and heathland (322), and sclerophyllous vegetation (323).

Source: CLC, 2006.

The pace of change for agriculture and forestry practices, urbanisation and infrastructure has varied across Europe and has generally slowed considerably in the last two decades. The SOER 2010 land use assessment (EEA, 2010f) demonstrated that changes in land use are time and scale related. As a result, landscapes show a wide range of naturalness from heavily modified to semi-natural. The European Landscape Convention (2000) promotes the protection, management and planning of European landscapes and organises pan-European cooperation on landscape issues.

Loss of semi-natural habitats

Ecosystem coverage calculations, based on clustering land cover classes, show that the EU's semi-natural habitats have been in decline since 1990 (Table 2.2).

Agro-ecosystems continue to decrease in coverage, and between 2000 and 2006, semi-natural agricultural areas were lost to forest afforestation programmes and conversion to arable land or to mixed agriculture with pastures (EEA, 2010a).

Grasslands in particular continue to decline: between 1990 and 2006 more than 4 300 km² were lost to intensive agriculture, to urban residential sprawl and economic sites and to natural afforestation due to farmland abandonment. Their decline has affected a large number of species, including birds (BirdLife International in Veen et al., 2009) and grassland butterfly populations, which have declined by a further 70 % since 1990 (SEBI indicator 01; EEA, 2010a).

Box 2.3 Tourist pressures on biodiversity in Europe

Tourism is a significant and growing industry in the pan-European region, particularly impacting biodiversity in coastal, freshwater, mountain, and forests ecosystems. In 2009, the UN World Tourism Organization estimated that in 2020 more than 717 million international travellers will visit areas of Europe (WTO, 2001). Around 346 million will travel to the Mediterranean, resulting in additional pressure on the already fragile ecosystems there, especially the coveted sea and beaches (De Stanfano, 2004; EEA, 2007a).

Tourism's most obvious impacts on European biodiversity can be seen on the coast, but it actually seriously affects mountain ecosystems as well. For example, as competition for the growing number of tourists in the European Alps has increased in the last 15 years (Keller, 2004), so has infrastructure development at higher altitudes. This has meant ever more second homes, new roads and infrastructure to ensure the greatest opportunities for tourists. These activities degrade the fragile mountain environment and affect the natural food chain, reducing species diversity and the incidence of rare plants. They also affect insect populations, insectivorous birds and possibly even small mammals (Williams, 1998).

Spread of invasive alien species is also enhanced by tourism. This is expected to escalate with increased travel and climate change, seriously affecting Europe's wildlife and wild places despite efforts to halt their intrusion (EEA, 2009b).

Wetlands have continued to decrease as a proportion of their total area in1990 with decline between 2000 and 2006 mostly due to conversion to agriculture land and afforestation. Loss and degradation of wetlands is also linked to blocking, extraction of water inflow and over-exploitation of the groundwater resources (EEA, 2010a).

Heath and scrub habitats have increased their overall coverage. However, between 2000 and 2006, internal changes in this class included loss due to conversions from traditional woodland to forest, to fires and to conversion of agriculture. Gains may be attributed to abandoned pastures and/or burnt forest areas (EEA, 2010a). All these conversions can also bring a loss in biodiversity values. In addition, exceedance of critical loads of nitrogen has been shown to affect the species composition of heath and scrub, causing losses of sensitive shrubs, wild flowers and grasses (Pitcairn et al., 2002 in COST, 2009).

Fragmentation

Built-up areas have grown faster than Europe's total human population, indicating an increasing space claim per person. Biodiversity is generally decreasing along an urban gradient, from rural areas to city centres (Blair and Launer, 1997). As cities grow, the range of plant and animal species supported is restricted and the species present may be those most adaptable to the urban environment, rather than more typical native species. Both of these factors contribute to the homogenisation of biodiversity in urban areas (McKinney, 2006; Box 2.3).

As a result of this urban sprawl and infrastructural development, semi-natural habitats have not only decreased in absolute coverage, but have also become increasingly fragmented. Fragmentation of nearly 30 % of the EU land is moderately high to very high (Figure 2.7), occurring at its highest in lowlands of western Europe. High fragmentation has increased the vulnerability of ecosystems to diffuse external pressures such as drainage, eutrophication and acidification. In addition, isolated populations of animals and plants have become more vulnerable to local extinction due to disrupted migration and dispersal opportunities.

Connectivity of areas with remaining semi-natural features is very important for safeguarding biodiversity in the face of widespread intensification of resource management. The concept of establishing ecological networks was introduced by the Pan-European Biodiversity and Landscape Strategy (1995) and the Pan-European Ecological Networks initiatives and have contributed to studies and gap analyses of protected areas in different parts of Europe. The main challenge remains the practical implementation of such networks and the further development of the concept of green infrastructure.

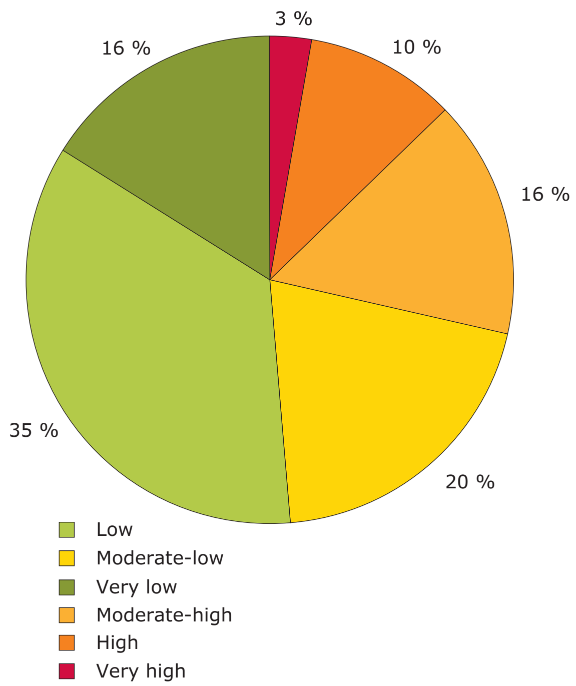
Although total forest coverage has increased since 1990, fragmentation also seems to affect forests. Patterns of forest fragmentation defined by the relative change since 1990 appear to have occurred primarily in the Baltic region and central and south-western Europe. In absolute terms however, the forest remnants in the heavily urbanised regions of lowland western Europe and northern Italy are extremely fragmented, but have not deteriorated further in recent years (SEBI indicator 13; EFDAC, 2010).

Intensive agricultural management and land abandonment

Agricultural intensification and land abandonment are two of the main pressures on biodiversity linked to agro-ecosystems in Europe. These developments are driven by a combination of factors including technological innovation, agriculture subsidies and international market developments, as well as climate change, demographic trends and lifestyle changes.

The concentration and specialisation of agricultural production have had major consequences for biodiversity, as it has become apparent in the strong decline of farmland birds during the last quarter of the 20th century but which stabilised since the mid-1990s. Farmland butterflies have also declined since 1990 at least, and the decline has not stopped since.

Figure 2.7 Landscape fragmentation in the EU-27 (% of total terrestrial area)



Source: EEA, 2010a.

Decreases in the diversity of crops, simplification of cropping methods, use of fertilisers and pesticides and the homogenisation of landscapes are all factors in the intensification process. The introduction of biofuel crops could lead to further intensification in terms of fertiliser and pesticide use resulting in further biodiversity loss (EEA, 2008c).

Europe-wide studies considering the effects of agricultural practices and landscape characteristics on biodiversity have confirmed the important impact of agriculture at different spatial scales. At the plot level, fertilisation, tillage and pesticides are disturbances with an overall negative effect. At the landscape level, negative effects are linked to the disappearance of such man-made elements as hedges and field margins. Eco-tones at the edge of agricultural areas might change as a result of alterations in hydrology and land use with the disappearance of woodland, semi-natural grassland and ponds. The same applies to the homogenisation of crops and the synchronisation of practices, such as harvesting and mowing dates. In addition, intensive agriculture in homogenous landscapes, leading to monocultures, promotes the development of populations of crop pests (INRA, 2008).

The ecological quality of agricultural ecosystems is as varied as the farming practices across Europe. Initial work on high nature value (HNV) farmland shows its approximate geographical distribution and was estimated to represent a third of agricultural land of EU-27, covering 74.7 million ha on the basis of 2000 data (Paracchini et al., 2008). Most of HNV farmland lies outside the Natura 2000 network. Within the Natura 2000 and in the wider EU countryside, protected habitat types which depend on agriculture — usually grazing land — have a below average conservation status compared to the rest. These less intensively farmed areas are important for maintaining species and species communities that otherwise would have become extinct (EEA, 2010a).

A significant decline in the utilised agricultural area (UAA) — the area taken up by arable land, permanent grassland, permanent crops, and kitchen gardens, has been observed in the past three decades in most EU Member States — a loss of between 0.1 and 1.5 % of their UAA per year (Eurostat, 2010a). The loss of UAA is mainly due to abandonment, but other land-use changes such as afforestation and soil sealing by urbanisation and infrastructure should be also taken into account (Paracchini et al., 2008).

The abandonment of farmland has significant environmental consequences and is often associated with social and economic problems in rural areas. In areas that were previously intensively managed, abandonment has brought environmental benefits, particularly a reduction in chemical pollution. However, cessation of farming in extensively managed areas may entail significant loss of biodiversity. A decline or loss of specialist species and the deterioration of habitats has been documented with farmland abandonment in semi-natural grasslands with high botanical value or conservation interest for birds and other animal groups (Moreira et al., 2005).

Forest exploitation

Forest is the predominant natural climax vegetation in Europe and a key repository of biological diversity, but only 5 % of the European forests is currently considered to be undisturbed by humans. The largest areas of old-growth forests in the EU can be found in Bulgaria and Romania, and overall in the EU the majority (87.6 %) of forests now consists of semi-natural stands with 7.3 % being plantations of indigenous or introduced species (EC, 2010b). Most are heavily exploited, particularly in the core forested regions of northern and eastern Europe. The total wood harvest in European countries has remained well below the annual re-growth, indicating the sustainable management of the total resource (SEBI indicator 17).

Old growth forests have a high biodiversity value, especially because of the high number of species

Box 2.4 Soil biodiversity

Little is known about how soil life reacts to human activities but there is evidence that soil organisms are affected by the content of soil organic matter (SOM), the chemical characteristics of soils (e.g. the amount of soil contaminants or salts) and the physical properties of soils such as porosity and bulk density, both of which are affected by compaction or sealing. Recent analysis has indicated that due to land use change, habitat disruption, invasive species, soil compaction, erosion, pollution and organic matter decline, soil biodiversity levels are potentially under high pressure in approximately 23 % of the surface area of EU-25 (excluding Sweden and Finland) and under very high pressure in 8 % on this area (Jeffery et al., 2010).

The SOER 2010 soil assessment revealed that intensively cultivated soils have been shown to have low levels of biomass, which is essential for maintaining key soil functions. A large proportion of intensively cultivated soils in Europe has already reached the lower threshold of 2 % soil organic carbon suggested for essential soil functions (Loveland and Webb, 2003; Arrouays et al., 2001; 2006). The problem exists in particular in the southern European countries, but also in parts of France, Sweden and the United Kingdom.

of fungi, lichens, bryophytes as well as arthropod, mammal and bird species associated with deadwood. The quality of deadwood for biodiversity is expressed in the variety of kinds of deadwood (stumps, snags, coarse woody debris) as well as the degree of its decay. The fact that deadwood, which is a key indicator for forest biodiversity and the conservation value of a forest, remains well below optimal levels in most European countries is a cause of concern (Figure 2.8) (EEA, 2008a; SEBI indicator 18).

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, 2008a). Intensifying forestry suppresses natural ecosystem processes such as limited fires (EEA, 2008a) and natural succession (Kuuluvainen, 2009). In many continental forests, game populations are increased due to game management so that forest regeneration is affected (EEA, 2008a).

The intensive management of forests is often linked to the draining of wet forests and peatlands, fertilisation and the introduction of tree species with differing genotypes, which negatively affect species and habitats diversity. Introduced tree species have become invasive species in 13 % of the forest area dominated by introduced tree species (MCPFE, 2007 in EEA, 2008a).

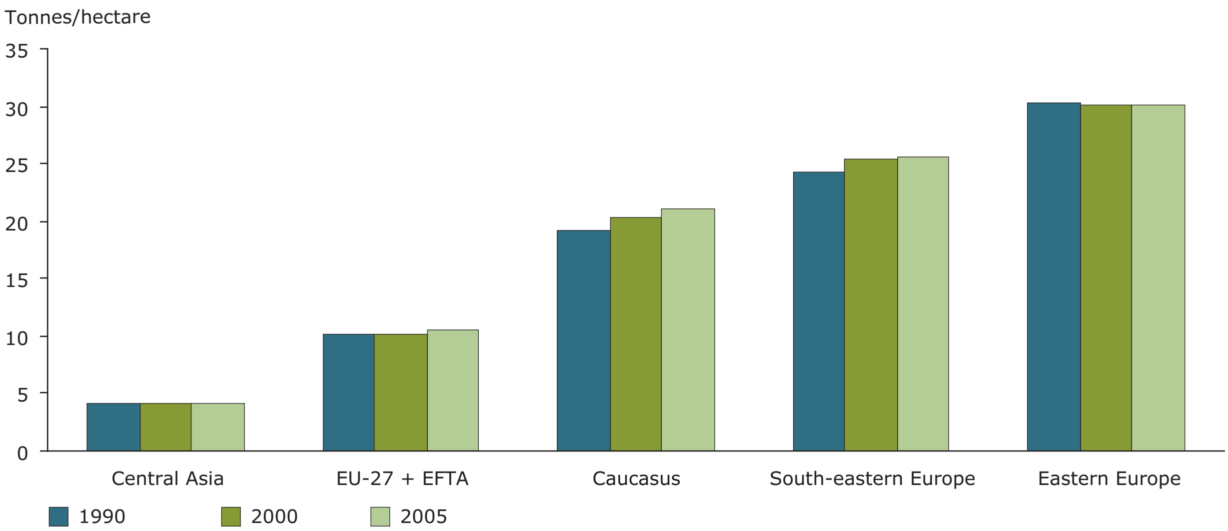
Box 2.5 Biotic homogenisation

Biodiversity loss can be observed through a homogenisation process in terrestrial ecosystems, by which, as a result of human interventions, many originally occurring species decrease in abundance while a few other species increase. The observed trend towards fewer specialist species and more generalist species reflects the decline in specific types of habitat or a uniqueness of a specific habitat type or a combination of habitats; generalist species generally indicate widespread mean conditions. In general, ecosystems lose their regional character and become more and more alike (Lockwood and McKinney, 2001; Kassen, 2002; MA, 2005).

Urbanisation, fragmentation, and disturbance of landscapes have been shown to negatively affect specialisation (Devictor et al., 2007; 2008a; 2008b). During this process, local or national species richness often initially increases, due to the arrival of new species, in a so-called intermediate disturbance diversity peak. However, for the disappearing species, extinction is just a final step in a long degradation process (Lockwood and McKinney, 2001).

