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EU 2010 biodiversity baseline

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Contents

Executive summary

In recent decades, growing awareness of biodiversity decline has led to improved commitments, policies and practices for the conservation and sustainable use of biodiversity throughout much of Europe.

In January 2010, the Commission presented a series of options for an EU biodiversity policy, vision, and target beyond 2010 (EC, 2010). Recognising the urgent need to reverse the trends of biodiversity loss and ecosystem degradation, on 26 March 2010 the European Council endorsed the long-term biodiversity vision and the 2020 headline target adopted by the Environment Council on 15 March 2010 (European Council, 2010). These initiatives will underpin the new EU biodiversity strategy to be developed and finalised by the end of 2010.

In its conclusions, the European Council specified that the strategy to address biodiversity loss and ecosystem degradation should set a clear baseline outlining the criteria against which achievements are to be assessed.

Therefore, the European Environment Agency and its European Topic Centre on Biological Diversity developed the *EU 2010 Biodiversity baseline* ([1]) to respond to this need.

This report provides facts and figures on the state and trends of the different biodiversity and ecosystem components. It, thereby, supports the EU in developing the post-2010 sub-targets and provides factual data for measuring and monitoring progress in the EU from 2011 to 2020. The baseline is not a target, but rather a reference point.

The baseline is based on best available data mainly resulting from the first assessment of the conservation status of habitats and species protected under the Nature Directives, the European Red List as well as existing indicator sets such as SEBI 2010. Preference was given to data sets that are subject to continuing monitoring and reporting: what is known in 2010 must also be measurable until 2020, with the focus being on EU-27, although some data used were limited to other geographical scopes.

This report is structured in such a way that it provides facts and figures on the status of biodiversity in major ecosystem types: agro-ecosystems, grasslands, heath and scrubs, forests, wetlands, lakes and rivers, coastal and marine ecosystems. It also includes a small chapter on soil biodiversity drafted by the Directorate-General for the Environment and the Joint Research Centre. For each ecosystem type, besides information on the status and trends of biodiversity, information is given on major threats and pressures as well as on the key ecosystem services provided by each ecosystem type. In

The vision

By 2050 European Union 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 well-being 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 insofar as is feasible, while stepping up the EU contribution to averting global biodiversity loss.

([1]) 'Baseline: the starting point (a certain date or state) against which the changes in the condition of a variable or a set of variables are measured'. This definition from the Convention on Biological Diversity (1997) was used to develop the EU baseline.

What do we mean by 'biodiversity'?

Biodiversity includes all living organisms found on land and in water. All species have a role and provide the 'fabric of life' on which we depend: from the smallest bacteria in the soil, to the largest whale in the ocean. The four basic building blocks of biodiversity are genes, species, habitats and ecosystems.

The distribution of wildlife and the variety of landscapes in Europe are the product of complex interactions. The basic physical qualities of the rock, soil and climate provide underlying structure and continuing influence. But the majority of the detail has been shaped through millennia of natural processes and human activity, the history of land use and management and its associated impacts. Human activities are themselves driven by economic, social, and environmental forces.

As a result of these interactions, which are particular to Europe, 'multifunctional landscapes' have developed in which traditional cultural practices sustain a range of economic, social and environmental services. Significantly, these practices support a diversity of characteristic plants, animals and habitats. Europe's influence also extends well beyond its geographical boundaries, however, so that it can truly be said to have a global influence. As well as its own landscapes, Europe must concern itself with the coral reefs and rain forests of dependent territories and beyond.

Genes: Genes are the basic building blocks of life. They determine the characteristics of all living organisms. Maintaining genetic diversity by conserving species and varieties is a cornerstone of nature conservation.

Species: Nearly two million species have been identified worldwide and it is estimated that these may represent only 20 % of the total currently existing on Earth. Soils alone host over one quarter of all species. Apart from micro-organisms, insects are the biggest and most varied group. Other large groups include fungi, plants, lichens and mosses. Compared to other continents, Europe and the EU have a relatively few species, although many are only present in the region (i.e. they are endemic).

Habitats: Different species of plants and animals come together to form ecological communities in a given area or natural environment called a habitat. A habitat includes physical factors such as soil, moisture, temperature and light. Habitats are formed in response to local environmental conditions such as soil type and climate. In Europe, human activities have played a major part in shaping and creating habitats of high biodiversity value (e.g. meadows).

Ecosystems: An ecosystem can include one or many different habitats. Healthy ecosystems help to maintain species and habitats as well as providing critical 'goods and services' to human beings.

addition, the baseline report dedicates a chapter to presenting the status of habitats and species listed in the Annexes to the Birds and Habitats Directives, a chapter that presents an analysis of the key European threats and a chapter on ecosystem services. These two latter chapters include some information and figures from the ecosystems chapters: this is voluntary and we believe it makes the chapters more coherent when used independently.

The baseline shows that although species extinction in the EU is not occurring nearly as rapidly as in other regions and continents, the percentage of species threatened with extinction is still a matter of concern. In particular 25 % of marine mammals and 15 % of terrestrial mammals, 22 % of amphibians, 21 % of reptiles, 16 % dragonflies, 12 % of birds and 7 % of butterflies are threatened with extinction at EU level.

Biogeographical evaluations revealed that only 17 % of the assessments of European habitats and species are 'favourable', while 65 % of habitats assessments and 52 % of species assessments are 'unfavourable'. The percentage of habitats and species whose status is 'unknown' is relatively high: 31 % of assessments for all species but reaching 59 % for marine species; 18 % of assessments for all habitats but reaching 40 % for marine habitats. This is an indication of the lack of appropriate monitoring in many parts of Europe, particularly in the marine environment.

Recent data from the last available Corine land cover inventory indicate that areas of extensive agriculture, grasslands and wetlands are continuing to decline across Europe:

- 5.0 % decline in marsh and bog land;
- 2.6 % decline in extensive agriculture land;
- 2.4 % decline in natural grassland area;
- 4.4 % growth in water bodies (mostly artificial reservoirs);
- 7.9 % growth in artificial surfaces (urban, industrial, infrastructures);
- 12.0 % growth in transitional land (woodland degradation, forest regeneration and recolonisation).

In fact, the main pressures and drivers causing biodiversity loss are habitat fragmentation, degradation and destruction due to land-use change.

Other important indicators of the state and trends of biodiversity and ecosystems are given in the box below.

However, progress is being made in some areas. For example, the establishment of Natura 2000 has progressed well in the terrestrial environment, with nearly 18 % of EU land designated, and there is some (still insufficient) progress in the marine environment.

Specific EU legislation in the following areas has also reduced pressure on biodiversity:

- atmospheric emissions, freshwater quality and wastewater treatment;
- pressures from agriculture, addressed directly by reducing nitrogen losses and indirectly by increasing organic farming, with varying success;
- acidification and eutrophication from excessive nitrogen accumulation are declining and nitrogen balances of farmlands are decreasing;
- water quality has improved in fresh waters and, indeed, the state of freshwater systems is improving generally and the marine environment is stable;
- forest cover is still slightly increasing in Europe and timber harvests from European forests are generally sustainable in terms of wood volume harvested.

Ecosystems provide a number of basic functions that are essential for using the Earth's resources sustainably. They include **provisioning** in the form of harvestable products such as food, drinking water and raw materials; **regulating** functions such as

- Invasive alien species remain a threat, increasingly so in aquatic systems and in the context of a changing climate.
- The impacts of changing climate are just beginning to emerge and the wider ecosystem implications have not yet been fully recognised. However, many ecosystems have been degraded, thereby reducing the capacity to respond to future shocks such as the effects of climate change.
- Agriculture still exerts considerable pressure on the environment despite agricultural mitigation measures and steadily increasing organic farming (the area of which has increased by 21 % between 2005 and 2008).
- In marine systems, many fishery resources are still not being managed sustainably, with some 46 % of assessed European stocks falling outside safe biological limits and 88 % of species overfished.
- Europe cannot sustainably meet its consumption demands from within its own borders and the gap between demand and production capacity has grown steadily since 1960. In addition, pressures that occur outside the European territory but have an impact in Europe (e.g. on migratory bird species or within dependent territories) need to be addressed.
- Estimates of EU actual spending on biodiversity are not widely available. The financial perspectives for 2007–2013 opens opportunities for co-financing of biodiversity under the European Agricultural Fund for Rural Development (EAFRD), the Cohesion and Structural Funds, LIFE+ and the seventh framework research programme. However, the best estimates on expenditure are those of the LIFE programme, which amounts to less than 0.1 % of the EU budget in any year.
- Public support and awareness to promote and fund biodiversity conservation is not wide with opinion polls across the EU showing that, in 2007, two thirds of citizens did not understand the word biodiversity: by 2010 this had only slightly reduced (from 65 % to 62 %).

carbon sequestration, waste treatment or slowing the passage of water; **cultural** services that directly involve people; and **habitat or supporting** services that are needed to maintain other services, and which include genetic diversity and maintenance of all life cycles.

The serious and continuing loss of Europe's biodiversity reflects the continuing decline in the ability of ecosystems to sustain their natural production capacity and perform regulating functions. For instance, healthy soil biodiversity is fundamental to maintaining and ensuring soil fertility and therefore production potential.

The current knowledge and data on ecosystem services at EU level is still scarce, but it provides valuable information on their qualitative status and trends. The majority of ecosystem services show either a degraded or mixed status across Europe. However, there are some exceptions such as timber production and climate regulation in forests.

In short, this report illustrates the fact that a large proportion of European species and habitats are either facing extinction, have an unfavourable conservation status or their status is unknown, highlighting the necessity for critical conservation actions and the need to urgently intensify efforts. In addition, key gaps in knowledge remain across Europe and in interdisciplinary knowledge on the links between biodiversity change, ecosystem services and human well-being. Filling such gaps through further monitoring, research and assessment would support a strengthened decision and policy making process on European biodiversity in the decade to come.

1 Introduction

In January 2010, the European Commission presented a series of options for a European Union biodiversity policy, vision, and target beyond 2010 (EC, 2010a). Recognising the urgent need to reverse the trends of biodiversity loss and ecosystem degradation, on 26 March 2010 the European Council endorsed the long-term biodiversity vision and the 2020 headline target adopted by the Environment Council on 15 March 2010 (European Council, 2010b).

Unlike other EU policy areas, for example climate change, the complexity of biodiversity and ecosystems mean that their status cannot be expressed with a single measure or indicator. The Council therefore called on the Commission to define a limited number of ambitious but achievable and measurable sub-targets.

The EU 2010 Biodiversity baseline provides facts and figures on the state and trends of the different biodiversity and ecosystem components. It thereby supports the EU in developing the post-2010 sub-targets and provides factual data for measuring and monitoring progress in the EU from 2011 to 2020. The baseline is not a target, but rather a reference point: *Baseline: the starting point (a certain date or state) against which the changes in the condition of a variable or a set of variables are measured*. This definition from the Convention on Biological Diversity (1997) was used to develop the EU baseline.

The main concern building the baseline was ensuring that the facts and figures are scientifically robust and validated by Member States or peer-reviewed. It was a priority to make full use of data already reported pursuant to the Birds and Habitats Directives and other relevant directives, as well as existing indicator sets such as SEBI 2010 (Streamlining European 2010 Biodiversity Indicators). Preference was given to data sets that are subject to continuing monitoring and reporting: what is known in 2010 must also be measurable until 2020.

The focus was on the EU-27 but several data sets extended or were limited to other geographical scopes. The most recent available data were used, meaning some variance in the time periods used for different indicators.

1.1 European and global biodiversity

Estimated number of known species

In comparison with others continents, Europe and the EU have a relatively low number of animal species; however, Europe has an important number of endemic species i.e. not present elsewhere in the world.