Biotic homogenisation is genetic, taxonomic, and functional. Genetic homogenisation reduces the spatial component of genetic variability within a population or among populations of a species; taxonomic homogenisation increases the compositional similarity among communities owing to the successful invasion of winning species, which may or may not be native, and the loss of losing species. Functional homogenisation results in a composition of community traits with weak variations between species and landscapes (Olden, 2006). This biotic homogenisation has consequences in terms of ecosystem health and resilience to global changes.

Figure 2.8 Deadwood in pan-European forests, 1990–2005



Source: FAO, 2005; SEBI 2010 indicator 18.

Because of their structural diversity, forests provide ideal habitats for a particularly high number of species. In the past few decades, however, an increase in uniformity of forest structures has reduced their biodiversity value in many areas (Box 2.5). For example, more than 50 % of the species listed on the Habitats Directives that are linked to forest ecosystems have an unfavourable conservation status (EEA, 2010a).

Pollution

A wide range of pollutants — including excess nutrients, pesticides, microbes, industrial chemicals, metals and pharmaceutical products — end up in the soil, or in ground- and surface-water. Adding to these is the atmospheric deposition of eutrophying and acidifying substances, including nitrogen oxide (NO_X), ammonium plus ammonia (NH_X) and sulphur dioxide (SO_2). All forms of pollution impact both threatened and non-threatened species, habitats and ecosystems. On land, pollution effects are mostly pronounced in amphibians, dragonflies and reptiles (EEA, 2010a).

Loss in species richness and further dysfunction of ecosystems from nutrient loads, primarily of nitrogen and phosphorus, is generated through eutrophication and acidification. Eutrophication leads to a reduced supply of oxygen in waters, or nutrient oversupply, for example in grasslands, forests and heathlands (Thimonier et al., 1994), with subsequent negative effects on nutrient-poor plant communities. Although the nutrient balance for many EU Member States has improved since 1990, more than 40 % of sensitive terrestrial and freshwater ecosystem areas are still subject to nitrogen deposition beyond their critical loads (EEA, 2010h).

As highlighted in the SOER 2010 air quality assessment, one of the success stories of Europe's environment policy has been the significant reduction in emissions of the acidifying pollutant SO_2 since the 1970s. The area subject to acidification has decreased further since 1990. With these emissions declining, nitrogen emitted by agriculture, road transports and industry is now the principal acidifying component in European air (EEA, 2007b). Although some decline in freshwater nutrients has been observed, eutrophication of terrestrial ecosystems continues to be a matter of concern as shown by excess atmospheric nitrogen deposition in all EU Member States (Map 2.2). Peatland ecosystems provide an example of how species replacement, resulting from nitrogen deposition, may alter ecosystem functions such as carbon sequestration (COST, 2009).

Over-exploitation

Fish, wildlife and plant species are harvested by people for food, clothing, pets, medicine, sport and many other purposes.

Over-harvesting is known to have caused the extinction of 50 bird species since 1500 at the global scale. Nearly 30 % of the Globally Threatened Birds are currently threatened by over-exploitation for human use, primarily through hunting for food and trapping for the cage bird trade (BirdLife International, 2004b). The Convention on International Trade in Endangered Species of Fauna and Flora (CITES, 1973) works to prevent the global trade of endangered wildlife, but there are many species that are not protected from being illegally traded or overharvested.

Over-exploitation affects the loss of genetic diversity and the loss in the relative species abundance of both individual and/or groups of interacting species. For example, the biological capacity of coastal ecosystems in Europe has been altered by overexploitation of key fish stocks in European seas (EEA, 2006b). As discussed further in the SOER 2010 marine and coastal assessment, unsustainable fishing practices have affected the marine trophic chains in all European seas. Incidental by-catch, the accidental capture of unmarketable or restricted commercial fishing species, which takes place during fishery operations, also contribute to the decline in aquatic biodiversity and

Box 2.6 Europe's freshwater ecosystems

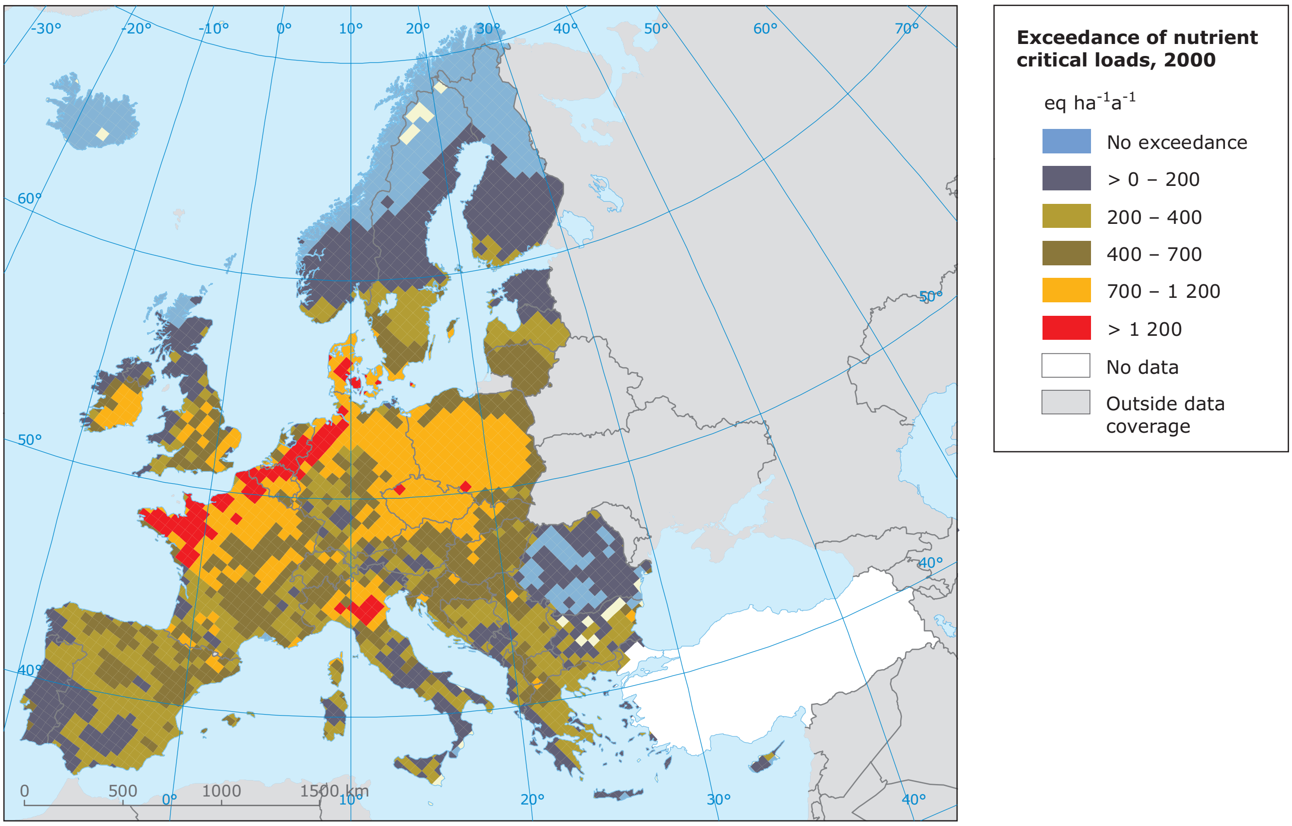
Europe's freshwater ecosystems range from rivers, floodplains, lakes and ponds, marshes and peatlands, to man-made water bodies such as canals and reservoirs (EC, 2007a; 2007b). They encompass a broad variety of systems which interact with groundwater. Around 250 species of macrophytes and 250 species of fish inhabit inland surface waters and a significant mumber of birds, fish and mammals depend on wetlands for breeding or feeding (EC, 2007a).

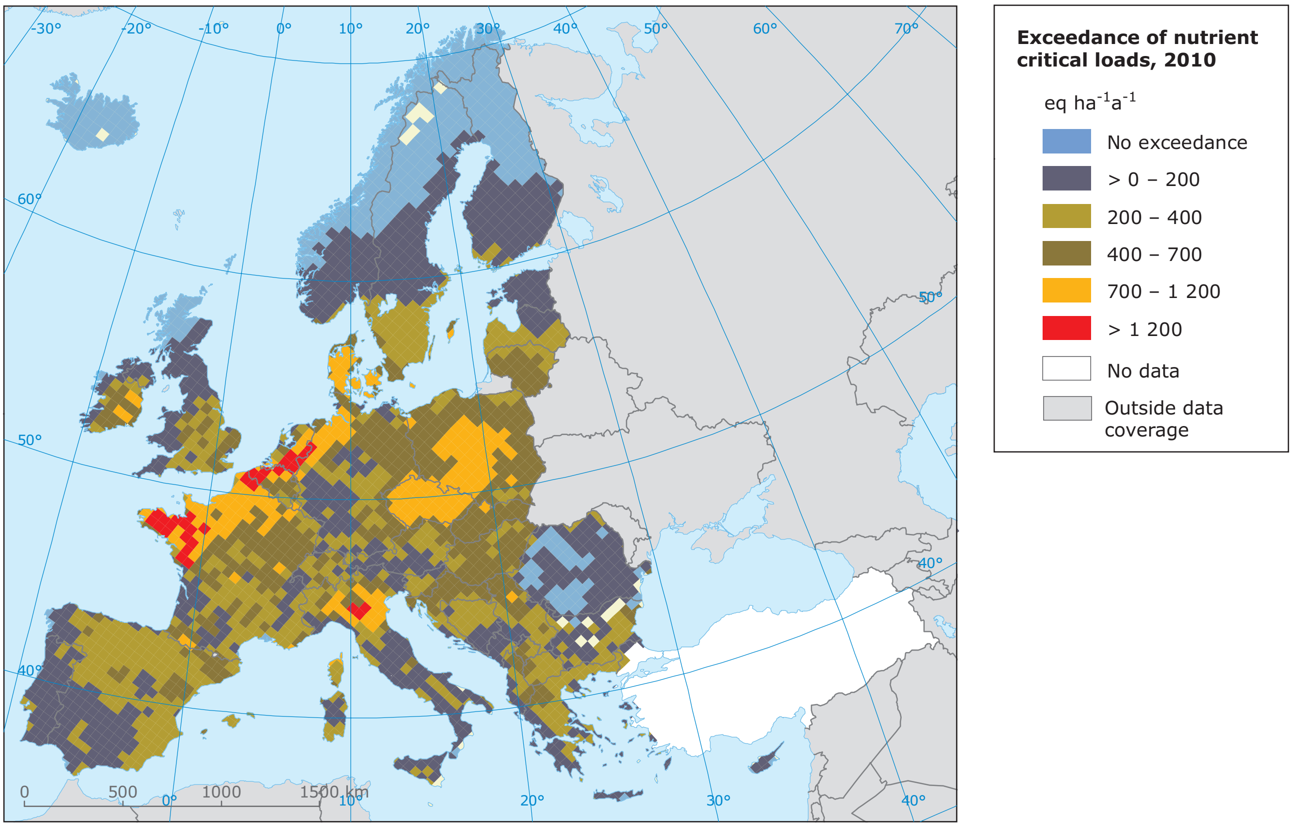
In addition to water-quality problems, many inland water systems suffer from:

- dramatic changes in their water regime, resulting in too little or too much water (water scarcity, drought, hydropeaking and floods);
- heavy modifications (dams, weirs, sluices, interrupted connectivity, straightening and canalisation and disconnection from floodplains) and related changes in the discharging regime (low flows, surge-low flow dynamics);
- invasive alien species.

Source: EEA, 2010h.

Map 2.2 **Exceedances of critical loads for eutrophication due to the deposition of nutrient nitrogen in 2000 and 2010**





Note: The results were computed using the 2008 Critical Loads database hosted by the Coordination Centre for Effects (CCE) and Clean Air for Europe scenarios. Turkey has not been included in the analyses due to an insufficient data basis for calculating critical loads. For Malta no data were available.

Source: Hettelingh et al., 2008, 2009; SEBI indicator 09.

impacts not only fish but marine mammals, sea turtles and sea birds. Fishery operations may also contribute to the degradation of marine habitats. In the Mediterranean, in particular, trawling has impacted sensitive habitats such as sea grass beds and deep corals (EEA, 2006b).

Invasive alien species

Invasive alien species (IAS) are non-native species whose introduction and/or spread outside their natural past or present ranges pose a threat to biodiversity. They occur in all major groups, including animals, plants, fungi and micro-organisms, and are considered to be the second most important reason for biodiversity loss worldwide (Shine et al., 2009); although in the EU habitat loss and degradation and pollution are currently more significant.

IAS not only represent a threat to native species of fauna and flora but can also result in major disruption to ecosystem health, with resulting damage and loss of goods and services.

An increasing vulnerability of ecosystems to invasions results from habitat loss, degradation, fragmentation, over-exploitation and climate change (EEA, 2009b). Globalisation, particularly increased trade and tourism, has resulted in an upsurge in the number and type of alien species arriving in Europe. The Delivering Alien Invasive Species Inventories for Europe (DAISIE) project has found that more than 90 % of alien species are introduced unintentionally, mostly by shipping and other forms of transporting goods.

More than 10 000 non-native species are now present in Europe, 10–15 % of which are considered to have negative economic or ecological effects (EC, 2010a). In order to gain a better understanding of invasive alien species and their impact on European biodiversity, a list of the worst invasive alien species threatening biodiversity in Europe has been established. The list currently contains 163 species or species groups. Species are added to the list if they are very widespread and/or if they create significant problems for biodiversity and ecosystems in their new habitats (EEA, 2009b; SEBI indicator 10).

Invasive species are found in all ecosystem types. Rapidly changing environmental conditions in marine systems combined with high fishing pressure and increased marine transportations have allowed an increased number of biological invasions in European seas, as discussed in detail in the SOER 2010 marine and costal environment assessment.

Another pronounced case of biological invasions is freshwater ecosystems. According to a recent inventory, 296 species of invertebrates and 136 fish species found in Europe's freshwater are alien. The primary pathways for introducing animal alien species to European inland waters are stocking of water bodies to support extensive fishculture and sport fishing (30 %), intensive aquaculture (27 %) and passive transportation by ships (25 %) (DAISIE, 2009).

It is essential to recognise this global threat at the European level and to take necessary actions to prevent, control, or eradicate those species which threaten ecosystems, habitats or species. In 2003, a European strategy on IAS (CoE, 2003) was adopted under the Bern Convention and it offers advice on measures to prevent unwanted introductions and tackle IAS. However, an overall framework to control/manage IAS is currently missing at the EU level. In December 2008, the EU adopted a Communication presenting policy options for an EU Strategy on Invasive Species (EC, 2008b) and it is now preparing this strategy to be adopted in 2011.

Climate change

Climate change impacts on biodiversity and ecosystems are now considered likely to be greater than initially forecast. Although scientists indicate that ecosystems will be able to adapt to a certain extent, the combination of human-induced pressures and climate change will increase the risk of losing numerous systems (TEEB, 2009).