Exact information on number of vascular plants present in EU is very difficult to determine; at global

The vision

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The headline target

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

Table 1.1 Species richness of selected groups in the EU-27

Species groups	EU-27	Europe *	World
Amphibians	84	85	6 000
Reptiles	141	151	8 800
Terrestrial mammals (only EU-25)	179	219	5 000
Marine mammals (only EU-25)	41	41	
Birds	453	482	9 900
Butterflies	451	482	20 000
Dragonflies	135	138	5 500

Note: * From Iceland to the Urals including Macaronesian islands, but excluding the Anatolian region.

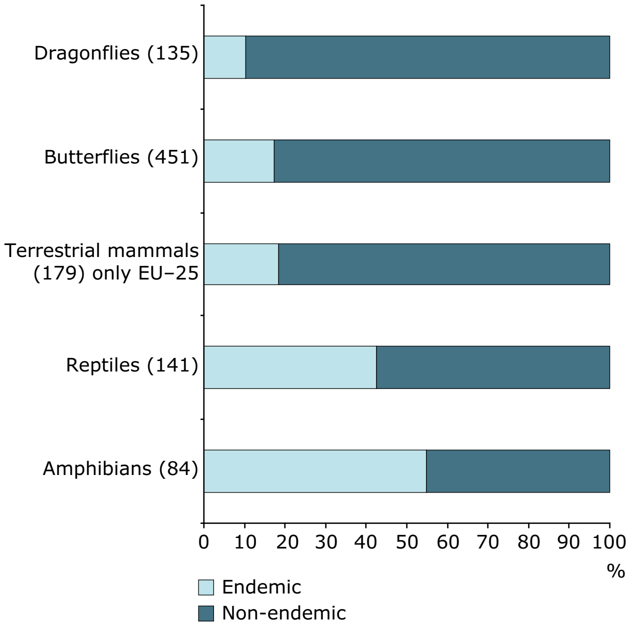
Source: IUCN 2007, 2009, 2010; BirdLife, 2004.

level, it is estimated than around 320 000 vascular plants are described (IUCN, 2010a). The Euro+Med Plantbase ([2]) which covers all of Europe from Iceland to the Urals, including the Caucasus and Turkey, and includes all the countries of the Mediterranean basin and Macaronesian region has more than 30 000 registered species, many of them endemic to Europe.

The IUCN Word Red List of threatened species

The IUCN Red List categories provide information on the risk of a species becoming extinct. Global Red Lists using the current criteria have been compiled since 1996 covering an increasingly high number of species. Individual countries have prepared national Red Lists, but not always using

Figure 1.1 Endemism of EU native species — amphibians, reptiles, mammals, dragonflies and butterflies



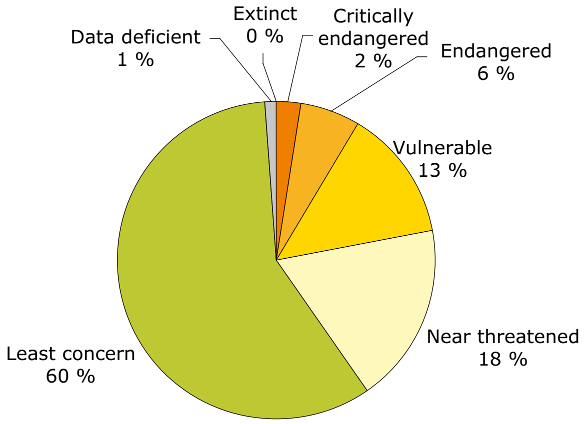
- Nearly half of the amphibians and reptiles occurring in the EU are restricted to this region (endemic), i.e. they cannot be found elsewhere in the world.
- Over 80 % of the Habitats Directive Annex II species (vertebrates and plants) are endemic to Europe.

Source: IUCN, 2007; 2009; 2010 (See Chapter 15 for definitions).

([2]) www.emplantbase.org/.

Figure 1.2 Threat status of EU species

Red list status of amphibians in EU-27

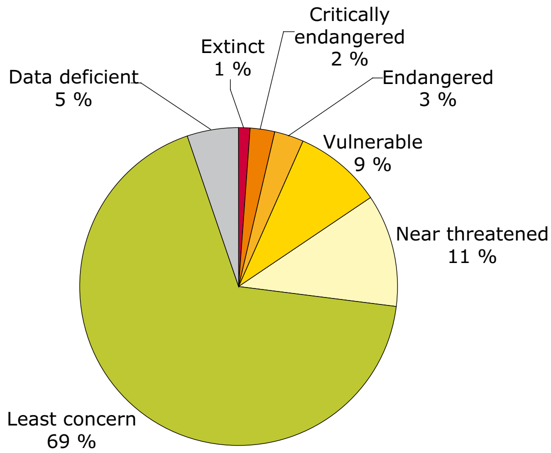


Source: IUCN, 2009a.

Amphibians

- More than 20 % of the amphibians found in the EU are considered threatened and a further 18 % are considered near threatened.
- All amphibian species considered threatened (critically endangered, endangered or vulnerable) at EU level are endemic to the European continent and are found nowhere else in the world.
- Habitat loss, fragmentation and degradation are the most significant threats to amphibians in Europe.

Red list status of terrestrial mammals in EU-25

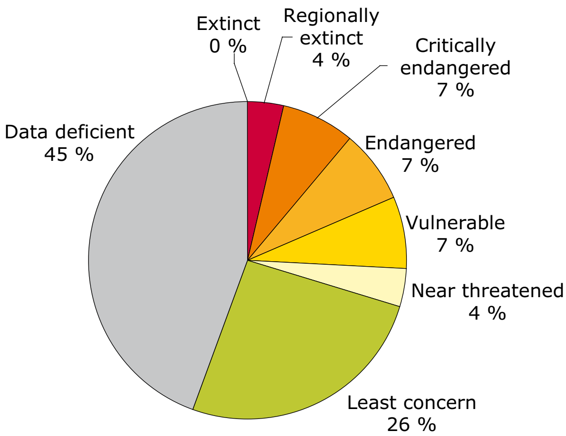


Source: IUCN, 2007.

Mammals

- Nearly one in six of terrestrial Europe's mammal species are threatened and a further 11 % are close to qualifying for threatened status.
- Two European mammal species have become globally extinct since AD 1 500 (the aurochs *Bos primigenius* and the Sardinian pika *Prolagus sardus*) and a third species is regionally extinct (the grey whale *Eschrichtius robustus*).
- Habitat loss and degradation is the greatest threat to terrestrial mammals in Europe, whilst the main threats to marine mammals are accidental mortality, pollution and over-exploitation.

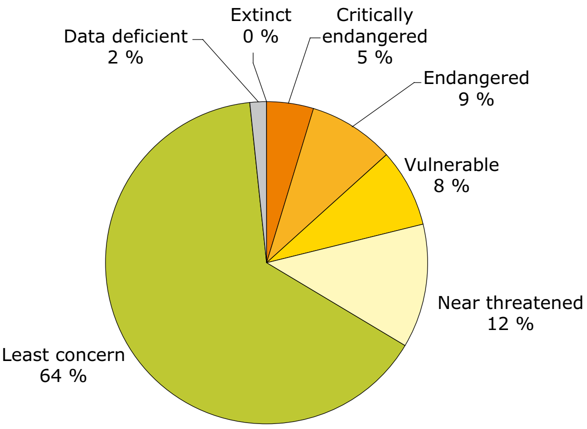
Red list status of marine mammals in Europe and the EU-25



Source: IUCN, 2007.

Figure 1.2 Threat status of EU species (cont)

Red List status of reptiles in EU-27

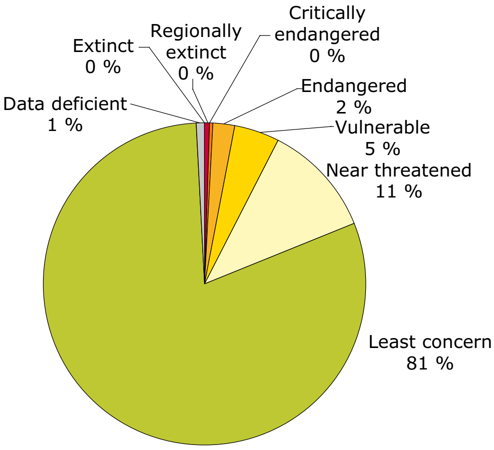


Source: IUCN, 2009b.

Reptiles

- Approximately one fifth of reptiles are considered threatened in Europe and a further 12 % are considered near threatened.
- The majority of threatened and near threatened reptile species, all critically endangered species and the vast majority of endangered and vulnerable species are endemic to both Europe and the EU.
- Habitat loss, fragmentation and degradation are the greatest threats to reptiles in Europe.

Red List status of butterflies in EU-27

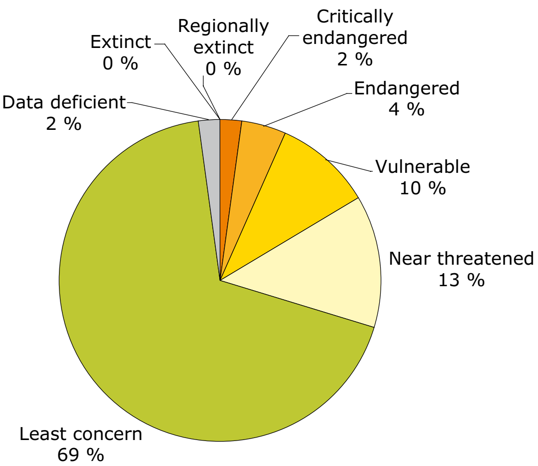


Source: IUCN, 2010d.

Butterflies

- Approximately 7 % of butterflies are considered threatened in Europe and a further 11 % are considered near threatened.
- Two butterfly species have become regionally extinct in recent years (*Aricia hyacinthus* and *Tomares nogelii*).
- The main current threat is the loss of their habitats or habitat connectivity due to changes in agricultural practices (intensification or abandonment).

Red List status of dragonflies in EU-27



Source: IUCN, 2010b.

Dragonflies

- Approximately 16 % of dragonflies are considered threatened in Europe and a further 13 % are considered near threatened.
- The main current threat is desiccation of their habitats.

the standard criteria adopted by the IUCN; this makes comparison difficult and aggregation of data virtually impossible. This is why the European Commission has been supporting the IUCN in developing assessments for the whole European region (geographical Europe and the EU, see below).

- The 2009 IUCN World Red List includes threat assessments for approximately 48 000 species, i.e. nearly 3 % of the 1.8 million species described worldwide.
- 'Vertebrates' is the best assessed group (45 % of known species); 'Invertebrates' and 'Fungi and Protists' (lichens, mushrooms and brown algae) are the groups least assessed (less than 1 % of known species actually assessed).
- Between 12 % and 55 % of selected vertebrate, invertebrate and plant groups are threatened with extinction at the global level.
- The decline of wild vertebrate species between 1970 and 2006 is especially severe in the tropics (59 %) and in freshwater ecosystems (41 %). Source: IUCN, 2010 and SCBD, 2010.

Threat status of EU species (3)

IUCN is currently reviewing approximately 6 000 European species (4) (mammals, reptiles, amphibians, freshwater fish, butterflies, dragonflies, and selected groups of beetles, molluscs, and vascular plants), including specific evaluations for the EU. These regional Red Lists identify those species that are threatened with extinction according to IUCN's regional Red Listing guidelines. Results are currently (mid 2010) available for mammals, amphibians and reptiles, butterflies, dragonflies and saproxylic beetles.

Birds

BirdLife International has also been assessing the threat status of European birds (5) using the IUCN threat categories; this was carried out in 2004 to complement the assessments of conservation status. Table 1.2 summarises the assessments published in 2004.

- Twelve per cent of EU birds are considered threatened in EU-25.

Trends in European groups of species (from IUCN European Red Lists)

Documenting population trends is fundamental when assessing threat status, and a special effort was made to determine which species are believed to be declining, stable, or increasing. IUCN experts have documenting trends for amphibians, reptiles, mammals, butterflies and dragonflies in addition of assessment of threat status. A species can have a declining population without reaching IUCN criteria to be assessed as threatened species (see paragraph on threat status of EU species).