Climate change impacts biodiversity through a complex interaction of species and their habitats. Milder winters are responsible for the observed northward and uphill distribution shifts of many European plant species. The timing of seasonal events in plants is also changing, due mainly to changes in climatic conditions (EEA, 2008b). Most notable are changes in species composition in the Alpine region, which represents 20 % of all native vascular plants in Europe (Väre et al., 2003).

Box 2.7 The introduced pathogene species of *Phytopthora ramorum* of woody plants in Europe

Nineteen EU Member States, as well as Norway and Switzerland, have taken and officially reported measures to control the pathogen *Phytopthora 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.

Birds, insects, mammals, freshwater species and other groups are also moving northwards and uphill. Climatic warming has caused advancement in the life cycles of many animal groups, including frog and fish spawning, birds nesting, the arrival of migrant birds and butterflies and earlier spring phytoplankton blooms (EEA, 2008b).

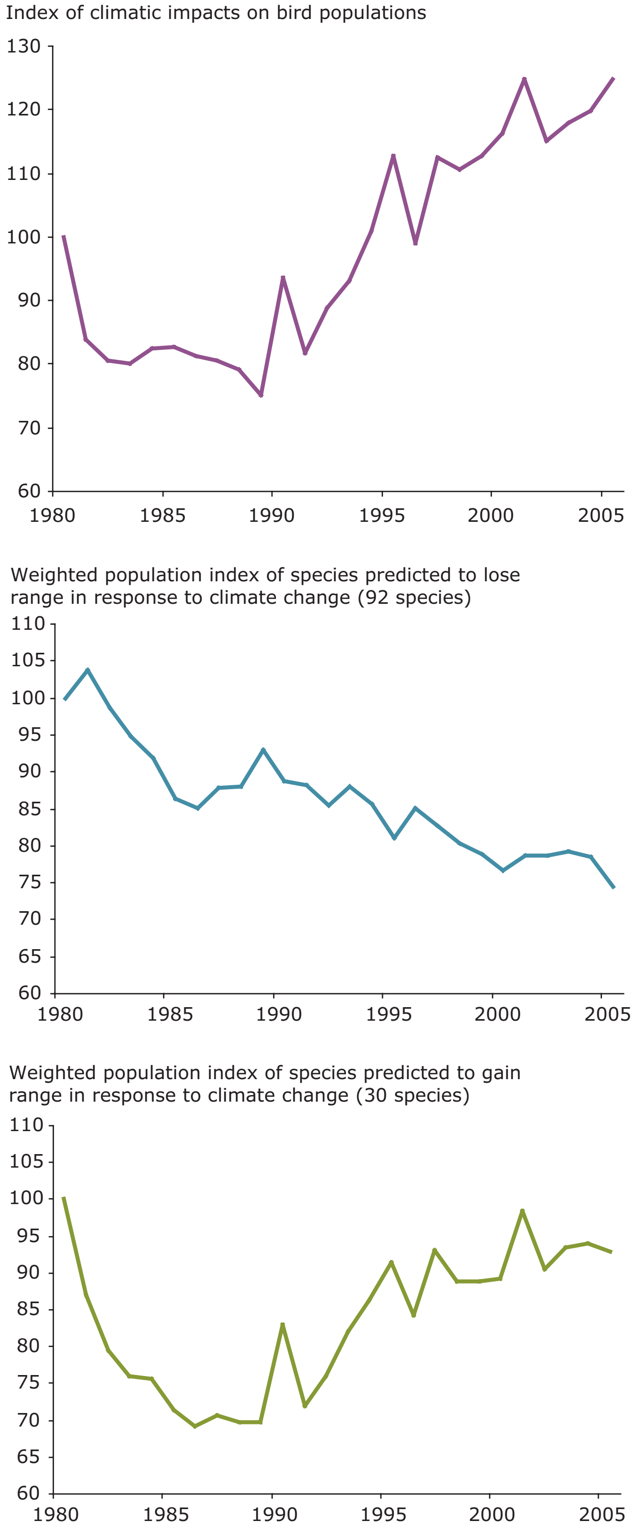
Rapid climate change in Europe in the past 20 years has strongly affected a number of common birds. As shown by an indicator based on observed populations of 122 common bird species across 18 European countries, tree-quarters of the populations declined as a result of climate change, whereas one-quarter benefited (EEA, 2010d; Figure 2.9). Changes in butterfly communities during the period 1990–2005 show a significant trend towards a higher proportion of warm species relative to cool species (EEA, 2010d).

There is now increasing evidence that healthy ecosystems can significantly mitigate the effects of climate change and help human societies adapt. For instance, recent reviews (Luyssaert et al., 2008; Richardson et al., 2009; Trumper et al., 2009) show the crucial role of undisturbed ecosystems in the carbon balance and their potential in mitigating greenhouse gas effects. Maintaining ecosystems is therefore vitally important for climate change mitigation and adaptation. It is now essential that political awareness of the interdependence of climate change and biodiversity protection be translated into concrete action at global, regional and national levels.

Implementing and maximising synergies between the two fields calls for three sets of actions (EU WG, 2009; The Nature Conservancy, 2009):

- Maintaining and restoring the biodiversity and ecosystems that underpin our resilience and ability to mitigate and adapt to climate change. This includes building up our 'green infrastructure'.
- Developing a policy framework that recognises the interdependence of climate change, biodiversity and ecosystem services. Such a framework should facilitate cross-sectoral interaction, drawing in areas such as agriculture, forestry and business, and also support further research.
- Use this cross-sectoral framework to design and implement concrete ecosystem-based actions. Examples include developing soft coastal defences, and maintaining and restoring floodplains, vegetation cover and green infrastructure.

Figure 2.9 Climate change impact indicator of European bird populations



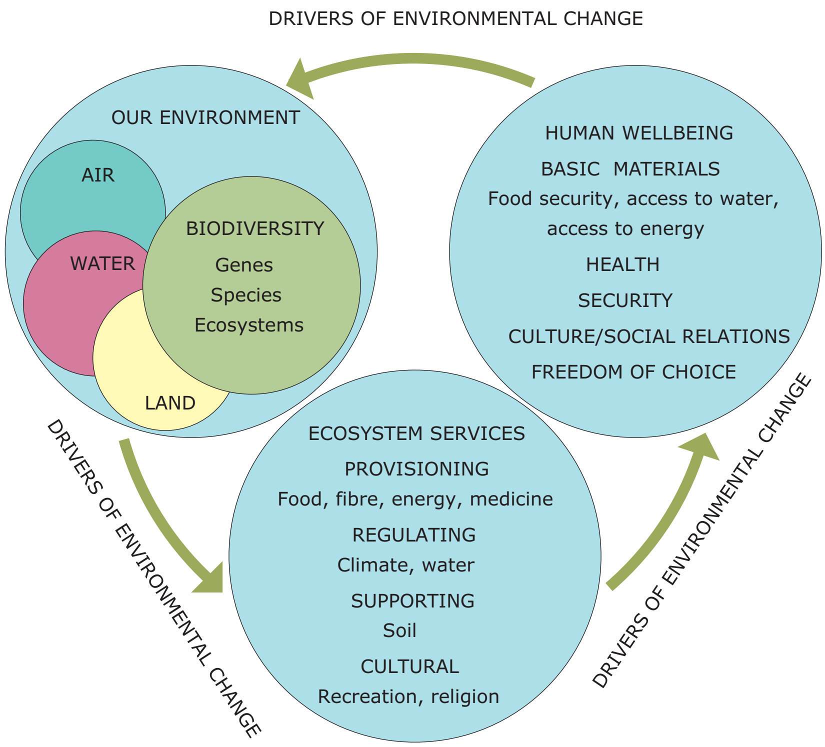
Source: Adapted from Gregory et al., 2009, SEBI indicator 11.

3 Biodiversity and ecosystem services

Ecosystem services are the direct and indirect contributions of ecosystems to human wellbeing (TEEB, 2009) and can be categorised in four main types: provisioning services, regulating services, habitat services and cultural services. Intensively managed ecosystems contribute mostly to vital provisioning services, agro-ecosystems, for example, provide food via crops and livestock, and forests provide wood; while semi-natural ecosystems including grasslands and mountains are key contributors of genetic resources and cultural services such as aesthetic values and sense of place. All ecosystem services support directly or indirectly human survival and the quality of life (Harrison and RUBICODE consortium, 2009; Box 3.1).

Biological communities have the unique quality of adaptation to environmental change, allowing the development of human societies. However, compromising ecosystems to our apparent benefit causes degradation, which compromises our health, societies, economies and cultures (Figure 3.1).

Figure 3.1 Dynamic of environment, services and human wellbeing



AGENTS OF CHANGE

Demography	Politics/institutions	Economy	Socio-cultural
Urbanisation	Security and conflict	Markets and finance	New paradigms
Aging populations	International environmental governance	Emerging economies	Ethics
Role of gender		Valuation of biodiversity	Spirituality

Source: McNeely and Mainka, 2009.

Box 3.1 Ecosystem services in Europe

What people are demanding from ecosystems is changing. The most recent trends in Europe have shown: an increase in the demand for crops from agro-ecosystems, timber and climate regulation from forests, water flow regulation from rivers and wetlands and recreation and tourism in most ecosystems; and a decrease in livestock production, freshwater capture fisheries and wild foods and virtually all services associated with ecosystems which have considerably decreased in area — for example semi-natural grasslands (Harrison et al., 2010).

Based on these demands, the condition of the majority of services shows either a degraded or mixed status across Europe, with the exception of recent enhancements in timber production in forests and mountains, freshwater provision, water/erosion/natural hazard regulation and recreation/ecotourism in mountains, and climate regulation in forests (Table 3.1).

Key gaps in knowledge are evident for certain services across all ecosystems, including the provision of biochemicals and natural medicines, genetic resources and the regulating services of seed dispersal, pest/disease regulation and invasion resistance.

Table 3.1 Trends in the status of European ecosystem services

Services \ Ecosystems	Agro ecosystems	Forests	Grasslands	Heath and scrubs	Wetlands	Lakes and rivers
Provisioning						
Crops/timber	Mixed ↓	Enhanced ↑			Degraded ↓	
Livestock	Mixed ↓	Degraded =	Degraded =	Degraded =	Degraded ↓	
Wild foods	Degraded =	Degraded ↓	Degraded ↓	Unknown	Mixed =	Unknown
Wood fuel		Mixed =		Degraded =		
Capture fisheries					Degraded =	Degraded =
Aquaculture					Degraded ↓	Degraded ↓
Genetic	Degraded =	Mixed ↓	Degraded ↓	Degraded =	Mixed =	Unknown
Freshwater		Degraded ↓	Unknown	Unknown	Mixed ↑	Mixed ↑
Regulating						
Pollination	Mixed ↑	Degraded ↓	Degraded =	Unknown		
Climate regulation		Enhanced ↑	Unknown	Mixed =	Degraded =	Degraded =
Pest regulation	Mixed ↑	Unknown	Degraded =		Unknown	
Erosion regulation		Mixed =	Degraded =	Degraded =	Unknown	Unknown
Water regulation	Unknown	Mixed =	Unknown	Mixed ↑	Enhanced ↑	Degraded =
Water purification		Unknown	Unknown	Unknown	Mixed =	Degraded =
Hazard regulation		Unknown	Unknown	Unknown	Mixed =	Degraded =
Cultural						
Recreation	Mixed ↑	Mixed =	Degraded ↓	Mixed ↑	Mixed ↑	Mixed =
Aesthetic	Mixed ↑	Mixed =	Degraded =	Degraded =	Mixed ↑	Degraded =

Status for period 1990–present Degraded Mixed Enhanced Unknown Not applicable

Trend between periods ↑ Positive change between the periods 1950–1990 and 1990 to present ↓ Negative change between the periods 1950–1990 and 1990 to present = No change between the two periods

Source: Adapted from Harrison et al., 2010.

Even though the challenge of attributing ecosystem services to species populations, functional groups of species and ecological communities still lies ahead of us, there is evidence that biodiversity loss affects ecosystem services.

3.1 Biodiversity loss and provisioning services

Managed ecosystems such as agro-ecosystems, forests, lakes and rivers mainly offer provisioning services — food, livestock, biofuels, wood and freshwater. Agro-ecosystems in the EU have a total annual economic value of around EUR 150 billion (Gallai et al., 2009 in Harrison et al., 2010) while European roundwood production in 2007 was 33.8 % of global production at 728 million m^3. Although the role of grasslands as food providers decreased significantly during the 20th century due to land abandonment, the importance of semi-natural grasslands for sustainable fodder production is increasing (Harrison et al., 2010).

Loss of domesticated animal breeds and wild crop relatives is a result of current production practices both on agricultural land and in forests. This loss of genetic diversity is related to the long term ability of ecosystems to deliver provisioning services as shown in the cases of crop wild relatives (Box 3.2). Similarly the loss of original — autochthonous — breeds of domesticated animals is linked to the ability of certain ecosystem types such as wetlands, grasslands, semi-natural forests to deliver livestock breeding services.

Animal genetic resources for food and agriculture are an essential part of the biological basis for world food security (FAO, 2007). Europe is home to a large proportion of the world's domestic livestock diversity, with more than 2 500 breeds registered in the Food and Agriculture Organization (FAO) breeds database (EEA, 2006a) but many native breeds are endangered.

Measures implemented in the Agri-Environmental Schemes (AES) under the EU Regulation 1698/2005 have been supporting the preservation of local plant varieties and rearing of endangered breeds. In Austria, for example, about 4 % of all holdings participating in the Austrian AES in 2008, were involved in keeping of endangered breeds (BMLFUW, 2009).

Together with these genetic resources, local knowledge of cultivation practices, land management, local foods and varieties has been lost. A number of EU initiatives have been taken to support the diversity of local food products by marketing based on the environmental credentials of the production systems and/or the landscape of origin including wine and cheese. Not all farmers providing public goods, however, are able to exploit these potential market opportunities. Given the economic fragility of many extensively grazed livestock farms, which are responsible for maintaining wide swathes of attractive agricultural landscapes, the development of such added-value products is often not an option.

Trade is a major driver of change in ecosystem services. This macroeconomic driver causes a loss in one part of the world while the real action (import and consumption) happens elsewhere. While the foreign exchange earned in the national economies is reflected in their net income from abroad, the costs of biodiversity loss or coastal water pollution are not recorded (Chopra et al., 2009).