Table 1.2 IUCN threat categories and trends of several animal groups in the EU

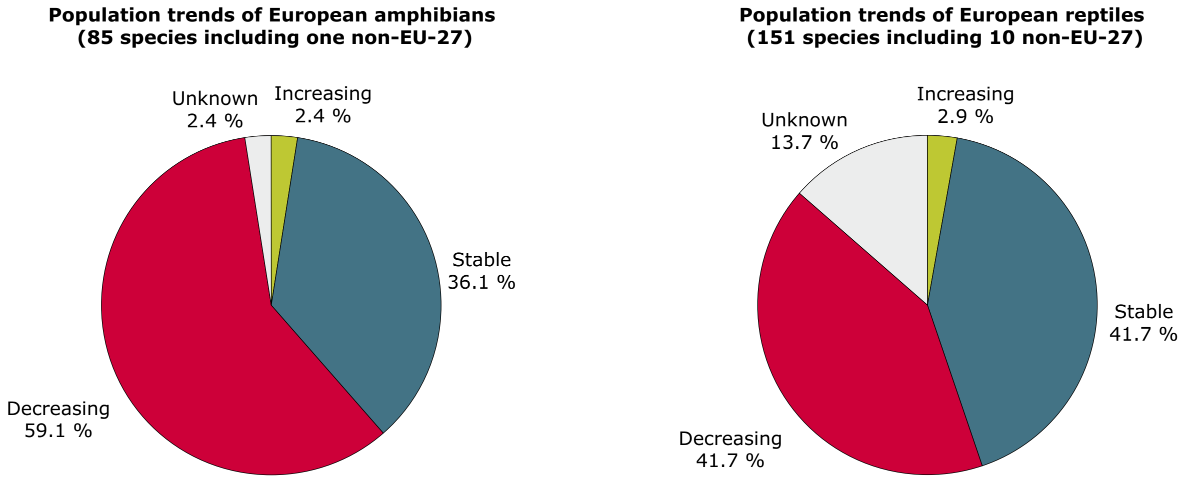
Group/IUCN category	Threatened (EX, RE, CR, EN, VU) (%)	Data deficient (DD) (%)	Stable and increasing trend (%)
Mammals — marine	25	45	40
Mammals — terrestrial	15	5	
Birds	12	0	62
Amphibians	22	1	38.5
Reptiles	22	2	44.6
Dragonflies	16	2	64
Butterflies	7	1	59

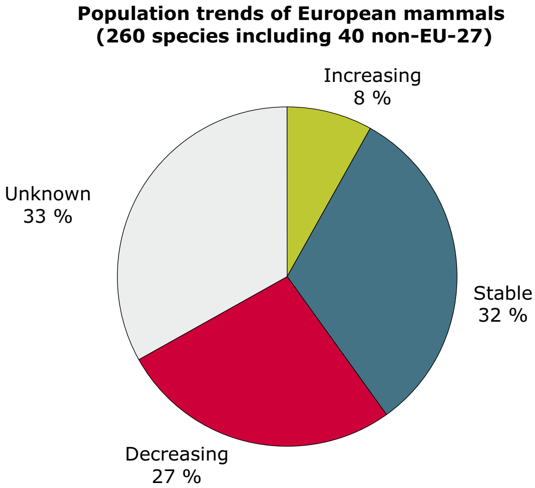
Note: There is no assessment at EU level yet but, at European level, 38 % of freshwater fish are threatened.

Source: IUCN, 2007; 2009; 2010 and BirdLife International, 2004b.

(3) See Chapter 15 for definitions.
(4) http://ec.europa.eu/environment/nature/conservation/species/redlist/index_en.htm.
(5) Birds in Europe (1994), Birds in Europe (2004), Birds in the European Union (2004) (www.birdlife.org/action/science/species/birds_in_europe/index.html).

Figure 1.3 Trends of European amphibians, reptiles and mammals





- Fifty-nine per cent of amphibians have declining populations: 36 % are stable and only 2 % are increasing.
- Some 42% of reptile species are declining and only 3 % are increasing.
- Twenty-seven per cent of European mammals have declining populations: 32 % are stable; 33 % are of unknown population trend; and only 8 % of species populations are increasing.

Source: IUCN, 2007; 2009.

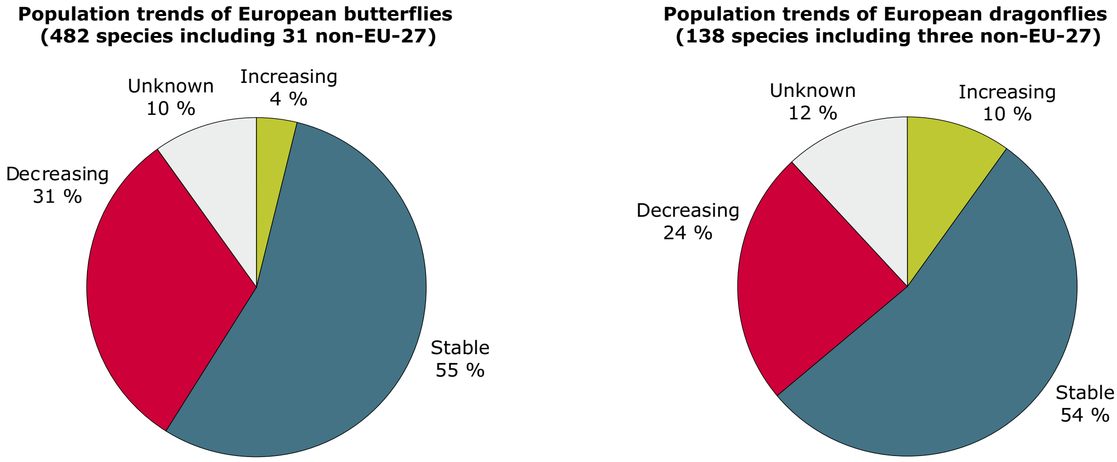
1.2 Biodiversity of the EU's outermost regions (ORs) and overseas countries and territories (OCTs) ([6])

The EU 'overseas dimension' includes 28 territorial entities linked to six Member States: Denmark, Spain, France, the Netherlands, Portugal, and the United Kingdom. Spread on all oceans, home to a unique diversity of species and ecosystems, European ORs and OCTs are of crucial importance for biodiversity at global scale. They are concentrated in biodiversity hotspots (Caribbean, western Indian Ocean, Oceania), major wilderness areas (Guyana shield), and key regions for polar ecosystems and fish stocks (Greenland, South Georgia, French subantarctic islands, Falkland Islands, etc.).

ORs and OCTs host more than 10 % of the world coral reefs and lagoons and a lot more species than mainland European EU. New Caledonia alone has about as man y endemic species as the entire European continent, and French Guyana includes an area of Amazon rainforest the size of Portugal.

([6]) www.iucn.org/about/union/secretariat/offices/europe/places/overseas/.

Figure 1.4 Trends of European butterflies and dragonflies



- Fifty-five per cent of butterflies are stable: 31 % have declining populations; only 4 % are increasing.
- Fifty-four per cent of dragonflies are stable: 24 % have declining populations; 10 % are increasing.

Source: IUCN, 2010.

1.3 Main trends regarding ecosystems, species, and genes in the EU

Changes in broad ecosystems between 1990 and 2006

Recent data from the last available Corine land cover inventory indicate that areas of extensive agriculture, grasslands and wetlands continue to decline across Europe. The biggest changes in ecosystems between 1990 and 2006 are in Table 1.3 (see Chapter 15 for information on use of CLC to estimate ecosystem areas).

During the same period, artificial surfaces increased some 12 535 km^2, i.e. + 8 %.

Table 1.4 lists the main conversion in land use, which shows a continued expansion of artificial surfaces — urban sprawl and building of economic sites and infrastructures — and abandoned land at the expense of agricultural land, grasslands and wetlands across the EU. Natural grasslands are still being converted into arable land and built-up areas (see Chapter 15 for information on use of LEAC (7) methodology).

1.4 LIFE Nature and Biodiversity: areas and funds (8)

Between 1992 and 2008, 1 107 nature conservation projects have been funded by the LIFE programme,

Table 1.3 Changes in ecosystems between 1990 and 2006 — based on Corine land cover

Ecosystem	Surface change (km^2)	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

Source: Corine land cover, 1990; 2000; 2006.

(7) LEAC Land and Ecosystems Accounting: see Chapter 15 for information on use of CLC to estimate ecosystem areas.

Table 1.4 Conversion of broad ecosystems between 2000 and 2006

Change in agro-ecosystems (complex)	20 % mainly due to urban diffuse residential sprawl 31 % due to sprawl of economic sites and infrastructures
Change in agro-ecosystems (extensive)	22 % due to conversion from semi-natural land to agriculture 39 % due to forests creation and afforestation
Change in grasslands	21 % due to sprawl of economic sites and infrastructures 32 % due to arable and permanent crops
Change in forests	94 % due to recent felling and transition and forests internal conversions
Change in heaths and scrubs	84 % due to conversion from transitional woodland to forest
Change in wetlands	35 % due to conversion to agriculture 49 % due to forest creation and afforestation

Source: LEAC 2000–2006.

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 Nature projects have increased in budget and duration from an average LIFE contribution of EUR 0.6 million during LIFE II (1996–99) to EUR 1.2 million during LIFE III extension (2000–06) and from an average duration of 4.05 years during LIFE II to 4.7 years during LIFE III extension.
- The LIFE III programme has made financial contributions of about EUR 430 billion to 434 projects in Natura 2000 sites.
- For the period 2007–2008, LIFE+ (2007–2013) is financing 138 projects for a total EC funding of EUR 201 million. The average financing per project has been further increased to EUR 1.5 million.
- LIFE+ also includes, from 2007, under the strand LIFE+ Nature and Biodiversity, the possibility of co-financing projects for enhancing the biodiversity outside Natura 2000 sites and puts the accent also on 'green infrastructure' (e.g. Natura 2000 connectivity) and ecosystem services. From the 2010 call onwards, the programme will considerably increase the possibility of co-financing biodiversity-oriented projects, not only through the traditional strand LIFE+ Nature and Biodiversity, but also through the strand LIFE+ Environment Policy and Governance, including, among others, green infrastructures, soil biodiversity in farmland, water bodies, urban biodiversity, and coastal areas.

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.

(8) LIFE Focus *LIFE improving the conservation status of species and habitats* (http://ec.europa.eu/environment/life/publications/lifepublications/lifefocus/documents/art17.pdf). *Ex post* evaluation of projects and activities financed under the LIFE programme (2009) (http://ec.europa.eu/environment/life/publications/lifepublications/evaluation/documents/lifeval_nature.pdf).

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2 Habitats, species and sites of the Nature Directives

2.1 Conservation Status of habitats of Community interest

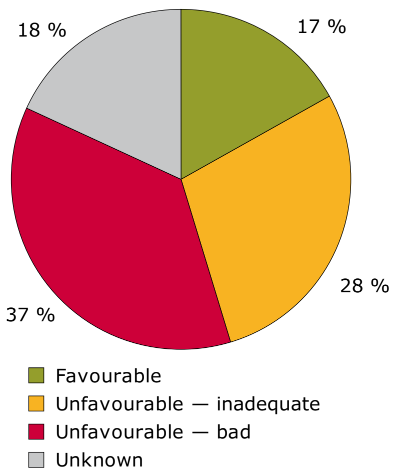
The first EU-wide nature protection policies came into force 30 years ago with the adoption of the Birds Directive in 1979, establishing a protection regime for all bird species naturally occurring in the EU, which included the classification by Member States of special protection areas for threaten and migratory birds. Policymakers extended the approach with the Habitats Directive in 1992, which required Member States to designate special areas of conservation for a selection of fauna and flora species and particular habitat types.

The Habitats Directive identifies the most at-risk and valuable natural resources. Some 200 habitats and 1 000 species of animals and plants are listed, and the goal is to ensure their long-term sustainability — known as 'favourable conservation status'.

The two main means used to achieve these goals are the Natura 2000 network of conservation sites, incorporating the areas created under the earlier Birds Directive, and a strict system of species protection on the other hand (EC 2010).

In 2007, Member States reported for the first time on the conservation status of habitats and species covered by the Habitats Directive (Article 17 reports). As this reporting period was until 2006, it did not cover Bulgaria and Romania (which joined the EU on 1 January 2007).

Figure 2.1 Conservation status of habitats

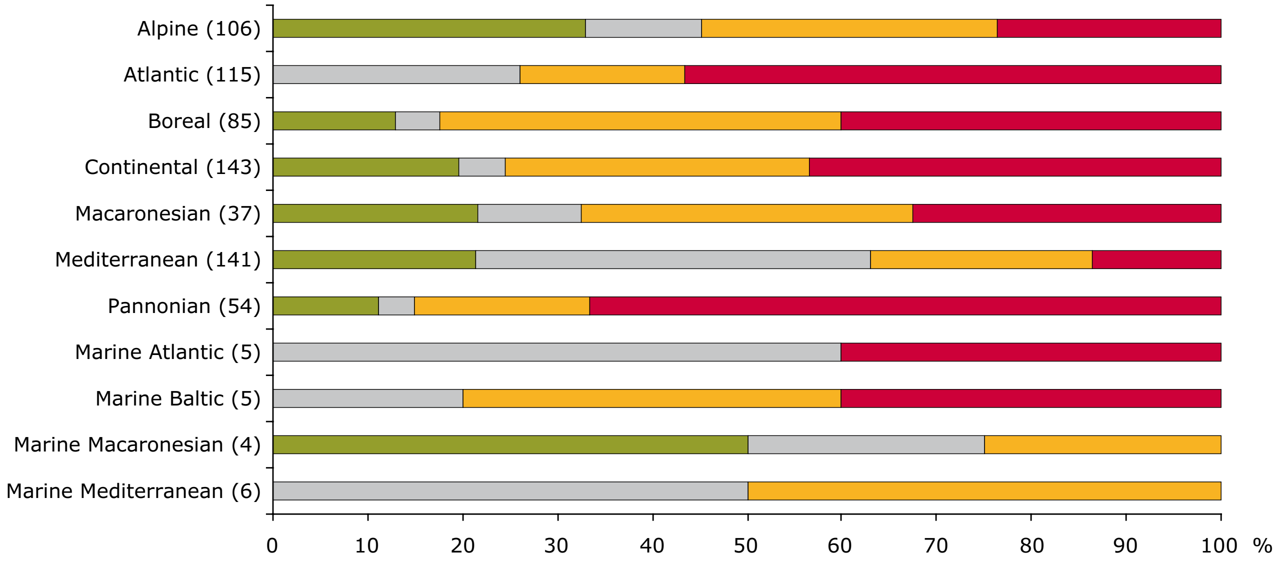


- At EU level, 65 % of Annex I habitat types assessments are 'unfavourable' (orange and red).
- More than half of that number are 'unfavourable — bad' (red), representing almost 40 % of all assessments.
- Only 17 % of the habitats assessments are 'favourable' (green) at EU level.
- Conservation status is 'unknown' (grey) for 18 % of the habitat type assessments.

Note: Geographical coverage: EU except Bulgaria and Romania. (See Chapter 15 for details on conservation status categories).

Source: ETC/BD, 2008.

Figure 2.2 Conservation status of habitats per region

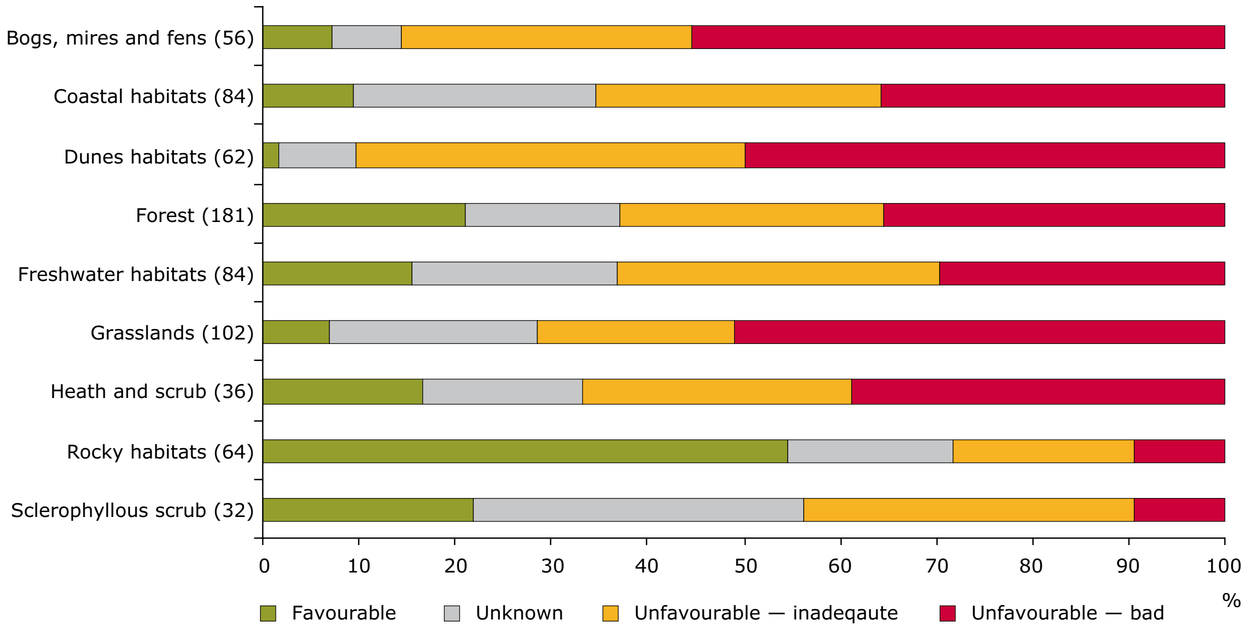


- The proportion of the habitats assessed as 'unfavourable — bad' exceeds 40 % in most of the biogeographical and marine regions.
- The proportion of the habitats assessed as 'unfavourable' is more than 70 % in most of the terrestrial biogeographical regions.
- In the Atlantic and Pannonian biogeographical regions, more than 50 % of the habitats are assessed as 'unfavourable — bad'; this percentage slightly exceeds the percentage in the other biogeographical regions.

Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

Figure 2.3 Conservation status of Habitats per main broad habitats



- Annex I to the Habitats Directive includes a wide variety of habitats which are divided into nine groups of related habitat types such as forests or grasslands.
- Between these groups, dune habitats, grasslands and bogs, mires and fens have the worst conservation status.

Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

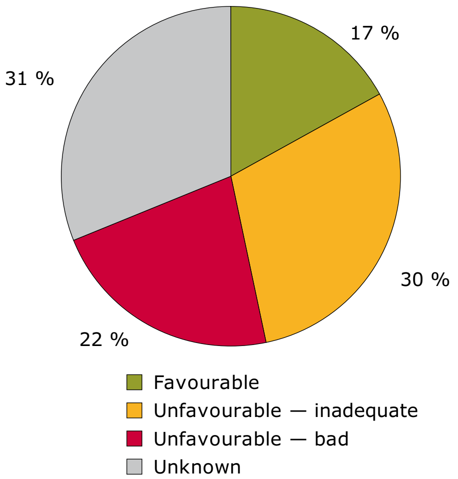
2.2 Conservation status of species of Community interest

The concept of 'favourable conservation status' (FCS) constitutes the overall objective to be reached for all habitat types and species of Community interest. In simple words, it can be described as a situation where a habitat type or species is prospering (in both quality and extent/population) and with good prospects to do so in future as well. The fact that a habitat or species is not threatened (i.e. not faced by any direct extinction risk) does not mean that it is in favourable conservation status. The target of the directive is defined in positive terms, oriented towards a favourable situation, which needs to be defined, reached and maintained. It is, therefore, more than avoiding extinctions. Favourable Conservation Status is assessed across all national territory (or by biogeographical region within a country where two or more regions are present) and should consider the habitat or species both within the Natura 2000 network and in the wider countryside ([9]).

The following graphs summarise the conservation status of species targeted by the Habitats Directive as reported in the framework of its Article 17 ([10]); covering the period from 2001 to 2006, they concern species listed in Annexes II, IV and V.

However, there are marked differences between the six terrestrial biogeographical regions and the four marine regions assessed as described below.

Figure 2.4 Conservation status of species



- Seventeen per cent of the assessments of conservation status of species across the EU were favourable (green).
- Fifty-two per cent were unfavourable (22 % 'unfavourable — bad' in red; and 30 % 'unfavourable — inadequate' in orange).
- Thirty-one per cent of the species assessments are 'unknown' ([11]).

Note: Geographical coverage: EU except Bulgaria and Romania.

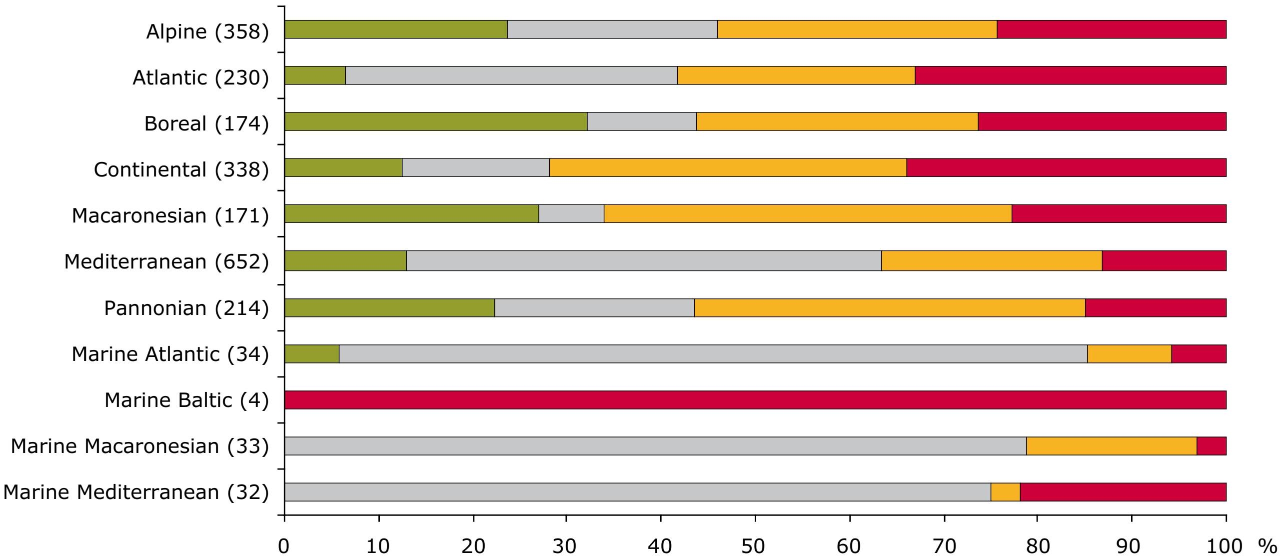
Source: ETC/BD, 2008.

([9]) *Assessment, monitoring and reporting under Article 17 of the Habitats Directive: Explanatory Notes and Guidelines*, European Commission, October 2006 (http://circa.europa.eu/Public/irc/env/monnat/library?l=/habitats_reporting/reporting_2001-2007/guidlines_reporting&vm=detailed&sb=Title).

([10]) *Article 17 Technical Report*, European Topic Centre on Biological Diversity (http://biodiversity.eionet.europa.eu/article17).