The SOER 2010 consumption and environment assessment (EEA, 2010k) demonstrate that the overall demand for consumption of goods in European countries exceeds

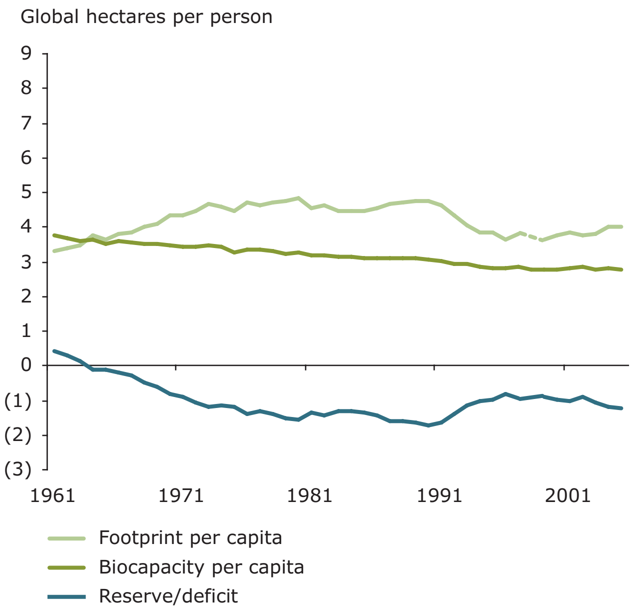
Box 3.2 Crop wild relatives

Crop wild relatives have undeniably been of benefit to modern agriculture, providing plant breeders with a broad pool of potentially useful genetic resources. Since the mid-1980s, the discovery and use of new resistance genes from the wild have increased steadily in crops, because they are helping to effectively reduce pathogens that are problematic in these new varieties (Hajjar and Hodgkin, 2007).

The most used varieties are registered and protected in national gene banks and international cooperation is fostered by the International Treaty for Genetic Resources used in Food and Agriculture. On ratifying the treaty, countries agree to make their genetic diversity and related information about the crops stored in their gene banks available to all. Access and benefit-sharing is organised in a multilateral system, through which 64 of the crops that together account for 80 % of all human consumption — will comprise a pool of genetic resources that are accessible to everyone (International Treaty on Plant Genetic Resources for Food and Agriculture, 2010).

Crop wild relatives still occur in the wild: for example they comprise more than 80 % of the Euro-Mediterranean flora. Within the territories of the EU-27, more than 16 000 crop and crop wild relative (CWR) species occur; less than 3 % of them are included in Annexes II, IV and V of the Habitats Directive. On the other hand, 70 % of species listed in Annex II, IV and V of the Habitats Directive are included in the CWR catalogue. These plants represent a potential, not only useful for agriculture but also for minimising the risks of climate change.

Figure 3.2 European ecological footprint, biocapacity and reserve or deficit



Note: A dotted line is included for years with source data inconsistencies.

Source: Global Footprint Network, National Footprint Accounts 2009 Edition; SEBI 2010 Indicator 23.

their current production, and Europe's ecological footprint affects biodiversity in other parts of the world (Figure 3.2). Further to the global biodiversity loss and ecosystem degradation caused, globalisation of food production and supply procedures pose unprecedented challenges to the health and wellbeing of the populations of developing countries. Levels of hunger had decreased and per person energy consumption has risen consistently in most of these countries (Rosegrant et al., 2005), but inexpensive foodstuffs produced by large-scale agriculture can have adverse effects on diet quality/human health, undermine the self-sufficiency of small-scale farmers and threaten environmental sustainability.

Furthermore, the 800 million of the world's population whose diets are still insufficient in energy, and the approximately two billion suffering from micronutrient deficiencies, all have inadequate access to products of biodiversity that would improve their dietary options (Popkin, 2002).

3.2 Biodiversity loss and regulating services

Pollination is a key regulating service in agro-ecosystems, forests, semi-natural grasslands, heath and scrub ecosystems; pest regulation is a key service in agro-ecosystems and heath and scrub ecosystems. Forest and wetland ecosystems are of key importance for climate regulation and forests make a key contribution to erosion regulation. Rivers, lakes, wetlands and forests regulate the quantity and quality of freshwater; floodplains retain floods and regulate excess nutrients from agricultural practices (Harrison et al., 2010).

Pollination

More than 75 % of the world's crop plants, as well as many plants that are source species for pharmaceuticals, rely on pollination by animals; the annual economic value of insect pollinated crops in the EU is about EUR 15 billion; 30 % of fruits, 7 % of vegetables and 48 % of nuts produced in the EU depend on pollinators (Gallai et al., 2009 in Harrison et al., 2010).

In many agricultural systems pollination is actively managed through the establishment of populations of domesticated pollinators, particularly the honey bee (*Apis mellifera*). It has been shown, however, that wild pollinators may interact with managed bees resulting in

Box 3.3 Soil biodiversity and ecosystem services

Soil is a biological engine where dead plant and animal tissues, and other organic wastes, are decomposed to provide nutrients that sustain life. Soil is alive: decomposition processes are driven by a mass of soil microorganisms. A handful of soil may contain more than 10 billion microorganisms, the majority of which are bacteria. In addition to the huge amounts of bacteria, 1m^3 of fertile topsoil will contain hundreds of kilometres of fungal hyphae, tens of thousands of protozoa, thousands of nematodes, several hundred insects, arachnids and worms, and hundreds of metres of plant roots. The total weight of microorganisms in the soil below a hectare of temperate grassland can exceed that of a medium-sized elephant — five tonnes — and often exceeds the above-ground biomass. Soil microorganisms are involved in most of the key functions of soil, driving fundamental nutrient cycling processes, regulating plant communities, degrading pollutants and helping to stabilise soil structure. Soil organisms also represent a crucially important biotechnological resource, with many species of bacteria and actinomycetes providing sources of antibiotics and other medicines.

Source: EEA, 2010g.

increased crop productivity (Greenleaf and Kremen, 2006; Kremen et al., 2007 in TEEB, 2009).

Habitat destruction and deterioration by the increased use of pesticides has decreased the abundance and diversity of many insect pollinators and there is strong evidence that loss of pollinators reduces crop yield (EASAC, 2009). Thus, it is possible that a threshold in pollinator species exists below which pollination services become too scarce or too unstable (Klein et al., 2007 in TEEB, 2009). Such a tipping point might occur when sufficient habitat area is destroyed, reducing landscape diversity and increasing land-use intensity, causing a population crash. Conserving pollinators in habitats adjacent to agriculture improves both the level and the stability of pollination services (Klein et al., 2003 in TEEB, 2009).

Climate regulation

Europe's terrestrial ecosystems play a major role in climate regulation, since they represent a net carbon sink of some 7–12 % of the 1995 human generated emissions of carbon. In particular peat soils, which are extensively found in the boreal and cool temperate zones of Europe, contain the largest single store of carbon on the continent. The climate regulating function of peatlands depends on land use and is negatively affected by intensification such as drainage and conversion to agriculture. When mismanaged or drained, peat soils lose their capacity to store carbon and release large quantities of carbon to the atmosphere.

The restoration of peatlands may represent an important factor in enhancing carbon sequestration. In addition, carbon sequestration capacity in cultivated soils in Europe could be improved by increasing organic matter inputs on arable land, the expansion of organic and low-input farming, raising of water tables in farmed peatlands and the introduction of zero or conservation tillage (EASAC, 2009). Increased stocks of carbon in agricultural systems can represent a win-win situation with regard to climate change mitigation and crop production as high levels of soil organic carbon improve nutrient and water use efficiency, reduce nutrient loss and subsequently increase crop production (Trumper et al., 2009).

With 53 gigatonnes of carbon sequestered in forest biomas and deadwood, the forests of the countries participating in the Forest Europe (MCPFE) process are large storages of carbon. In the EU-27, 73 % of carbon stock biomass is above the ground, 20 % is below ground and 7 % resides in deadwood (MCPFE, 2007).

Recent reviews (Luyssaert et al., 2008; Richardson et al., 2009; Trumper et al., 2009) show the crucial role of undisturbed ecosystems in the carbon balance and their potential in mitigating greenhouse gas effects. They also indicate how some ecosystems can turn into negative carbon sinks if degraded (Table 3.2).

Water regulation/purification

Water movement on land is very much dictated by vegetation which controls flows, floods, and quality. Changes in upstream vegetation coverage can affect the quantity, quality and variability of water supply of a watershed. Moreover, soil invertebrates influence soil structure which regulates the surface runoff quantities of water. Soil micro-organisms are important in water purification (EASAC, 2009; Turbé et al., 2010).

Forests, wetlands and protected areas with dedicated management actions often provide clean water at a much lower cost than man-made substitutes like water treatment plants (TEEB, 2009).

Table 3.2 Characteristics and role of selected European ecosystems in the carbon balance

	Vegetation growth	Vegetation decomposition	Carbon source or sink	Current carbon storage (t/ha) approximately	Where majority of carbon is stored
Tundra	Slow	Slow	Sink	260	Permafrost
Boreal forest	Slow	Slow	Sink	Soil: 120–340 Vegetation: 60–90	Soil
Temperate forest	Fast	Fast	Sink	160–320	Biomass above and below ground
Peatlands	Slow	Slow	Sink	1 450	Soil
Oceans and coasts	Plankton: fast	Fast	Sink	Surface: 1020 Gt C; Deep ocean: 39 000	Deep ocean

Source: Adapted from Trumper et al., 2009.

Box 3.4 Wetlands contribute to many ecosystem services

Wetlands — especially bogs and peatlands — are vital carbon sinks and may account for as much as 40 % of the global reserve of terrestrial carbon and can make an important contribution in combating climate change.

Wetlands help maintain the water cycle by capturing and holding rainfall and snowmelt, retaining sediments and purifying water. They provide protection from floods and storms, control soil erosion and can serve as natural wastewater treatment systems. Coastal wetlands are known to play a major role in defence against tidal flooding.

The agricultural use of wetlands, ponds and river margins can also provide important services to farming systems such as pollination and the harbouring of natural predators of agricultural pests. Wetlands often function as collectors of nutrients, contributing to nutrient cycling and storage.

Seasonal wetlands can provide a valuable resource for livestock grazing. Fibre, fuel, fish and medicinal and dietary supplements are also products that can be derived from wetlands. Wetlands often provide a supply of drinkable water for the surrounding population, which is a critical function in many semi-arid or seasonally dry areas.

Wetlands are of cultural, spiritual and aesthetic significance and can be tourist attractions. They are important to a high number of species, and coastal wetlands provide breeding grounds for fish and nesting and migratory areas for birds.

Source: Adapted from TEEB, 2009; Vandewalle et al., 2010.

3.3 Biodiversity loss and cultural services

Natural areas are a source of mental as well as physical health, especially for the young (Louv, 2005). The health values that stem from contact with nature are universal and are not limited to developed countries. For many years wilderness experiences have been anecdotally and qualitatively recognised as being beneficial for personal and social skills development, healthcare, as well as helping youths at risk and with conflict resolution.

Interaction with nature has a calming effect on people, and time outside can restore health, relieve stress, and offer life balance. Grasslands, forests, wetlands, heath and scrub and lake and river ecosystems provide aesthetic values and a sense of place and they are important for recreation and ecotourism. Many visitor surveys show that the perceived quality of landscapes, biodiversity and the rural environment, particularly in mountainous areas, nature or national parks and other scenic landscapes, is the main motivation for visiting many regions of Europe. Many of these characteristics rely on the presence of public goods that are created and sustained by farming activity (Cooper et al., 2009).

In Romania, for example, the traditional, agricultural landscape of Southern Transylvania is not only of exceptionally high value for nature conservation, but is also a cultural landscape and the direct legacy of a long history of pastoral management and cultural inheritance. This heritage is particularly associated with the utilisation of semi-natural grasslands for sheep production, with the roots of many traditions, songs, foods and words deriving from traditional pastoralism (Cooper et al., 2009).

Evidence of the importance of wildlife and nature can also be found in the scale of membership of conservation organizations. For example, in the United Kingdom the Royal Society for the Protection of Birds has a membership of over 1 million and an annual income of almost EUR 60 million (EASAC, 2009).

3.4 Biodiversity loss and human health

The full gamut of ecosystem services supports human health. This includes provisioning services in the form of medicines and food, supporting services in the form of soils for food and improved nutrition, regulating services for suitable water and air quality, and cultural services that support mental health.

Loss of certain plants, fungi and micro-organisms results in loss of natural medicines. It is estimated that some 50 000–70 000 plant species are used in medicine yet up to 15 000 medicinal plants are under threat in the wild and, if no action is taken, some could become extinct in fewer than ten years (BGCI, 2008). The world trade in medicinal plants has increased by 85 % since 1991, though the vast majority of trade involves only about a dozen countries (Schippman et al., 2006).

A number of studies also point to the fact that the largely unexplored health benefits of cultivated and wild plants include micro-nutrient intake and functions related to energy density, glycæmic control, oxidative stress and immuno-stimulation. Research on the properties of neglected and underutilized species and local varieties deserves higher priority (Johns and Eyzaguirre, 2006).

Many animals provide important models for research into human health, such as the implications for osteoporosis of hibernating bears that lose no bone mass (Chivian and Bernstein, 2008). Numerous animals also provide medicines, often from toxins used for offence — for example, by poisonous snakes and cone snails — or defence — amphibians (McNeely and Mainka, 2009).

About 9 % of European patent activity relates to biodiversity, or 16 % if the full spectrum of pharmaceutical activity is included (Oldham and Hall, 2009). After rapid growth, patent activity for biodiversity now shows a downward trend.

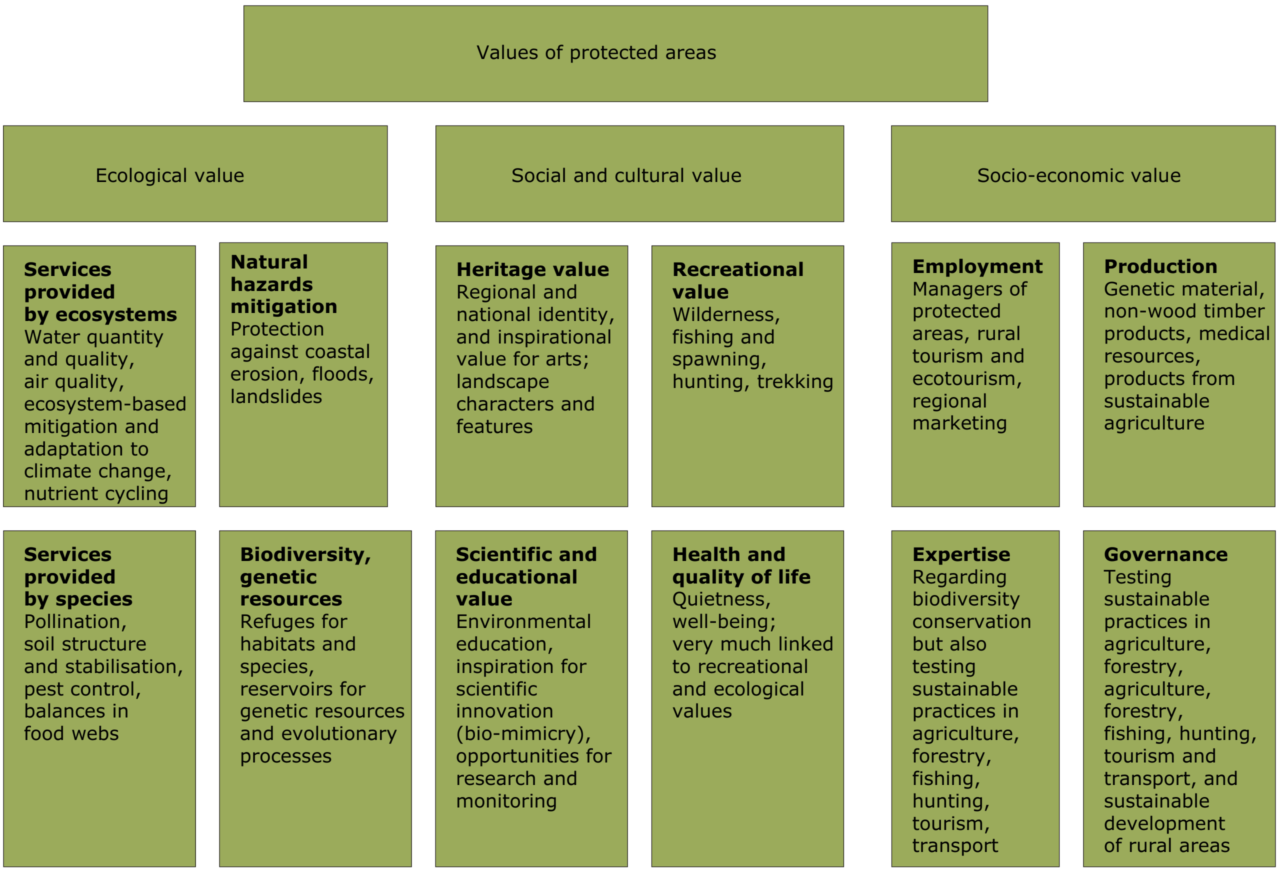
3.5 Protected areas and ecosystem services

Protected areas in Europe are designated in a wide range of ecosystems, including forests, grasslands, wetlands, mountain, coastal and marine areas, which are delivering ecosystem services. Thus, provisioning, regulating and cultural ecosystem services are embedded in the ecological, social and socio-economic values of protected areas (Figure 3.3).