([11]) Indicating an important lack of quantitative/qualitative data from the Member States.

Figure 2.5 Conservation status of species per region

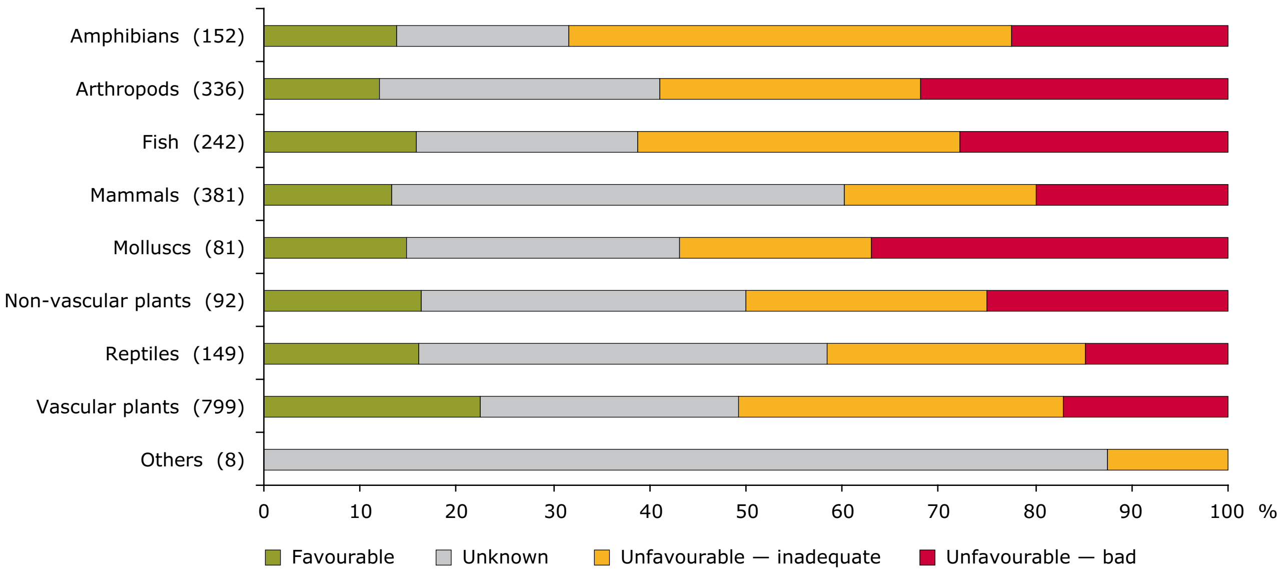


- The proportion of species assessed as 'unfavourable — bad' exceeds 20 % in most of the biogeographical regions.
- However, the highest percentage of 'unfavourable-bad' assessments is in the Continental and Atlantic regions.
- The proportion of 'favourable' assessments exceeds 20 % in the Alpine, Boreal, Macaronesian and Pannonian regions.
- The proportion of 'unknown' assessments is overwhelming in most of the marine regions indicating that gaps in knowledge are in general much higher for the marine environment than for the terrestrial environment.

Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

Figure 2.6 Conservation status of species per groups



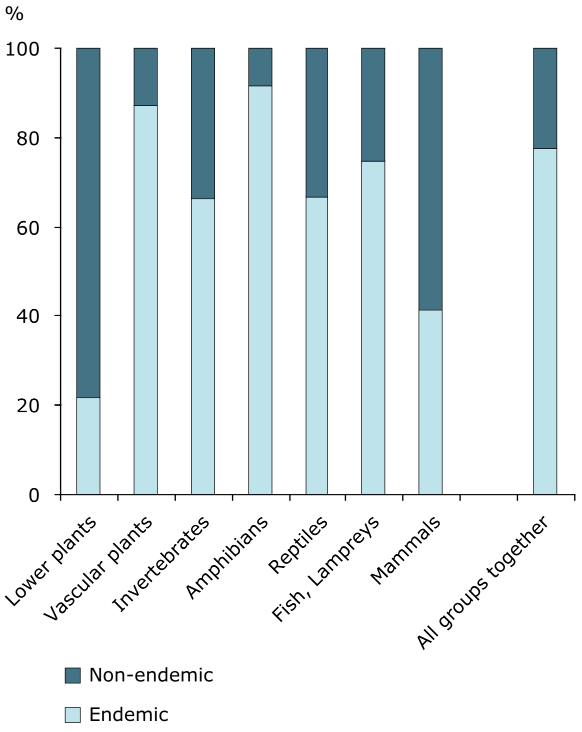
- Amphibians are in bad status with nearly 70 % unfavourable assessments.
- Fish and arthropods have around 60 % unfavourable assessments.
- The highest percentage of favourable assessments corresponds to vascular plants (over 20 %).
- Mammals and reptiles are the species groups with highest percentage of unknown assessments.

Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

2.3 Endemic species in Annex II to the Habitats Directive

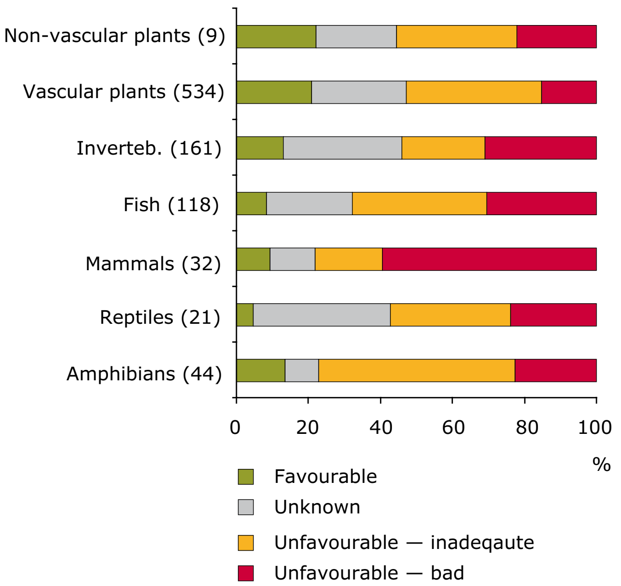
Figure 2.7 Proportion of endemic species in Annex II to the Habitats Directive



- Over 80 % of the Annex II species occur only in Europe (703 out of 865) with 60 % being narrow endemics (i.e. only occurring in a small geographical area).
- The proportion of endemics varies from more than 90 to 20 % according to the taxonomic group.

Source: ETC/BD, 2010.

Figure 2.8 Conservation status of endemic species from Annex II to the Habitats Directive



- Nearly 80 % of assessments of mammals and amphibians endemic to Europe are unfavourable.
- Nearly 40 % of endemic reptiles and invertebrates have an 'unknown' status, indicating that little is known about them.

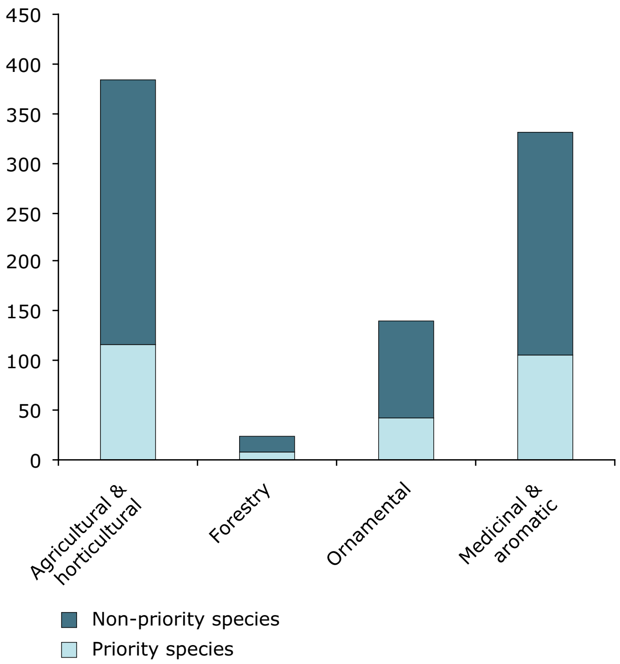
Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

2.4 Crops and wild relatives in the Annexes to the Habitats Directive

More than 80 % of Euro-Mediterranean flora consists of crops and their wild relatives. 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 to the Habitats Directive. On the other hand, 70 % of species listed in Annexes II, IV and V to the Habitats Directive are included in the CWR Catalogue.

Figure 2.9 Number of crops and wild relatives species present in the Annexes to the Habitats Directive



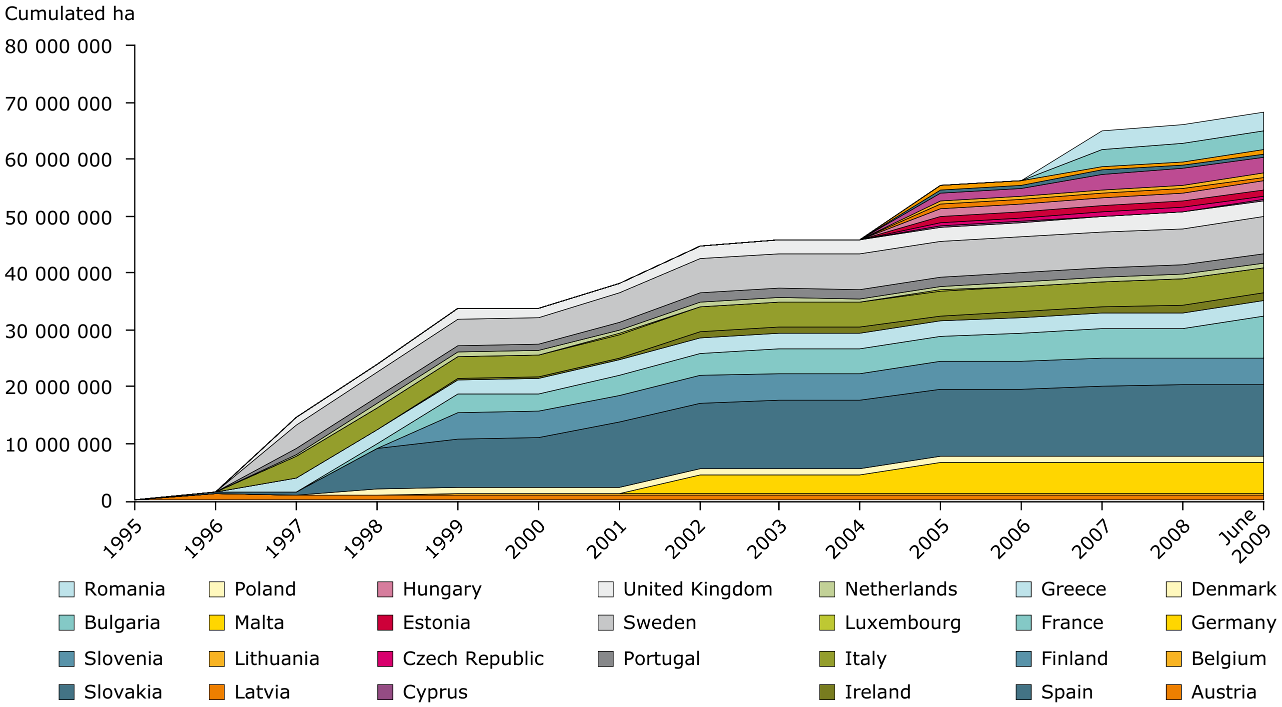
- From the CWR listed under the Habitats Directive, 60 % fall into the agricultural and horticultural crop group, 51 % in the medicinal and aromatic plant group, 22 % in the ornamental group and 4 % in the forestry group.

Source: Kell et al., 2008.

2.5 Natura 2000 network

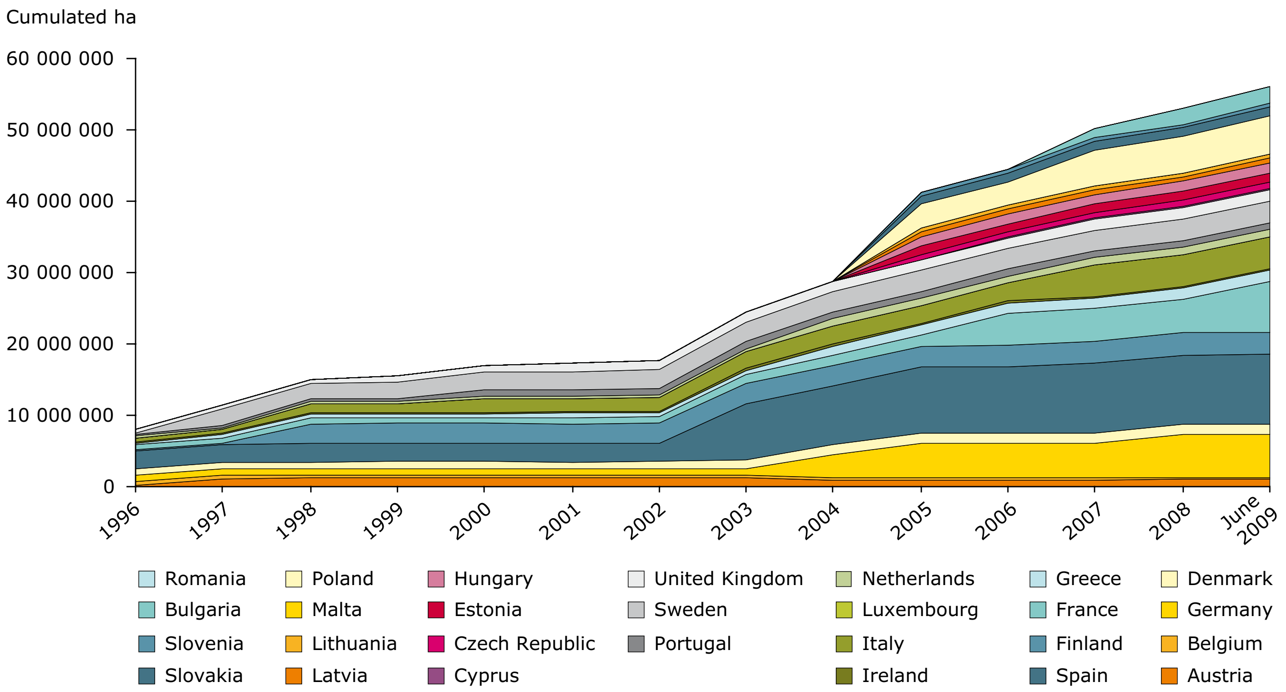
By the end of 2009, the Natura 2000 network covered 17.6 % of the EU-27 terrestrial area with around 26 000 sites classified as Special Protection Area (Birds Directive) and/or Site of Community Importance (Habitats Directive); its terrestrial area is 754 710 km^2 (about the surface area of Spain and Romania together) and its marine area is 167 561 km^2 (about the area of Estonia, Latvia and Lithuania together).

Figure 2.10 Cumulative surface area of sites designated by the Habitats Directive over time (SCIs)



Source: Natura 2000 EUNIS database (www.eea.europa.eu/data-and-maps/data/natura-2000-eunis-database).

Figure 2.11 Cumulative surface area of sites designated for Birds Directive over time (SPAs)



- Some 22 419 terrestrial sites are designated as Sites of Community Importance including 1 391 marine sites.
- In all, 5 242 sites are designated as Special Protection Areas including 619 marine sites.

Source: Natura 2000 EUNIS database.

2.6 References

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ETC/BD. 2008. *Habitats Directive Article 17 Report (2001–06)*. http://biodiversity.eionet.europa.eu/article17.

ETC/BD, 2010. *Endemic species in Annex II and Annex IV to the Habitats Directive,* ETC/BD, ILE SAS.

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3 Agro-ecosystems

Agricultural environments and landscapes provide a reservoir of biodiversity with a range of rare and specialised species and characteristic managed habitats, supporting important functions such as pollination and recycling of organic matter (INRA, 2008). Biodiversity in agro-ecosystems is under considerable pressure as a result of intensified farming and land abandonment.

In this section, the term 'agro-ecosystems' includes three main types of agro-ecosystems which correspond to the following Corine land cover categories.

- Regularly cultivated land includes: 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).
- Sixty-three habitats listed in Annex I to the Habitats Directive were selected because they depend on, or are linked to, some agricultural practices; these includes meadows, grasslands, heathland and some forms of bogs.

A specific chapter is dedicated to grasslands.

3.1 Status and trends

Change in agro-ecosystem areas since 1990 ([12])

See Table 3.1.

Table 3.1 Surface area (km^2) of agro-ecosystems in 1990, 2000 and 2006

	1990	2000	2006
Regularly cultivated land	1 368 129	1 360 694	1 356 981
Mixed cultivated land	398 698	397 931	397 235
Semi-natural areas	173 691	170 168	169 215
Total	**1 940 518**	**1 928 793**	**1 923 431**

- In 2006, the total agro-ecosystem area was over 1 923 000 km^2: 70 % regularly cultivated land; 21 % mixed cultivated land; and 9 % semi-natural.
- In 2006, the total agro-ecosystem area was nearly 1 % smaller than in 1990 for the same geographical area.
- In 2006, for the same geographical area as surveyed in 1990, regularly cultivated land had decreased by 0.8 %; mixed cultivated land by 0.4 %; and semi-natural agro-ecosystems by 2.6 %.

Note: Geographical coverage: EU except Greece, Finland, Sweden and the United Kingdom.

Source: Corine land cover.

([12]) CLC 1990–2000 is based on 24 EU Member States excluding Finland and Sweden; CLC 2000–06 is based on 25 EU Member States excluding Greece and the United Kingdom (their CLC inventories had not been finalised by Spring 2010). Therefore, comparisons between 1990 and 2006 do not include the four countries mentioned above.

Causes of loss of agro-ecosystems between 2000 and 2006

The figures following provide an overview of the land cover changes of the two more extensive agro-ecosystems, using Corine land cover data from the 2000 and the 2006 inventories.

The surface of intensively and extensively managed agriculture is shrinking in Europe mainly due to urbanisation and afforestation but also, in part, as a result of land abandonment (EEA, 2006). In many places, agriculture has been marginalised as an economic activity, often resulting in land abandonment: while new areas may be taken into production elsewhere, on average, the loss caused by land abandonment outweighs this (EEA, 2009).

Table 3.2 Changes in surface area (km² and %) since 1990

	1990—2000	2000—2006	1990—2006
Regularly cultivated land	– 7 435 – 0.5 %	– 3 713 – 0.3 %	– 11 148 – 0.8 %
Mixed cultivated land	– 767 – 0.2 %	– 696 – 0.2 %	– 1 463 – 0.4 %
Semi-natural areas	– 3 523 – 2.1 %	– 953 – 0.6 %	– 4 476 – 2.6 %
Total	**11 725 – 0.6 %**	**5 362 – 0.3 %**	**– 17 087 – 0.9 %**

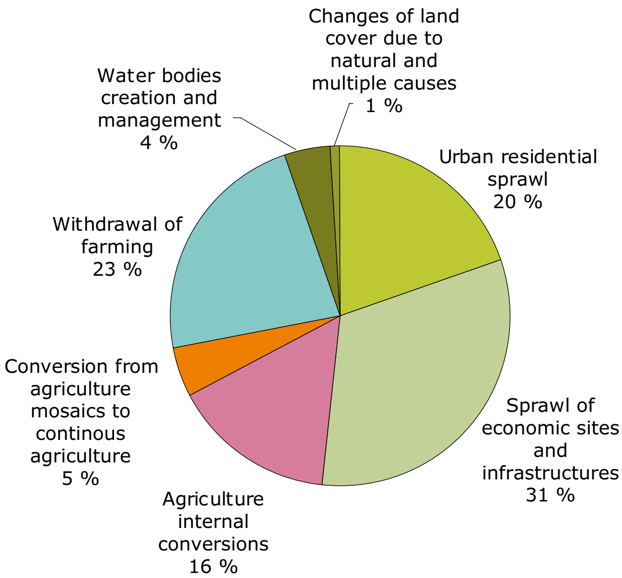
Between 1990 and 2006:

- More than 17 000 km² of arable land and other regularly cultivated land was lost (three times the surface of Cyprus), but this figure is surely higher for the whole EU;
- The highest rate of loss (– 2.6 %) corresponds to the semi-natural areas, but the rate of loss was much smaller between 2000 and 2006 (– 0.6 %).

Note: Geographical coverage: EU except Greece, Finland, Sweden and the United Kingdom.

Source: Corine land cover.

Figure 3.1 Causes of loss of mixed cultivated land



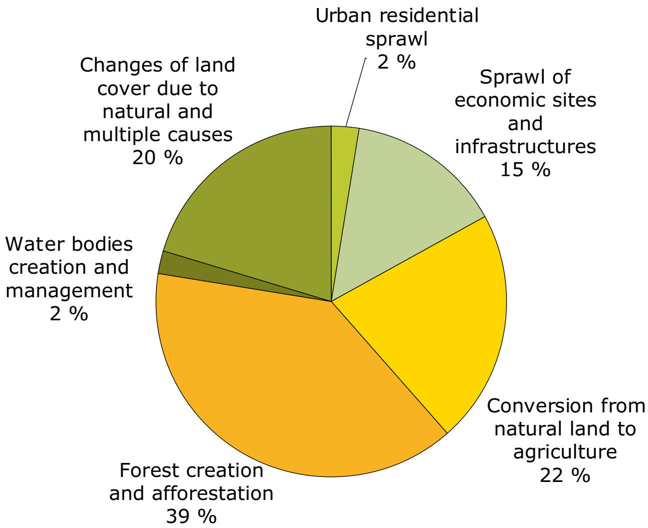
Between 2000 and 2006:

- 31 % of the mixed cultivated land was lost due to the sprawl of economic infrastructures;
- 20 % was lost due to diffuse urban residential sprawl including associated services and infrastructures;
- 23 % of change was due to farmland abandonment with land being taken over by natural transition to woodland and scrub.

Note: Geographical coverage: EU except Greece and the United Kingdom.

Source: Corine land cover 2000 and 2006.

Figure 3.2 Causes of loss of semi-natural areas



Between 2000 and 2006:

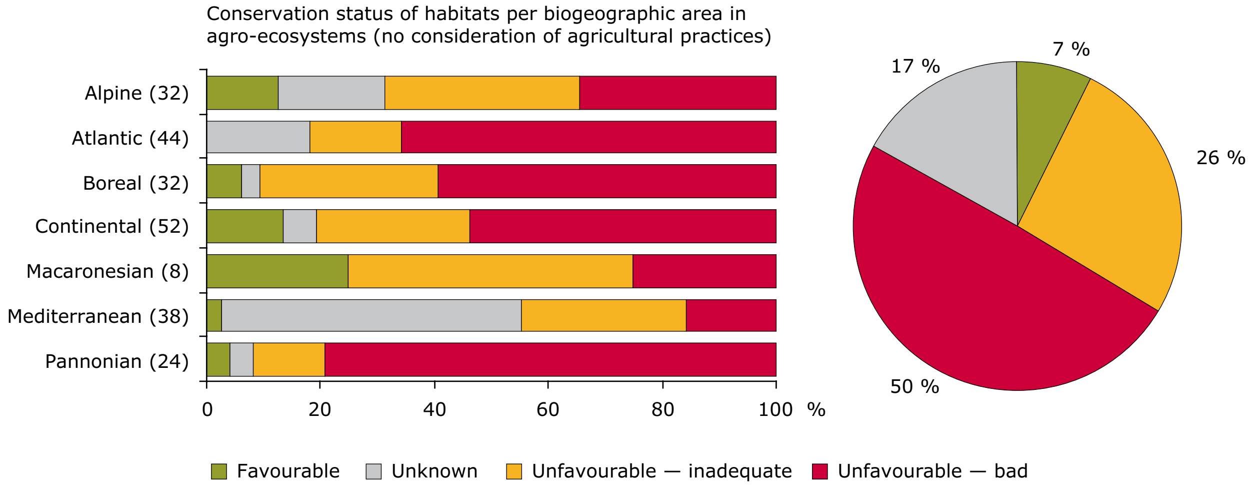
- 39 % of semi-natural area was lost due to forest creation and afforestation programmes;
- 22 % of loss was due to conversion to crops or to mixed agriculture with pastures.