The large majority of countries in Europe have assessed the management effectiveness of at least some of their protected areas within the last ten years, aiming to establish the extent to which their values are protected and their goals and objectives are achieved. The average overall management effectiveness in Europe was estimated to 0.56 on a zero-to-one scale, where one equates with fully effective management, slightly higher than the average of 0.53 from the global analysis (Nolte et al., 2010). This result implies that a number of ecosystem services provided by protected areas in Europe have been degraded.

Meeting the management objectives of protected areas has significant recurring and non-recurring costs, which, for example, for implementing the Natura 2000 network were estimated as EUR 5.8 billion per year for the EU-27 (Gantioler at al., 2010). While this amount is most certainly an underestimate, it may represent the 'hidden cost' of ecosystem maintenance and restoration in protected areas which escapes fiscal accounting but is essential in maintaining ecosystem services (EEA, 2010j).

Figure 3.3 Ecological, social and socio-economic values of protected areas



Source: Adapted from CREDOC, 2008 and Stolton, 2009.

4 Outlook and responses

4.1 Outlooks

Combined changes in land use, exploitation of forests and marine resources, rising atmospheric carbon dioxide (CO_2) concentrations, climate change and eutrophication are projected by models to result in significant changes in the distribution and abundance of species, species groups and biomes at the global level. In particular, projections of global change impacts on biodiversity over the 21st century show continuing and, in many cases, accelerating species extinctions, loss of natural habitat, and changes in the distribution and abundance of species and biomes (Leadley et al., 2010).

Many of the global trends are likely to affect species and ecosystems in Europe as well even though no specific biodiversity outlooks or scenarios are available for the continent. Work for the EEA reviews a number of studies that provide European medium-term land use outlooks with a time horizon of 10–20 years (RIKS, 2010). Most of these build on economic or land use models, based on different driver assumptions regarding, for example, socio-economic trends and technology as well as (European) policies including the Common Agricultural Policy (CAP), the Birds and Habitats Directives, the Nitrates Directive or the Water Framework Directive. A couple of the studies explore likely impacts of land use trends on biodiversity while only one (LUMOCAP, an EC 6th Framework Programme project) explores different climate scenarios (RIKS, 2010).

Land-use trends of particular relevance for biodiversity include the relative share and intensity of agricultural land use categories. The selected studies mostly expect that grassland cover over the EU-27 will further decrease, while the area of permanent crops will remain stable or decrease slightly. The share of set-aside on arable land will decline strongly while agricultural land in general is also projected to decrease (RIKS, 2010).

While information about environmental impacts in the studies is limited, one of them, the European Fertilizer Manufacturers Association (EFMA) Forecast (RIKS, 2010), points at increased consumption of nitrogen (N), phosphate (P_2O_5) and potash (K_2O) fertilisers in EU-12, while they will remain stable in the EU-15. Combined with the shrinking farmland area, this intensification may locally lead to increased water pollution.

One study from ETC-LUSI (RIKS, 2010) explicitly reviews the impact of the biofuel target of the Renewable Energy Directive on farmland birds. The associated conversion of set-aside areas to biofuel crops is expected to have negative impacts on this species group, particularly in Bulgaria, France, Hungary, Italy, Portugal, Spain and Romania. This is consistent with Scenar-II findings (RIKS, 2010), indicating that urban areas, intensive agriculture and forest are likely to increase at the expense of grasslands, extensive agriculture and wetlands. As a result bird populations in general may decrease by 10 %, while farmland bird populations are projected to decrease even more (RIKS, 2010).

These projections are in line with a model-based study on the likely impact of land use trends on European farmland bird populations (Butler et al., 2010). This study reviews likely farmland bird population trends under four different land use scenarios and predicts a further decline of European farmland bird populations under all four scenarios. The strongest loss is associated with the abolishment of the compulsory set-aside EU policy, agricultural intensification in the eastern Member States and further land abandonment in the EU.

Some information on biodiversity outlooks can also be found in climate change projections for Europe. As highlighted in the SOER 2010 adapting to climate change assessment (EEA, 2010m), the impacts of climate change are expected to vary considerably and to be more pronounced in the Mediterranean basin, north-western Europe and the Arctic. Loss of biodiversity is among the main consequences expected, related also to the increased risk of floods and droughts and the impacts to economic sectors such as energy, forestry, agriculture and tourism (EEA, 2008b).

By the end of the 21st century, distributions of European plant species are projected to have shifted several hundred kilometres to the north, assuming they can migrate across intensively managed and fragmented European landscapes, forests are likely to have contracted in the south and expanded in the north, and up to 60 % of mountain plant species may be facing extinction.

Many key climate indicators suggest that the world has already moved beyond the patterns of natural variability within which contemporary societies and economies have developed and thrived. This means that, even if European and global emission reductions and mitigation efforts over the coming decades prove to be successful, adaptation measures will still be necessary to deal with the impacts of climate change already being experienced today, and those that may be unavoidable in the future.

As a response to the alarming global biodiversity outlook (CBD, 2010), in October 2010 the 10th Conference of the Parties to CBD has adopted a new mission and Strategic Plan for the next ten years. This plan aims to guide international and national efforts to save biodiversity through enhanced action and fulfil the objectives of the Convention.

4.2 Response

Pan-European commitments, the 6th Environment Action Programme of the EU and the EU BAP endorsed the target of halting biodiversity loss by 2010. Significant targeted responses to restore habitats, protect threatened species and reduce the main threats to biodiversity in Europe have been made by public, civil society and private institutions (EEA, 2010b). Actions were taken within environmental policy as well as within the agriculture and forestry sectors. However, this and many other recent assessments developed by the EEA (EEA, 2010a; EEA, 2010b) show that Europe is still far from meeting its 2010 biodiversity target and that it risks missing future targets unless it changes the way our environment is being managed.

Progress has been made, however, in a number of objectives of the BAP, especially with implementing environmental legislation (EC, 2010d). There are indications that the Birds and Habitats Directives can deliver positive results in terms of the targeted species and habitat types (EEA, 2010b). In particular the Birds Directive has made significant progress towards halting the decline of many of Europe's most threatened birds. Key measures include designating Special Protection Areas (SPAs) as part of Natura 2000; adopting and implementing international Species Action Plans (SAPs); additional measures by Member States; and empowering conservation non-governmental organisations (Donald et al., 2007).

Under the Habitats Directive some species, including the wolf (*Canis lupus*), brown bear (*Ursus arctos*), Eurasian beaver (*Castor fiber*), Eurasian otter (*Lutra lutra*), Lake Constance forget-me-not (*Myosotis rehsteineri*) and the Troodos rockcress (*Arabis kennedyae*) are showing signs of recovery or positive trends (EC, 2009c).

Natura 2000 sites now cover 18 % of EU land and overall protected areas cover almost 22 % of EEA member countries. Protected areas, species and habitat types have received increased support in several countries resulting in positive effects on species and habitats, such as in England, the United Kingdom, where 95 % of Sites of Special Scientific Interest (SSSI) are in a good state or on a recovery track (Kirby et al., 2010). EU funding for nature conservation and biodiversity has increased, however, it remains a tiny fraction of the EU annual budget (Box 4.1).

Conserving and managing these sites effectively and enhancing their coherence with their neighbouring land by developing the green infrastructure of Europe is key to maintaining and restoring favourable conservation status for Europe's most important habitats and species.

Legislation and investments have improved air and water quality, reducing pollution pressures on ecosystems. The reduction in emissions of acidifying and eutrophicating pollutants, if continued effectively, will allow the recovery of freshwater and terrestrial ecosystems, which are still under pressure from the exceedance of critical loads of nitrogen. The current proposal for revising the National Emission Ceiling Directive (EC, 2001) includes provisions on monitoring the effects on aquatic and terrestrial ecosystems within all types of Natura 2000 sites (EEA, 2009a).

Recent reforms of the EU's Common Agricultural Policy have encouraged a more careful use of fertilisers and a wider uptake of environmentally-friendly management, such as organic farming and agri-environment schemes, which can support biodiversity in agro-ecosystems. Certain land management obligations related to water courses and habitats introduced in 2009 are expected to support biodiversity, the abolition of compulsory set-aside, however, has raised concerns (EC, 2010d). First introduced in 1988 and made obligatory since 1992, set-aside had positive results in supporting species depending on farmland including species typical of extensively used farmland (Eurostat, 2010b).

However, all these measures were not sufficient to stop biodiversity loss. Targeting of agricultural support payments has not been sufficiently aligned with the distribution of high nature value farmland between different EU-15 Member States (EEA, 2009c). Consequently, there remains considerable scope under the EU CAP to improve management of agricultural areas including high nature value farmland, to safeguard ecosystem services and integrate biodiversity into agricultural management practices, including conserving genetic resources.

Ecological compensation areas in agricultural lands, such as those in Switzerland; green bridges partially restoring connectivity across highways and other measures have been implemented in many countries, usually following the elaboration of environmental impact assessments. An important step forward would be a more integrated approach to biodiversity management across sectors, and across administrative boundaries, at landscape scales, with the aim of achieving multifunctional land-use planning at a regional scale.

The diversity of forest functions has been recognised by the EU Forest Action Plan (EC, 2006b) which sets out key actions to be implemented over five years (2007–2011) which include coordinating EU initiatives with the forest policies of Member States. Forest harvesting pressures, however, are likely to increase in the future if biomass demands for energy increase (Eurostat, 2010c).

The need of coherence between the EU energy policies and biodiversity has been recognised, especially in the issue of biofuels. Consequently there has been progress towards the adoption of sustainability criteria for liquid biofuels and for the implementation of the Renewable Energy Directive, with a view to preventing, negative impacts on EU and global biodiversity (EC, 2010d). However, concerns remain that conventional energy crops and indirect effects of EU biofuel targets may lead to biodiversity loss within and outside Europe (BfN, 2009; Eickhut et al., 2008).

Some key gaps remain in EU policy for the conservation and sustainable use of biodiversity, for instance addressing the increasing number of invasive alien species (EEA, 2010b). There is also a need to put in place an effective legal EU framework for conserving soil structure and functions, as soil biodiversity is also of fundamental significance to ecosystem health (EEA, 2010b). Additional measures to safeguard a network of Special Areas of Conservation and to facilitate landscape-scale initiatives for biodiversity in overseas territories and the outermost regions need to be considered (EEA, 2010b).

Furthermore, continuing and deepening the mainstreaming of biodiversity in public and private sector decisions and policies, such as those concerned with trade, planning, transport, tourism and finance, would help address many of the underlying threats to biodiversity.

Direct funding for biodiversity in the EU is provided by the LIFE+ funding programme; EU funds for agriculture and rural development, EAFRD; research, 7th Framework Programme; and regional development, the European Regional Development Fund, European Social Fund and Cohesion Fund (EEA, 2010b). It is not possible at this stage, however, to assess the effectiveness of the measures funded in many of these areas.

Even though the 2010 target has not been met, progress has been made in communicating biodiversity issues, developing biodiversity indicators such as the SEBI 2010 set, building a knowledge base and setting up the 2010 biodiversity baseline for the EU. Biodiversity and ecosystems are now higher on the political agenda in Europe than ever before.

Box 4.1 Funding for nature conservation and biodiversity in the EU

Between 1992 and 2008, 1 107 nature conservation projects have been funded by the LIFE programme, with a budget of more than EUR 1 700 million, a tiny fraction of the EU annual budget:

- Forest, grasslands and freshwater habitats were the habitat types most often targeted by LIFE (respectively 20 %, 19 % and 15 %).
- Birds and mammals are species groups most often targeted with 34 % and 21 % of the projects.
- Approximately half of the projects aiming at species protection or reintroduction achieved favourable status at local and regional level for one or more species in the long term.
- More than 100 LIFE projects dealt with the eradication and control of invasive alien species.
- Approximately 320 000 ha of Natura 2000 sites were restored.
- Nine per cent of total SPAs and 8 % of total SCIs in the EU-27 have been targeted by LIFE projects (approximately 450 SPAs and 1 700 SCIs).

The European Agricultural Fund for Rural Development (EAFRD) provides for financing of measures likely to contribute to maintenance and restoration of biodiversity:

- Some 44 % of the EAFRD, for the period 2007–2013 has been allocated by Member States to Axis 2 measures, whose objectives are 'improving the environment and the countryside'.
- The CAP Health Check assigned some additional funding to five 'new challenges' including biodiversity; for the current programming period, EUR 20 billion, representing half of the budget devoted to the environmental axis of Rural Development policy, will be spent on agri-environment measures.
- EUR 472 million will be spent on Natura 2000 measures on farm land and EUR 111 million on Natura 2000 measures on forestry land.

Source: EEA, 2010a.

4.3 Way forward and knowledge gaps

While ambitious targets are being set in Europe to halt biodiversity loss and some progress is being made, many threats remain and new ones are growing. Future progress in addressing these threats and conserving Europe's remaining biodiversity, as identified in a recent biodiversity assessment (EEA, 2010b) will depend on success in four key areas:

1. **Enhanced implementation** of measures targeted at biodiversity conservation. There remains considerable opportunity to scale up such practices across the region, that are essential to managing the most important threats and conserving the most threatened biodiversity. However, alone they are insufficient to address biodiversity loss in the medium and long term because many of the direct drivers, and all of the indirect drivers of biodiversity loss, emanate from other sectors.