Note: Geographical coverage: EU except Greece and the United Kingdom.

Source: Corine land cover 2000 and 2006.

Conservation status of habitats and species of European interest in agro-ecosystems

Figure 3.3 Conservation status of habitat types of European interest in agro-ecosystems (overall statistics on the right, statistics by region on the left)

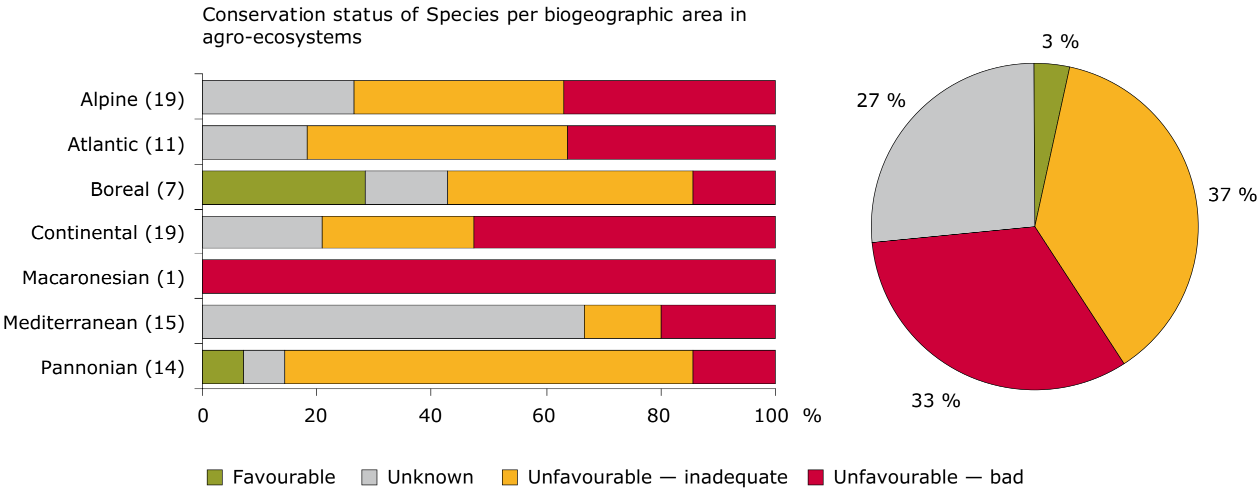


- Seventy-six per cent of the assessments of habitats linked to agro-ecosystems are unfavourable.
- Some 17 % of the assessments are unknown.
- The Macaronesian region has the highest percentage of favourable assessments (more than 20 %).
- The Mediterranean region has more than 40 % of unknown assessments.
- The Atlantic region has no favourable assessments.

Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

Figure 3.4 Conservation status of species of European interest in agro-ecosystems (overall statistics on the right, statistics by region on the left)

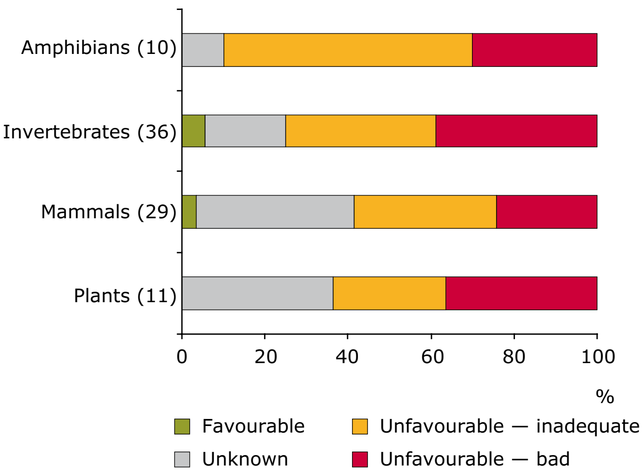


- Three per cent of the conservation status assessments of species linked to agro-ecosystems are favourable.
- Some 70 % of the assessments are unfavourable.
- In the order of 27 % of assessments are unknown.
- The only favourable assessments are in the Pannonian (less than 10 %) and Boreal (almost 30 %) regions.
- The Mediterranean region has more than 60 % of unknown assessments.

Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

Figure 3.5 Conservation status of species of European interest in agro-ecosystems per group



- More than 80 % of assessments for amphibians linked to agro-ecosystems are unfavourable.
- Mammals and invertebrates are the only species groups with favourable assessments (less than 10 %).
- Plants and mammals have the highest percentage of unknown assessments.

Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

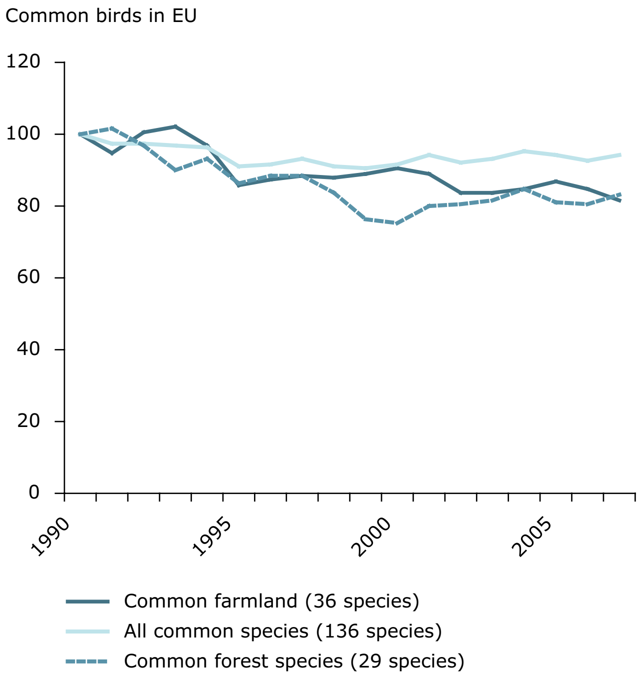
Source: ETC/BD, 2008.

Additional information:

- Nearly 30 species in the Habitats Directive are linked to agro-ecosystems and nearly 40 species in the Birds Directive are linked to agro-ecosystems.
- Of the mammals of European interest linked to agro-ecosystems, 25 % are threatened.
- Of the birds of European interest linked to agro-ecosystems, 42 % are threatened.
  Source: IUCN, 2007; BirdLife, 2004.

Since 1990, the European Union's common farmland birds have declined by 20–25 % and, during the same period, common bird populations have decreased by around 10 % ([13]).

Figure 3.6 Trends in the common bird indicators for the European Union, base = 1990



Note: Geographical coverage: Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Italy, Latvia, the Netherlands, Norway, Poland, Portugal, Republic of Ireland, Spain, Sweden, Switzerland, the United Kingdom.

Source: Eurostat (env_bio2) — EBCC/RSPB/BirdLife/Statistics Netherlands.

Agro-ecosystems and Natura 2000

More than one third of the area of the Natura 2000 sites is made up of agro-ecosystems.

- Agro-ecosystems cover 38 % of the surface of Natura 2000: 17.5 % regularly cultivated;14 % which need extensive practice; and 6.5 % with complex agro-ecosystems.
- Agro-ecosystems cover 40.5 % of the surface of SPAs under the Birds Directive (20 % regularly cultivated; 14 % which need extensive practice; and 6.5 % with complex agro-ecosystems).
- Agro-ecosystems cover 33 % of the surface of SCIs under the Habitats Directive (11.5 % regularly cultivated; 15.5 % which need extensive practice; and 6 % with complex agro-ecosystems).

Source: Natura 2000, CLC 2006 for the EU except Greece and the United Kingdom (where CLC 2000 was used).

Share of total utilised agricultural area occupied by organic farming

Organic farming has developed rapidly since the beginning of the 2000s and continues to do so.

- The area under organic farming increased by 21 % between 2005 and 2008 and 7.4 % between 2007 and 2008.
- However, only about 5 % of the share of total utilised agricultural area was occupied by organic farming in 2008 (Eurostat, 2010).

High Nature Value farmland

High Nature Value (HNV) farming is a low-input farming system which favours the preservation of high biodiversity values on farmland. Such farmland may be characterised by having a high proportion of semi-natural vegetation, a mosaic of low intensity agriculture and semi-natural structural elements (e.g. field margins, hedgerows, stone walls, patches of woodland or scrub, small rivers, etc.) and, in some cases, supporting rare species whose numbers may sometimes represent a high proportion of the European or world populations (EEA, 2010). An estimation of the extent

([13]) SEBI2010 indicator No 1 — Common birds in Europe — uses a population index of 100 for the year 1980, but its geographical coverage is wider than the European Union.

of HNV farmland in the EU-27 is limited due to the availability of data and discrepancies between different sources. According to the different sources, the share of HNV farmland varies between 32 and 43 % of agricultural land (Paracchini et al., 2008).

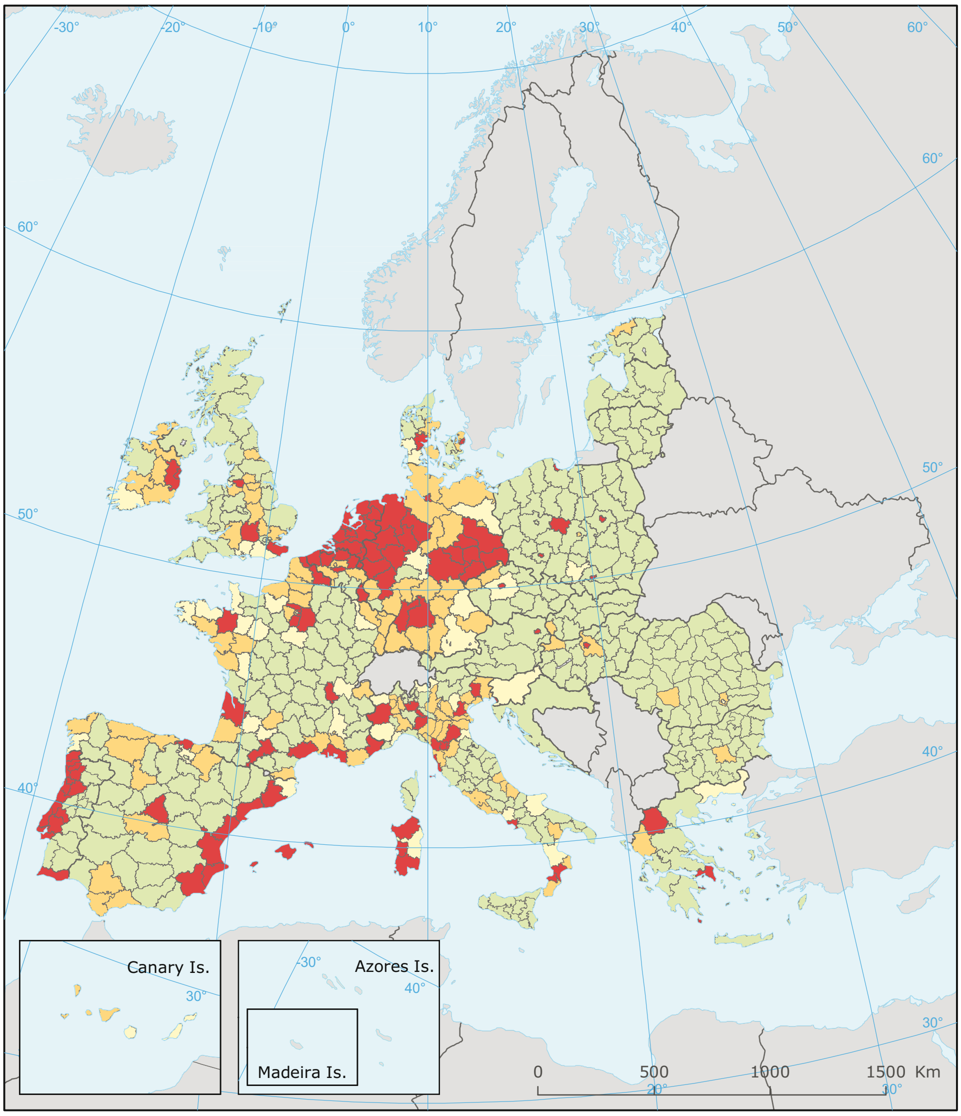
3.2 Pressures and threats

Mixed cultivated areas are most affected by urban and economic site sprawl and their associated infrastructure, whilst semi-natural areas have been impacted most by forest creation and afforestation, land abandonment and conversion to intensive agriculture.