2. **Policy coherence** on biodiversity is required with other sectors. In order to conserve and sustainably use biodiversity, policies in other sectors that have an impact on or depend on biodiversity need to be supportive. These include those on trade, agriculture, energy, fisheries, planning, transport, health, tourism, and the financial sector, including insurance. Mainstreaming biodiversity into these areas — in both the public and private sectors — is essential for an integrated approach to biodiversity conservation. Successful mainstreaming will require all sectors to recognise the value of biodiversity and account for the natural capital they use. Recent work, such as the Economics of Ecosystems and Biodiversity study (TEEB, 2010), provide a basis for mainstreaming.

3. **A more integrated ecosystem management approach across sectors and administrative boundaries**, at landscape scale, is needed. Such approaches are already starting to be applied in forestry and freshwater systems but are lagging behind in agricultural land and mountains. Integrating protected areas, ecological networks, connectivity areas, production and urban landscapes at watershed and landscape scales can help build Europe's green infrastructure. The integration of biodiversity and natural resources management, including water, at regional scales can be supported by a variety of tools such as optimal land use plans, adaptation to climate change strategies, ecosystem accounts, sustainable management indicators.

4. **Public awareness** of the relevance of biodiversity to the lives of European citizens, and the consequences of biodiversity loss at local, European and global scales, needs to be raised. Significant efforts are therefore required in communication, education and public awareness to complement the policy framework and encourage both individual action for biodiversity conservation, and a supportive public opinion for changes in policy and practice.

Key knowledge gaps in individual elements of biodiversity remain across Europe and filling these would support action and policies across the four key areas. Little is known, for example, about genetic diversity beyond the agricultural sector and for many taxa at the species level. Considerable further work is required to assess the status of plants, invertebrates and fungi, and to assess trends in species status. European-level data on species, communities and genetic stock are often not available or lacking at relevant scales for assessing key environmental drivers or habitat change (EEA, 2010b).

In addition to knowledge of specific elements of biodiversity, interdisciplinary knowledge gaps are particularly apparent, with little in the way of accumulated knowledge on the linkages between biodiversity, ecosystem services and human wellbeing. Recent efforts to link biodiversity science with economics have been particularly promising but further interdisciplinary research and assessment would strengthen decision- and policymaking processes (EEA, 2010b).

One major issue linked to the response of governments and citizens is public awareness and the need to better understand biodiversity issues. Public support and awareness to promote and fund biodiversity conservation has hardly changed: according to opinion polls across the EU, in 2007 two thirds of citizens did not understand the word biodiversity and by 2010 this had only slightly reduced — down from 65 % to 62 %. Communication and education must continue to raise public awareness about the importance of biodiversity, its links to livelihoods by way of ecosystem services, and its ongoing loss. These actions can encourage both individual action to conserve biodiversity and public support for changes in policy and practice.

Another major challenge is to identify and address issues of policy coherence between biodiversity targets and other sectors such as energy, agriculture and transport. For example increasing the share of renewable energy in total EU energy consumption is a key policy objective. Biomass is by far the most important renewable energy source, providing two thirds of the total energy produced from renewables (EEA, 2007c). The substantial rise in the use of biomass from agriculture and other sectors for transport fuels and energy can put additional environmental pressures on farmland or forest biodiversity.

Only continuous and concerted effort towards more sustainable consumption and production practices will ensure that positive trends in European nature and biodiversity conservation are maintained and negative trends reversed. This is essential to meet national, regional and global commitments to halt and reduce biodiversity loss and degradation of ecosystems and their services. Given the characteristic response times for political, socioeconomic, and ecological systems, longer-term goals and targets, such as those for 2050, are needed to guide policy and actions. Many events in 2009 and 2010 at the EU and pan-European levels paved the way for the 10th Meeting of the Parties to the CBD in Nagoya, Japan (October 2010) in order to agree on a post-2010 vision and target.

The Nagoya meeting achieved its three inter-linked goals: adoption of a new ten year Strategic Plan to guide international and national efforts to save biodiversity through enhanced action to meet the objectives of the Convention on Biological Diversity; a resource mobilisation strategy that provides the way forward to a substantial increase to current levels of official development assistance in support of biodiversity; and a new international protocol on access to and sharing of the benefits from the use of the genetic resources of the planet (see Box 4.2).

Box 4.2 Global biodiversity targets adopted in CBD-COP10

The Strategic Plan of the CBD adopted in Nagoya in October 2010 includes 20 targets, many of which represent a high level of ambition and reflect the EU's key priorities. These include:

- ensuring that biodiversity values are incorporated into national accounting and reporting systems (target 2);
- incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed (target 3).
- new global targets for terrestrial and marine protected areas: 17 % of terrestrial and inland water, and 10% of coastal and marine areas (target 11);
- a requirement to restore at least 15% of degraded ecosystems (target 15);
- to cut the rate of loss of all natural habitats, including forests, by at least half as well as to significantly reduce fragmentation and degradation of habitats (target 5). This last target is especially significant because it is the first time that a global target has been agreed that captures both the quantitative and qualitative dimensions of the problems affecting forests and other habitat types;
- an ambitious target for fisheries, focusing on the need to ensure that stocks are exploited within safe ecological limits in order to avoid overfishing (target 6);
- the biodiversity science base and technologies relating to biodiversity to be improved, widely shared and transferred, and applied (target 19).

Whereas most targets are for 2020, three have earlier deadlines of 2015, notably in relation to minimizing anthropogenic pressures on coral reefs (target 10), to making operational the Access and Benefit Sharing (ABS) Protocol (target 16), and to put in place updated biodiversity strategies and action plans (target 17).

Last but not least, target 20 requires that by 2020 at the latest, financial resources from all sources should have increased substantially from current levels, in accordance with a process set out in the separate but related decision on the Strategy for Resource Mobilization, which will culminate in the adoption of quantified funding targets by the next Conference of the Parties (COP11) in 2012.

References

Alpine Convention, 1991. Convention on the Protection of the Alps. www.alpconv.org/index_en (accessed 4 October 2010).

Arrouays, D.; Deslais, W. and Badeau, V., 2001. 'The carbon content of topsoil and its geographical distribution in France'. *Soil Use and Management* 17, 7–11.

Arrouays, D.; Saby, N.; Walter, C.; Lemercier, B. and Schvartz, C., 2006. 'Relationships between particlesize distribution and organic carbon in French arable topsoils'. *Soil Use and Management* 22, 48–51.

Barcelona Convention, 1982. *Convention for the protection of the Mediterranean Sea against pollution*. http://europa.eu/legislation_summaries/environment/water_protection_management/l28084_en.htm (accessed 4 October 2010).

Bern Convention, 1992. Convention on the Conservation of European Wildlife and Natural Habitats. http://conventions.coe.int/Treaty/en/Treaties/Html/104.htm (accessed 4 October 2010).

BfN, 2009. *Where have all the flowers gone?* Grünland im Umbruch. Bundesamt für Naturschutz, Bonn.

BGCI, 2008. *Plants for Life: Medicinal Plants Under Threat*. Botanical Gardens Conservation International. www.bgci.org/ourwork/medplants (accessed 5 October 2010).

BirdLife International, 2004a. *Birds in the European Union: a status assessment*. Wageningen, the Netherlands, BirdLife International.

BirdLife International,2004b. *State of the world's birds. Pressure: Many species are exploited beyond sustainable levels*. www.birdlife.org/action/science/sowb/case_studies/p42-43.pdf (accessed 11 November 2010).

Blair, R.B. and Launer, A.E., 1997. 'Butterfly diversity and human land use: Species assemblages along an urban gradient'. *Biological Conservation* 80(1), pp. 113–125.

BMLFUW, 2009. *Grüner Bericht. Bericht über die Situation der österreichischen Land- und Forstwirtschaft*. Federal Ministry of Agriculture, Forestry, Environment and Water Management, Vienna.

Bonn Convention, 1979. Convention on Migratory Species. www.cms.int/index.html (accessed 4 October 2010).

Bucharest Convention, 1992. The Commission on the Protection of the Black Sea Against Pollution. www.blacksea-commission.org/main.asp (accessed 4 October 2010).

Butler, S.J.; Boccaccio, L.; Gregory, R.D.; Vorisek, P. and Norris, K., 2010. 'Quantifying the impact of land-use change to European farmland bird populations'. *Agriculture, Ecosystems and Environment* 137 (2010) 348–357.

Carpathian Convention, 2003. Convention on the Protection and Sustainable Development of the Carpathians. www.carpathianconvention.org/index.htm (accessed 4 October 2010).

CBD, 2010. Global Biodiversity Outlook 3. Secretariat of the Convention for Biological Diversity, Montreal. www.cbd.int/doc/publications/gbo/gbo3-final-en.pdf (assessed 4 October 2010).

CDDA, 2009. Nationally designated areas (National — CDDA). www.eea.europa.eu/data-andmaps/data/nationally-designated-areas-nationalcdda-4/#previous-versions (accessed 16 August 2010).

Chivian, E. and Bernstein, A. (eds), 2008. *Sustaining Life: How Human Health Depends on Biodiversity.* Oxford University Press, New York, USA.

Chopra, K.; Kapuria, P. and Kumar, P., 2009. *Biodiversity, Land-Use Change and Human Well Being: A Case Study of Sundarbans*. Oxford University Press, Delhi.

CREDOC, 2008. *La valeur économique et sociale des espaces protégés*. Cahier de recherche n°247, Novembre 2008, Paris. www.credoc.fr/pdf/Rech/C247.pdf (accessed 11 January 2010).

CITES, 1973. Convention on International Trade in Endangered Species of Wild Fauna and Flora. www.cites.org/ (accessed 4 October 2010).

CLC, 2006. Corine land cover. Corine land cover 2006 raster data. www.eea.europa.eu/data-and-maps/data/corine-land-cover-2006-raster (accessed 16 August 2010);

Corine land cover 2000 raster data, www.eea.europa.eu/data-and-maps/data/corine-land-cover-2000-raster (accessed 16 August 2010); Corine land cover 1990 raster data, www.eea.europa.eu/data-and-maps/data/corine-land-cover-1990-raster (accessed 16 August 2010); Corine land cover 1990–2000 changes, www.eea.europa.eu/data-and-maps/data/corine-land-cover-1990-2000 (accessed 16 August 2010); Corine land cover 2000–2006 changes, www.eea.europa.eu/data-and-maps/data/corine-land-cover-2000-2006 (accessed 16 August 2010).

Coleman A. and Aykroyd, T., 2009. Conference Proceedings: Wild Europe and Large Natural Habitat Areas, Prague 2009. www.wildeurope.org/attachments/051_proceedings%20document%20FINAL.pdf (accessed 5 October 2010).

COST, 2009. COST 729 — Assessing and managing nitrogen fluxes in the atmosphere-biosphere system in Europe — Nitrogen deposition and Natura 2000: Science and practice in determining environmental impacts, findings of a European Workshop linking scientists, environmental managers and policymakers, 18–20 May 2009, Brussels, summary for policymakers. http://cost729.ceh.ac.uk/n2kworkshop/documents (accessed 5 October 2010).

CoE, 2003. European Strategy on Invasive Alien Species. Convention on the Conservation of European Wildlife and natural habitats. Council of Europe. https://wcd.coe.int/com.instranet.InstraServlet?command=com.instranet.CmdBlobGet&InstranetImage=1322677&SecMode=1&DocId=1440418&Usage=2 (accessed 8 November 2010).

Cox, N.A. and Temple, H.J., 2009. *European Red List of Reptiles*. Luxembourg, Publications Office of the European Union.

Cooper, T.; Hart, K.; Baldock, D., 2009. *The provision of public goods through agriculture in the European Union*. Report prepared for DG Agriculture and Rural Development No 30-CE-0233091/00-28. Institute for European Policy: London. www.ieep.eu/publications/pdfs/2010/final_pg_report.pdf (accessed 5 October 2010).

DAISIE, 2009. *Handbook of Alien Species in Europe. Invading nature — DAISIE-Spinger Series in Invasion Ecology, Vol. 3*. Springer,Dordrecht, 2009.

De Stanfano, L., 2004. *Freshwater and Tourism in the Mediterranean*. WWF Mediterranean Programme, Rome.

Devictor, V.; Julliard, R.; Couvet, D.; Lee, A. and Jiguet, F., 2007. 'Functional homogenization effect of urbanization on bird communities'. *Conservation biology* 21: 741–751.

Devictor, V.; Julliard, R.; Clavel, J.; Jiguet, F.; Lee, A. and Couvet, D., 2008a. 'Functional biotic homogenization of bird communities in disturbed landscapes'. *Global Ecology and Biogeography* 17: 252–261.

Devictor, V.; Julliard, R. and Jiguet, F., 2008b. 'Distribution of specialist and generalist species along spatial gradients of habitat disturbance and fragmentation'. *Oikos* 117: 507–514.

Donald, P.F.; Sanderson, F.J.; Burfield, I.J.; Bierman, S.M.; Gregory, R.D. and Waliczky, Z., 2007. 'International conservation policy delivers benefits for birds in Europe'. *Science* 317, pp. 810–813.

Dudley, N. (ed.), 2008. *Guidelines for Applying Protected Area Management Categories*. IUCN, Gland, Switzerland. http://data.iucn.org/dbtwwpd/edocs/PAPS-016.pdf (accessed 11 January 2010).

EASAC, 2009. *Ecosystem services and biodiversity in Europe*, EASAC policy report 09, the Royal Society, 2009. http://www.easac.org/document.asp?id=90&pageno=1&detail=1&parent=31 (accessed 12 November 2010).

EC, 1991. Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31991L0676:EN:HTML (accessed 4 October 2010).

EC, 1992. Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora. OJ L 206, 22.7.1992. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31992L0043:EN:NOT (accessed 12 August 2010).

EC, 2000. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. OJ L 327, 22.12.2000, p. 1–73. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32000L0060:EN:NOT (accessed 16 August 2010).

EC, 2001. Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2001:309:0022:0030:EN:PDF (accessed 4 October 2010).

EC, 2002. Decision No 1600/2002/EC of the European Parliament and of the Council of 22 July 2002 laying down the Sixth Community Environment Action Programme. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:242:0001:0015:EN:PDF (accessed 4 October 2010).

EC, 2004. Directive 2004/35/CE of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage. http://eur-lex.europa.eu/smartapi/cgi/sga_doc?smartapi!celexplus!prod!DocNumber&lg=en&type_doc=Directive&an_doc=2004&nu_doc=35 (accessed 4 October 2010).

EC, 2006a. EU Biodiversity Action Plan. SEC(2006) 621. Commission staff working document. Annexes to the communication from the Commission 'Halting the loss of biodiversity by 2010 — and beyond: Sustaining ecosystem services for human well–being' (COM(2006)216 final). http://ec.europa.eu/environment/nature/biodiversity/comm2006/pdf/sec_2006_621.pdf (accessed 4 October 2010).

EC, 2006b. Communication from the Commission to the Council and the European Parliament of 15 June 2006 on an EU Forest Action Plan (COM(2006)302 final).

EC, 2007a. *LIFE and Europe's wetlands: Restoring a vital ecosystem*. European Commission. Office for Official publications of the European Communities, Luxembourg, 2007. http://ec.europa.eu/environment/life/publications/lifepublications/lifefocus/nat.htm.wetlands (accessed 22 February 2010).

EC, 2007b. *LIFE and Europe's rivers: Protecting and improving our water resources.* European Commission. Office for Official publications of the European Communities, Luxembourg, 2007. http://ec.europa.eu/environment/life/publications/lifepublications/lifefocus/nat.htm.rivers (assessed 22 February 2010).

EC, 2008a. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:164:0019:0040:EN:PDF (accessed 4 October 2010).

EC, 2008b. Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions — Towards an EU Strategy on Invasive Species. COM(2008) 789 final. http://ec.europa.eu/environment/nature/invasivealien/docs/1_EN_ACT_part1_v6.pdf (accessed 12 August 2010).

EC, 2009a. Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:020:0007:0025:EN:PDF (accessed 20 August 2010).

EC, 2009b. Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC. www.energy.eu/directives/pro-re.pdf (accessed 4 October 2010).

EC, 2009c. Report from the Commission to the Council and the European Parliament — Composite Report on the Conservation Status of Habitat Types and Species as required under Article 17 of the Habitats Directive. COM(2009) 358 final. http://ec.europa. eu/environment/nature/knowledge/rep_habitats/docs/com_2009_358_en.pdf (accessed 12 August 2010).

EC, 2009d. Towards a green infrastructure for Europe — Developing new concepts for integration of Natura 2000 network into a broader countryside EC study ENV.B.2/SER/2007/0076. ATECMA, ECOSYSTEMS, RIKS, TERSYN, EEZA-CSIC.

EC, 2010a. European Council — 25/26 March 2010 — Conclusions. http://europa.eu/rapid/pressReleasesAction.do?reference=DOC/10/1&format=HTML&aged=0&language=EN&guiLanguage=en (accessed 12 August 2010).

EC, 2010b. Green Paper Forest Protection and Information in the EU: Preparing forests for climate change, COM(2010) 66 final of 1 March 2010. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0066:FIN:EN:PDF (accessed 5 October 2010).

EC, 2010c. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions — Options for an EU vision and target for biodiversity beyond 2010. COM(2010) 4 final. http://ec.europa.eu/environment/nature/biodiversity/policy/pdf/communication_2010_0004.pdf (accessed 12 August 2010).

EC, 2010d. Report from the Commission to the Council and the European Parliament. The 2010 Assessment of Implementing the EU Biodiversity Action Plan. COM(2010) 548 final. http://ec.europa.eu/environment/nature/biodiversity/comm2006/pdf/bap_2010/1_EN_ACT_part1_ v2.pdf (accessed 6 November 2010).

EEA, 2006a. *Progress towards halting the loss of biodiversity by 2010*. EEA Report No 5/2006. European Environment Agency, Copenhagen. www.eea.europa.eu/publications/eea_ report_2006_5 (accessed 4 March 2009).

EEA, 2006b. *The changing faces of Europe's coastal areas*. EEA Report No 6/2006. European Environment Agency, Copenhagen. www.eea.europa.eu/publications/eea_report_2006_6 (accessed 5 August 2010).

EEA, 2007a. *Europe's environment — the fourth assessment. Chapter 7: Sectors that drive environmental change: Tourism*. European Environment Agency, Copenhagen. www.eea.europa.eu/publications/state_of_environment_report_2007_1/chapter7.pdf (accessed 13 July 2010).

EEA, 2007b. *Air pollution in Europe 1990–2004*. EEA Report No 2/2007. European Environment Agency, Copenhagen. www.eea.europa.eu/publications/eea_report_2007_2 (accessed 5 October 2010).

EEA, 2007c. *Estimating the environmentally compatible bioenergy potential from agriculture*. EEA Technical report No 12/2007. European Environment Agency, Copenhagen. www.eea.europa.eu/publications/technical_report_2007_12 (accessed 20 August 2010).

EEA, 2008a. *European forests — ecosystem conditions and sustainable use*. EEA Report No 3/2008. European Environment Agency, Copenhagen. www.eea.europa.eu/publications/eea_report_2008_3 (accessed 5 October 2010).

EEA, 2008b. *Impacts of Europe's changing climate — 2008 indicator-based assessment*. EEA Report No 4/2008. European Environment Agency, Copenhagen. www.eea.europa.eu/publications/eea_report_2008_4 (accessed 5 October 2010).

EEA, 2008c. *Maximising the environmental benefits of Europe's bioenergy potential*. EEA Technical report No 10/2008. European Environment Agency, Copenhagen. www.eea.europa.eu/publications/technical_report_2008_10 (accessed 26 October 2010).

EEA, 2009a. *Progress towards the European 2010 biodiversity target*. EEA Report No 4/2009. European Environment Agency, Copenhagen. www.eea.europa.eu/publications/progress-towards-the-european-2010-biodiversitytarget (accessed 13 July 2010).

EEA, 2009b. *Killer slugs and other aliens — Europe's biodiversity is disappearing at an alarming rate*. www.eea.europa.eu/articles/killer-slugsand-other-aliens (accessed 13 July 2010).

EEA, 2009c. *Distribution and targeting of the CAP budget from a biodiversity perspective*. EEA Technical report No 12/2009. European Environment Agency, Copenhagen. www.eea.europa.eu/publications/distribution-and-targeting-of-the-cap-budget-from-a-biodiversity-perspective (accessed 6 November 2010).

EEA, 2010a. *EU 2010 Biodiversity Baseline*. EEA Technical report No 12/2010. European Environment Agency, Copenhagen. www.eea.europa.eu/publications/eu-2010-biodiversity-baseline/eu-2010-biodiversity-baseline (accessed 26 October 2010).

EEA, 2010b. *Assessing biodiversity in Europe — the 2010 report*. EEA Report No 5/2010. European Environment Agency, Copenhagen, Denmark. www.eea.europa.eu/publications/assessing-biodiversity-in-europe-84 (accessed 5 October 2010).

EEA, 2010c. *10 Messages for 2010 — Protected areas*. European Environment Agency, Copenhagen. www.eea.europa.eu/publications/10-messages-for-2010-2014 (accessed 4 October 2010).

EEA, 2010d. *10 Messages for 2010 — Climate change and biodiversity*. European Environment Agency, Copenhagen. www.eea.europa.eu/publications/10-messages-for-2010-climate-change (accessed 4 October 2010).

EEA, 2010e. *The European environment — state and outlook 2010: marine and coastal environment.* European Environment Agency, Copenhagen.

EEA, 2010f. *The European environment — state and outlook 2010: land use.* European Environment Agency, Copenhagen.

EEA, 2010g. *The European environment — state and outlook 2010: soil.* European Environment Agency, Copenhagen.

EEA, 2010h. *The European environment — state and outlook 2010: freshwater quality.* European Environment Agency, Copenhagen.

EEA, 2010i. *The European environment — state and outlook 2010: air quality.* European Environment Agency, Copenhagen.

EEA, 2010j. *Ecosystem accounting and the cost of biodiversity losses — The case of coastal Mediterranean wetlands*. EEA Technical report No 3/2010. European Environment Agency, Copenhagen.

EEA, 2010k. *The European environment — state and outlook 2010: consumption and environment.* European Environment Agency, Copenhagen.

EEA, 2010l. *10 Messages for 2010 — Freshwater ecosystems*. European Environment Agency, Copenhagen. www.eea.europa.eu/publications/10-messages-for-2010-freshwater (accessed 4 October 2010).

EEA, 2010m. *The European environment — state and outlook 2010: adapting to climate change.* European Environment Agency, Copenhagen.

EFDAC, 2010. *European Forest Data Centre.* http://efdac.jrc.ec.europa.eu (accessed 6 September 2010).

Eickhout, B.; Notenboom, J.; Ros, J.P.M; van den Born, C.J.; van Oorschot, M.; van Vuuren, D.P. and Westhoek, H.J., 2008. *Local and global consequences of the EU renewable directive for biofuels*. MNP-report 500143001, Bilthoven, the Netherlands. www.rivm.nl/bibliotheek/rapporten/500143001.pdf (accessed 11 November 2010).

ETC/BD, 2008. *Habitats Directive Article 17 Report (2001–2006)*. http://biodiversity.eionet.europa.eu/article17 (accessed 12 August 2010).

ETC/BD, 2009. Habitats Directive Article 17 technical report. European Topic Centre on Biological Diversity, Paris. http://biodiversity.eionet.europa.eu/article17 (accessed October 2009).

EU WG, 2009. *Towards a strategy on climate change, ecosystem services and biodiversity*. European Union Ad Hoc Expert Working Group on Biodiversity and Climate Change. http://ec.europa.eu/11environment/nature/pdf/discussion_paper_climate_change.pdf (accessed 7 December 2009).

European Landscape Convention, 2000. http://conventions.coe.int/Treaty/en/Treaties/Html/176.htm (accessed 5 October 2010).

Eurostat, 2010a. Agriculture, land use data (including data for BE , DK, SP, FR, GR, IE, IT, LU, NL, UK, (1973–2005), SE (1983–2004) PT (1984–2005), AT, BG, CZ, EE, HU, LT, LV, PL, RO, FI, CY(1987–2005), SK (1988/2005), DE, SL, MT (1991–2005)). http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/ (accessed 6 November 2010).

Eurostat, 2010b. Environmental statistics and accounts in Europe. Chapter on Biodiversity and Land use. Luxembourg: Publications Office of the European Union, 2010. http://epp.eurostat.ec.europa.eu/portal/page/portal/product_details/publication?p_product_code=KS-32-10-283.

Eurostat, 2010c. Environmental statistics and accounts in Europe. Chapter on Forestry. Luxembourg: Publications Office of the European Union, 2010. http://epp.eurostat.ec.europa.eu/portal/page/portal/product_details/publication?p_product_code=KS-32-10-283.

Evans, D., 2006. The habitats of the European Union Habitats Directive. Biology and Environment: Proceedings of the Royal Irish Academy, 106b (3):167–173.

FAO, 2005. *Global Forest Resources Assessment 2005 — Country tables — Biomass stock in forest and other wooded land*. www.fao.org/forestry/32100/en/ (accessed 27 April 2009).

FAO, 2006. *Global Forest Resources Assessment 2006 — Progress towards sustainable forest management*. Food and Agriculture Organization of the United Nations, Rome. ftp://ftp.fao.org/docrep/fao/008/A0400E/A0400E00.pdf (accessed 4 October 2010).

FAO, 2007. *Global Plan of Action for animal genetic resources and the Interlaken declaration. Commission on genetic resources for food and agriculture*. Food and Agriculture Organization of the United Nations, Rome.

FAO, 2009. *How to feed the world. Issue brief for the High-Level Expert Forum, Rome, 12–13 October 2009*. Food and Agriculture Organization of the United Nations, Rome.

Forest Europe, 1991. The Ministerial Conference on the Protection of Forests in Europe. www.foresteurope.org/eng/ (accessed 4 October 2010).

Gantioler S.; Rayment, M.; Bassi, S.; Kettunen, M.; McConville, A.; Landgrebe, R.; Gerdes, H. and ten Brink, P., 2010. *Costs and Socio-Economic Benefits associated with the Natura 2000 Network.* Final report to the European Commission, DG Environment on Contract ENV.B.2/SER/2008/0038. Institute for European Environmental Policy/GHK/Ecologic, Brussels.

Global Footprint Network, 2008. *National Footprint Accounts, 2008 Edition*. www.footprintnetwork.org/atlas (accessed 23 June 2009).

Greenleaf S.S and Kremen, C., 2006. 'Wild bees enhance honey bees' pollination of hybrid sunflower'. *Proc. Natl Acad. Sci. USA.* 103, 13 890–13 895. doi:10.1073/pnas.0600929103.

Gregory, R.D.; Willis, S.G.; Jiguet, F.; Voříšek, P.; Klvaňová, A.; van Strien, A.; Huntley, B.; Collingham, Y. C.; Couvet, D. and Green R.E., 2009. *An indicator of the impact of climatic change on European bird populations*. PLoS ONE 4(3): e4678. doi:10.1371/journal.pone.0004678.

Hajjar, R. and Hodgkin, T., 2007. 'The use of wild relatives in crop improvement: A survey of developments over the last 20 years'. *Euphytica* 156: 1–13.

Harrison, P.A. and the RUBICODE consortium, 2009. Conservation of Biodiversity and Ecosystem Services in Europe: From Threat to Action. www.eci.ox.ac.uk/research/biodiversity/downloads/rubicode-final.pdf (accessed 5 October 2010).

Harrison, P.A.; Vandewalle, M.; Sykes, M.T.; Berry, P.M.; Bugter, R.; de Bello, F.; Feld, C.K.; Grandin, U.; Harrington, R.; Haslett, J.R.; Jongman, R.H.G.; Luck, G.W.; Martins da Silva, P.; Moora, M.; Settele, J.; Sousa, J.P. and Zobel, M., 2010. *Identifying and prioritising services in European terrestrial and freshwater ecosystems*. Springer Science+Business Media B.V. 2010.

Helsinki Convention, 1992. Convention on the Protection of the Marine Environment of the Baltic Sea Area. www.helcom.fi/Convention/en_GB/text/ (accessed 4 October 2010).

Hettelingh, J.-P.; Posch, M.; Slootweg, J. (eds.), 2008. *Critical Load, Dynamic Modelling and Impact Assessment in Europe.* CCE Status Report 2008. Report No. 500090003, ISBN No 978-90-6960-211-0.

Hettelingh, J.-P.; Posch, M.; Slootweg, J. (eds.), 2009. *Progress in the modelling of critical thresholds, impacts to plant species diversity and ecosystem services in Europe*. CCE Status Report 2009. Report No. 500090004. ISBN No 978-90-78645-32-0.

INRA, 2008. *Agriculture and biodiversity — Benefiting from synergies, Synthesis of the multidisciplinary scientific assessment*. www.international.inra.fr/the_institute/scientific_expertise/expert_reports/agriculture_and_biodiversity (accessed 5 October 2010).

International Treaty on Plant Genetic Resources for Food and Agriculture, 2010. www.planttreaty.org/mls_en.htm (accessed 5 October 2010).

IUCN, 1994. Guidelines for Protected Area Management Categories. IUCN World Commission on Protected Areas with the assistance of the World Conservation Monitoring Centre. IUCN, Gland. www.unep-wcmc.org/protected_areas/categories/eng/index.html (accessed 4 October 2010).

IUCN, 2010. European Red List. http://ec.europa.eu/environment/nature/conservation/species/redlist/ (accessed 5 October 2010).

Jeffery, S.; Gardi, C.; Jones, A.; Montanarella, L.; Marmo, L.; Miko, L.; Ritz, K.; Peres, G.; Römbke, J. and van der Putten, W.H. (eds.), 2010. *European Atlas of Soil Biodiversity*. European Commission, Publications Office of the European Union, Luxembourg.

Johns, T. and Eyzaguirre P.B., 2006. 'Linking biodiversity, diet and health in policy and practice'. *Proceedings of the Nutrition Society* 65: 182–189 Cambridge University Press, doi: 10.1079/PNS2006494.

Johnsen, K.I.; Alfthan, B.; Hislop, L. and Skaalvik, J.F. (eds), 2010. *Protecting Arctic Biodiversity.* United Nations Environment Programme, GRID-Arendal. www.grida.no/_res/site/file/publications/arctic-biodiv/arcticMEAreport_screen.pdf (accessed 4 November 2010).

Kalkman, V.J.; Boudot, J.P.; Bernard, R.; Conze, K.J.; De Knijf, G.; Dyatlova, E.; Ferreira, S.; Jović, M.; Ott, J.; Riservato, E. and Sahlaon, G., 2010. *European Red List of Dragonflies*. Luxembourg, Publications Office of the European Union.

Kassen, R., 2002. 'The experimental evolution of specialists, generalists, and the maintenance of diversity'. *Journal of Evolutionary Biology* 15**:** 173–190.

Keller, P., 2004. Conclusions of the Conference on Innovation and Growth In Tourism. Lugano, Switzerland.

Kirby, K.; Jefferson, R.; Larwood, J.; Russel, D.; Le Bas, B. and Wright, R., 2010. 'What has the SSSI improvement programme achieved for nature conservation in England?' *British Wildlife*.

Kuuluvainen, T., 2009. 'Forest Management and Biodiversity Conservation Based on Natural Ecosystem Dynamics in Northern Europe: The Complexity Challenge'. *AMBIO: A Journal of the Human Environment* 38(6): 309–315. doi:10.1579/08-A-490.1.

Leadley, P.; Pereira, H.M.; Alkemade, R.; Fernandez-Manjarrés, J.F.; Proença, V.; Scharlemann, J.P.W.; Walpole, M.J., 2010. B*iodiversity Scenarios: Projections of 21st century change in biodiversity and associated ecosystem services*. Secretariat of the Convention on Biological Diversity, Montreal. Technical Series no. 50, 132 pages. www.diversitas-international.org/uploads/File/GBO3_Biodiversity_Futures.pdf (accessed 6 October 2010).

Lockwood and McKinney (eds), 2001. *Biotic Homogenization*. New York: Kluwer Academic/Plenum Press.

Louv, R., 2005. *The Last Child in the Woods: Saving our children from nature-deficit order.* Algonguin Books, New York, USA.

Loveland, P.J. and Webb, J., 2003. 'Is there a critical level of organic matter in the agricultural soils of temperate regions: a review'. *Soil and Tillage Research* 70, 1–18.

LUMOCAP, 2007. Dynamic land use change modelling for CAP impact assessment on the rural landscape. EC DG-RTD 6th Framework Programme Contract: SSPE-CT-2005-006556. www.riks.nl/projects/LUMOCAP (accessed 21 October 2010).

Luyssaert, S.; Detlef Schulze, E.; Börner, A.; Knohl, A.; Hessenmöller, D.; Law, B.E.; Ciais, Ph. And Grace, J., 2008. 'Old-growth forests as global carbon sinks'. *Nature* 455, 213–215.

MA, 2005. *Ecosystems and human well-being: synthesis. Millennium Ecosystem Assessment*. Island Press, Washington, DC. www.millenniumassessment.org/en/Synthesis.aspx (accessed 12 August 2010).

McKinney, M.L., 2006. 'Urbanization as a major cause of biotic homogenization'. *Biological Conservation* 127 (3), pp. 247–260.

McNeely, J.A. and Mainka, S.A., 2009. *Conservation for a New Era*. IUCN, Gland, Switzerland. 220 pp. http://data.iucn.org/dbtw-wpd/edocs/2009-026.pdf (accessed 5 October 2010).

MCPFE, 2007. *State of Europe's forests 2007. The MCPFE Report on Sustainable Forest management in Europe. Jointly prepared by the MCPFE Liaison Unit Warsaw, UNECE and FAO.* Ministerial Conference on the Protection of Forests in Europe, Warsaw. www.mcpfe.org/filestore/mcpfe/Publications/pdf/state_of_europes_forests_2007.pdf (accessed 24 March 2010).

Moreira, F.; Pinto, M. J.; Henriques, I. and Marques, T., 2005. The importantance of low-intensity farming Systems for fauna, flora and habitats protected under the European 'Birds' and 'Habitats' Directives: Is agriculture Essentials for preserving biodiversity in the Mediterranean region? In: Burk, A.R. (ed.), Trends in Biodiversity Research. Nova Science Publishers, New York, pp. 117–145.

Natura 2000, 2009. *Natura 2000 data — the European network of protected sites*. www.eea.europa.eu/data-and-maps/data/natura-2000 (accessed 5 August 2010).

Nieto, A. and Alexander K.N.A., 2010. *European Red List of Saproxylic Beetles*. Luxembourg, Publications Office of the European Union.

Nolte, C.; Leverington, F.; Kettner, A.; Marr, M.; Nielsen, G.; Bomhard, B.; Stolton, S.; Stoll-Kleemann, S. and Hockings, M., 2010. *Protected Area Management Effectiveness Assessments in Europe — A review of application, methods and results*. http://naturschutzportal.de/fileadmin/MDB/documents/service/Skript_271a.pdf (accessed 6 November 2010).

Olden, J.D., 2006. On defining and quantifying biotic homogenization. *Global Ecology and Biogeography* 15: 113–120.

Oldham, P. D. and Hall, S., 2009. *A European Patent Indicator for Access to Genetic Resources and Benefit-Sharing*. SSRN: http://ssrn.com/abstract=1397108 (accessed 11 May 2009).

Ospar Convention, 1992. The Convention for the Protection of the marine Environment of the North-East Atlantic. www.ospar.org/welcome.asp?menu=0 (accessed 4 October 2010).

Paracchini, M.L.; Petersen, J.-E.; Hoogeveen, Y.; Bamps, C.; Burfield, I. and van Swaay, C., 2008. *High Nature Value Farmland in Europe. An estimate of the distribution patterns on the basis of land cover and biodiversity data*. JRC Scientific and Technical Reports. European Communities, Luxembourg. http://agrienv.jrc.ec.europa.eu/activities_HNV.htm (accessed 7 June 2010).

PEBLDS, 1995. Pan European Biodiversity and Landscape Diversity Strategy. www.peblds.org/index.php?ido=11&lang=eng (accessed 4 October 2010).

Popkin, B.M., 2002. The shift in stages of the nutrition transition in the developing world differs from past experiences! *Public Health Nutrition* 5(1A): 205–214, www.cpc.unc.edu/projects/china/uncpapers (accessed 18 October 2010).

Ramsar, 1971. The Convention on Wetlands text, as amended in 1982 and 1987. www.ramsar.org/cda/en/ramsar-documents-texts-convention-on/main/ramsar/1-31-38^20671_4000_0__ (accessed 16 August 2010).

Rapra, 2009. *Summary:pest Risk Analysis for Phytopthora ramorum.* European Commission, Brussels. http://rapra.csl.gov.uk/SUMMARY_pra_26feb09.pdf (accessed 25 March 2010).

Richardson, K.; Steffen, W.; Schellnhuber, H.J.; Alcamo, J.; Barker, T.; Kammen, D.M.; Leemans, R.; Liverman, D.; Munasinghe, M.; Osman-Elasha, B.; Stern, N. and Waever, O. (eds), 2009. *Synthesis report on the conference 'Global Risks, Challenges & Decisions' held in Copenhagen, 10–12 March 2009*. http://climatecongress.ku.dk/pdf/synthesisreport (accessed 4 October 2010).

RIKS, 2010. *Exploration of land use trends under SOER 2010*. Report to the European Environment Agency. Research Institute for Knowledge Systems, Maastricht, the Netherlands.

Rosegrant, M.W.; Ringler, C; Benson, T; Diao, X; Resnick, D.; Thurlow, J; Torero, M. and Orden, D., 2005. *Agriculture and achieving the Millennium Development Goals*. Washington,D.C.: World Bank (Report No. 32729GLB).

Sanderson, E.; Jaiteh, M.; Levy, M.; Redford, K.; Wannebo, A. and Woolmer, G., 2002. 'The human footprint and the last of the wild'. *Bioscience* 52: 891–904.

Shine, C.; Kettunen, M.; ten Brink, P.; Genovesi, P. and Gollasch, S., 2009. *Technical support to EU strategy on invasive species (IAS) — Recommendations on policy options to control the negative impacts of IAS on biodiversity in Europe and the EU*. Final report for the European Commission. Institute for European Environmental Policy (IEEP), Brussels, Belgium. 35 pp. http://ec.europa.eu/environment/

nature/invasivealien/docs/Shine2009_IAS_Final%20report.pdf (accessed 5 October 2010).

SEBI Indicators, 2010. *Streamlining European 2010 Biodiversity Indicators*. www.eea.europa.eu/data-and-maps/indicators/#c7=all&c5=&c0=10&b_start=0&c10=SEBI (accessed 20 August 2010).

Schippmann, U.; Leaman, D. and Cunningham, A.B., 2006. 'A comparison of cultivation and wild collection of medicinal and aromatic plants under sustainability aspects'. *Medicinal and Aromatic Plants*. In Bogers, R.J., Craker, L.E. and Lange, D., (eds). Springer, Dordrecht, the Netherlands. pp. 75–95.

SCENAR 2020, 2007. Scenario study on agriculture and the rural world. www.lei.wur.nl/UK/research/projects/Scenar+2020/ (accessed 21 October 2010).

Stolton, S. (ed.), 2009. *Communicating values and benefits of protected areas in Europe. Results of a seminar organised by BfN and EUROPARC federation at the International Academy for Nature Conservation on the Island of Wilm, Germany.* BfN and Europarc, Vilm, Germany. www.bfn.de/fileadmin/MDB/documents/ina/vortraege/2009-Report-values-andbenefits.pdf (accessed 11 January 2010).

TEEB, 2009. *The Economics of Ecosystems and Biodiversity for National and International Policymakers*. www.teebweb.org/ForPolicymakers/tabid/1019/language/en-US/Default.aspx (accessed 5 October 2010).

TEEB, 2010. The Economics of Ecosystems and Biodiversity (TEEB). www.teebweb.org/ (accessed 20 August 2010).

Temple, H.J. and Cox, N.A., 2009. *European Red List of Amphibians*. Luxembourg, Office for Official Publications for the European Communities.

Temple, H.J. and Terry, A., 2007. *The Status and Distribution of European Mammals*. Luxembourg, Office for Official Publications of the European Communities, viii + 48 pages.

The Nature Conservancy, 2009. *Adapting to Climate Change — Ecosystem-based Approaches for People and Nature*. www.nature.org/initiatives/protectedareas/files/adaptation_to_climate_change_06_25_09_pages.pdf (accessed 7 December 2009).

Thimonier, A.; Dupouey, J.L.; Bost, F. and Becker, M., 1994. 'Simultaneous eutrophication and acidification of a forest ecosystem in North-East France'. *New Phytologist* 126, 3: 533–539. doi:10.1111/j.1469-8137.1994.tb04252.x.

Trumper, K.; Bertzky, M.; Dickson, B.; van der Heijden, G.; Jenkins, M.; Manning, P., 2009. *The Natural Fix? The role of ecosystems in climate mitigation. A UNEP rapid response assessment*. United Nations Environment Programme, UNEP-WCMC, Cambridge, UK. www.unep.org/pdf/BioseqRRA_scr.pdf (accessed 5 October 2010).

Turbé, A.; De Toni, A.; Benito, P.; Lavelle, P.; Ruiz, N.; Van der Putten, W.H.; Labouze, E. and Mudgal, S., 2010. *Soil biodiversity: functions, threats and tools for policy makers*. Contract 07.0307/2008/517444/ETU/B1. Final report. Bio Intelligence Service, IRD, and NIOO report for the European Commission. European Commission, Brussels. http://ec.europa.eu/environment/soil/pdf/biodiversity_report.pdf (accessed 24 March 2010).

UNCCD, 1992. United Nations Convention to Combat Desertification. www.unccd.int/convention/text/convention.php (accessed 12 November 2010).

UNECE, 2003. Kiev Resolution on Biodiversity. Fifth ministerial Conference 'Environment for Europe', Kiev, Ukraine, 12–23 May 2003. Document ECE/CEP/108. United Nations Economic Commission for Europe.

UNFCCC, 1992. United Nations Framework Convention on Climate Change. http://unfccc.int/essential_background/convention/status_of_ratification/items/2631.php (accessed 12 November 2010).

Vandewalle, M.; Sykes, M.T.; Harrison, P.A.; Luck, G.W.; Berry, P.; Bugter, R.; Dawson, T.P.; Feld, C.K.; Harrington, R.; Haslett, J.R.; Hering, D.; Jones, K.B.; Jongman, R.; Lavorel, S.; Martins da Silva, P.; Moora, M.; Paterson, J.; Rounsevell, M.D.A.; Sandin, L.; Settele, J.; Sousa, J.P. and Zobel, M., 2010. Review paper on concepts of dynamic ecosystems and their services, The RUBICODE project — Rationalising Biodiversity Conservation in Dynamic Ecosystems (Funded under the European Commission Sixth Framework Programme). www.rubicode.net/rubicode/RUBICODE_Review_on_Ecosystem_Services.pdf (accessed 5 October 2010).

Van Swaay, C.; Cuttelod, A.; Collins, S.; Maes, D.; López Munguira, M.; Šašić, M.; Settele, J.; Verovnik, R.; Verstrael, T.; Warren, M.; Wiemers, M. and Wynhof, I., 2010. *European Red List of Butterflies*. Luxembourg, Publications Office of the European Union.

Väre, H.; Lampinen, R.; Humphries, C. and Williams, P., 2003. Taxonomic diversity of vascular plants in the European alpine areas. In Nagy, L.; Grabbher, G.; Körner, C. and Thompson, D.B.A. (ed.). Alpine Biodiversity in Europe — A Europe wide Assessment of Biological Richness and Change. Springer: 133–148.

Veen, P., Jefferson, R., de Smidt, J. and van der Straaten, J. (eds), 2009. *Grasslands in Europe of high nature value.* KNNV Publishing.

Williams, S., 1998. *Tourism Geography*. Routledge, London.

WTO, 2001. Tourism 2020 vision- Europe. World Tourism Organisation. http://pub.unwto.org/WebRoot/Store/Shops/Infoshop/Products/1152/1152-1.pdf (accessed 6 November 2010).

TH-30-10-543-EN-N
doi:10.2800/58023

European Environment Agency
Kongens Nytorv 6
1050 Copenhagen K
Denmark

Tel.: +45 33 36 71 00
Fax: +45 33 36 71 99

Web: www.eea.europa.eu
Enquiries: www.eea.europa.eu/enquiries

Publications Office

ISBN 978-92-9213-153-1

European Environment Agency