Agricultural intensification and land abandonment are two of the main pressures on biodiversity linked to agro-ecosystems in Europe (EEA, 2010). Decreases in the diversity of crops, the simplification of cropping methods, use of fertilisers and pesticides and the homogenisation of landscapes all have negative effects on biodiversity in agricultural areas (INRA, 2008). Land abandonment causes the loss of specialised species and the deterioration of habitats associated with extensively farmed agro-ecosystems (Moreira et al., 2005 in EEA, 2010).

Europe-wide studies considering the effects of agricultural practices and landscape characteristics

Map 3.1 Loss of agricultural land to artificial surfaces in Europe from 1990 to 2000



Agriculture to artificial land

% difference to European mean value

- < – 10
- – 10–10
- 10–100
- > 100
- NUTS region (*)
- Outside data coverage

(*) NUTS 2: Austria, Belgium, Germany, Greece, the Netherlands and the United Kingdom
NUTS 3: Bulgaria, Czech Republic, Denmark, Estonia, France, Hungary, Ireland, Italy, Latvia, Lithuania, Poland, Portugal, Romania, Slovakia and Spain
NUTS 0: Croatia, Luxembourg and Slovenia

- The percentage of loss of agricultural land to artificial surfaces 1990—2000 has been more significant in the Netherlands, Germany, Belgium, western Portugal, the eastern coast of Spain and Sardinia.

Source: EEA, 2006.

on biodiversity have confirmed the important impact of agriculture at different spatial scales. At the plot level, fertilisation, tillage and pesticides are environmental disturbances that have an overall negative effect. At the landscape level, negative effects are caused by the disappearance of semi-natural environments at the edge of agricultural areas (such as woodland, semi-natural grassland and hedge and field margins). The same applies for the homogenisation of crops and the synchronisation of practices (such as harvesting and mowing dates). In addition, intensive agriculture in homogeneous landscapes, leading to monoculture, promotes the development of populations of crop pests (INRA, 2008).

The loss of biodiversity in agro-ecosystems through agricultural intensification and habitat loss negatively affects the maintenance of pollination systems and causes the loss of pollinators (TEEB, 2009). Less intensive production methods have positive effects on biodiversity, in particular for animals such as pollinators and the natural enemies of pest species (INRA, 2008).

In the past, nitrogen inputs in European agricultural systems have exceeded crop and forage needs, resulting in diffuse pollution in water bodies. However, the implementation of the Nitrates Directive ([14]) and the introduction of set-aside measures has stabilised pollution from nutrients and pesticides reducing the environmental pressures on soil, water and air (EEA, 2009).

3.3 Services

Along with provisioning services, such as food, fibre and fuel, agro-ecosystems provide vital services in the form of pollination and natural sources of pest control.

The biodiversity associated with provisioning services of agricultural landscapes comprises: crops

Figure 3.7 Current state and trends of agro-ecosystems services

Provisioning	
Crops/timber	↓
Livestock	↓
Wild food	=
Wood fuel	
Capture fisheries	
Aquaculture	
Genetic	=
Fresh waters	

Regulating	
Pollination	↑
Climate regulation	
Pest regulation	↑
Erosion regulation	
Water regulation	
Water purification	
Hazard regulation	

Cultural	
Recreation	↑
Aesthetic	↑

Trend between periods

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

Status for period 1990–present

	Enhanced
	Mixed
	Degraded
	Unknown
	Not applicable

- Wild foods and genetic resources services have a degraded status.
- Pollination, pest regulation, recreation and aesthetic services have a mixed status; they are degraded in some regions and enhanced in others; all show a positive trend when compared to the period 1950–1990.
- Crops and livestock show a mixed status, but their trend is negative.

Source: RUBICODE project 2006–2009.

([14]) The Nitrates Directive (Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources) seeks to reduce or prevent the pollution of water caused by the application and storage of inorganic fertiliser and manure on farmland. It is intended to both safeguard drinking water supplies and prevent wider ecological damage in the form of eutrophication of freshwater and marine waters generally (Tucker and de Soye, 2009).

grown for food, livestock, wood and fibre, fuel and biofuels, genetic resources, ornamental resources, pharmaceuticals, perfumes and fresh water.

European agro-ecosystems have a total annual economic value of around EUR 150 billion (Gallai et al., 2009, in Harrison et al., 2010). There is increasing evidence that conserving wild pollinators in habitats adjacent to agriculture improves both the level and the stability of pollination services, leading to increased yields and incomes (Klein et al., 2003, in TEEB, 2009). Biological control of pests is also a key service of agro-ecosystems which are dependent on the presence of appropriate flora, and soil condition, clearly of vital importance to support agriculture, is dependent on biodiversity (Vandewalle et al., 2010).

Perennial crops (such as forage crops) reduce the run-off of water during storm conditions, thereby reducing the impact of downstream flooding, and are important for carbon sequestration. Indeed, restoring some of the large amounts of carbon lost from soils, particularly from agricultural soils, has a great potential to actively remove carbon dioxide from the atmosphere (Trumper et al., 2009). Hedges and shelter belts have an important function in reducing soil erosion, and provide regulating services in the form of habitat and shelter for pollinators and sources of natural pest control, whilst increasing ecological connectivity (Vandewalle et al., 2010; Harrison et al., 2010).

Low-input agricultural systems support cultural services with many local traditions based on the management of land and its associated biological resources (TEEB, 2009), and provide genetic resources and cultural services such as cultural heritage, recreation, aesthetics and sense of place (Harrison et al., 2010).

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4 Grassland ecosystems

Grasslands are areas covered by grass-dominated vegetation with little or no tree cover. Various types of grasslands exist in Europe: from desert-like in the south-east of Spain, through steppes and dry grasslands, on to humid and generally damper grasslands and meadows, often on deeper and more fertile soils, lowland and montane, which dominate in the north and north-west (EC, 2008).

Most European grasslands can be defined as 'semi-natural' because they have developed through natural processes over long periods of grazing by domestic stock, cutting and even deliberate light burning regimes; others may have originated from sown and grass leys aimed at producing forage for livestock. In almost all cases, they are modified and maintained by human activities, mainly through grazing and/or cutting regimes (Turbé et al., 2010).

In this section, the term 'grasslands' includes meadows, steppes and grasslands managed (grazing, cutting, burning) with variable intensity. There is a large overlap with agro-ecosystems, which are covered in the corresponding section.

- Two CLC categories are used: Pastures (231) and Natural grasslands (321).
- About 45 habitat types listed in Annex I to the Habitats Directive were selected; they include all natural and semi-natural grassland formations, salt meadows and steppes and dune grasslands.

4.1 Status and trends

Grasslands are among the most species-rich vegetation types (up to 80 plant species/m^2) in Europe and have great conservation value (Eriksson et al., 2002; Poschlod and Wallis de Vries, 2002; Wallis de Vries et al., 2002, in Vandewalle et al., 2010). Annex I to the Habitats Directive lists 45 grassland and meadow habitats of different types: natural, semi-natural, calcareous, dry, mesophile and humid; this reflects the high diversity of grasslands and the fact that most of them have been modified, created or maintained by agricultural activities.

Large areas of grassland have been lost in recent decades, causing severe fragmentation of the remaining habitat areas and a consequent drop in populations of certain species by as much as 20–50 % across Europe (EC, 2008). Grasslands are key habitats for many species: plants, butterflies, reptiles and many birds as well as grazing mammals such as deer and rodents. However, the overall population trend is negative for characteristic grassland species such as the great bustard (*Otis tarda*), the corncrake (*Crex crex*), kestrels and several species of invertebrates (EC, 2008).

Eighty-nine of the 152 grassland bird species (59 %) have an unfavourable conservation status in Europe (Birdlife International in Veen et al., 2009). This is a slight deterioration compared to a decade ago, when 81 grassland species had an unfavourable conservation status. A number of the now threatened species were formerly common in Europe: such as the lapwing (*Vanellus vanellus*), European starling (*Sturnus vulgaris*) and corn bunting (*Miliaria calandra*) (Tucker and Heath, 1994, in Veen et al., 2009).

Europe's grassland butterflies have declined by 60 % since 1990 and this reduction shows no sign yet of levelling off (EEA, 2009). Intensification in use and production across the relatively flat areas of western (and other parts of) Europe is the most important threat to butterflies, By contrast, abandonment and lack of extensive (low intensity) grazing is the major threat in southern and eastern Europe, in mountain areas or areas with relatively poor soils (EEA, 2009).

Change in grassland ecosystem areas since 1990 (15)

Table 4.1 Surface area (km²) of grassland ecosystem in 1990, 2000 and 2006

	1990	2000	2006
Pastures	292 264	290 903	289 711
Natural grasslands	77 308	75 795	75 514
Total	**369 572**	**366 697**	**365 224**

- In 2006, the total grassland ecosystem area was 365 000 km²: 79 % pasture; the remaining 21 %, natural grasslands.
- In 2006, the total grassland ecosystem area was just over 1 % smaller than in 1990 for the same geographical area.
- In 2006, for the same geographical area as surveyed in 1990, pasture had decreased by 0.9 % and natural grassland by 2.4 %.

Note: Geographical coverage: EU except Greece, Finland, Sweden and the United Kingdom.

Source: Corine land cover.

Table 4.2 Changes in surface area (km² and %) since 1990

	1990–2000	2000–2006	1990–2006
Pastures	– 1 361 – 0.5 %	– 1 192 – 0.4 %	– 2 553 – 0.9 %
Natural grasslands	– 1 514 – 2.0 %	– 281 – 0.4 %	– 1 795 – 2.4 %
Total	– 2 874 – 0.8 %	– 1 473 – 0.4 %	– 4 347 – 1.2 %

Between 1990 and 2006:

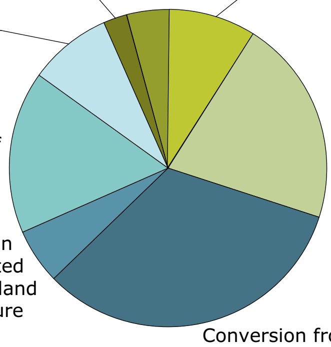
- more than 4 300 km² of grassland was lost;
- the highest rate of loss (– 2.4 %) concerns natural grassland areas, and the rate of loss was highest between 1990 and 2000 (– 2.0 %).

Note: Geographical coverage: EU except Greece, Finland, Sweden and the United Kingdom.

Source: Corine land cover.

Causes of loss of grassland ecosystems between 2000 and 2006

Figure 4.1 Cause of loss of grasslands



Between 2000 and 2006, in grassland areas:

- 32 % of change was due to conversion from pasture to arable land and permanent crops and 21 % due to sprawl of economic sites and infrastructure;
- 17 % was due to farmland abandonment leading to natural afforestation.

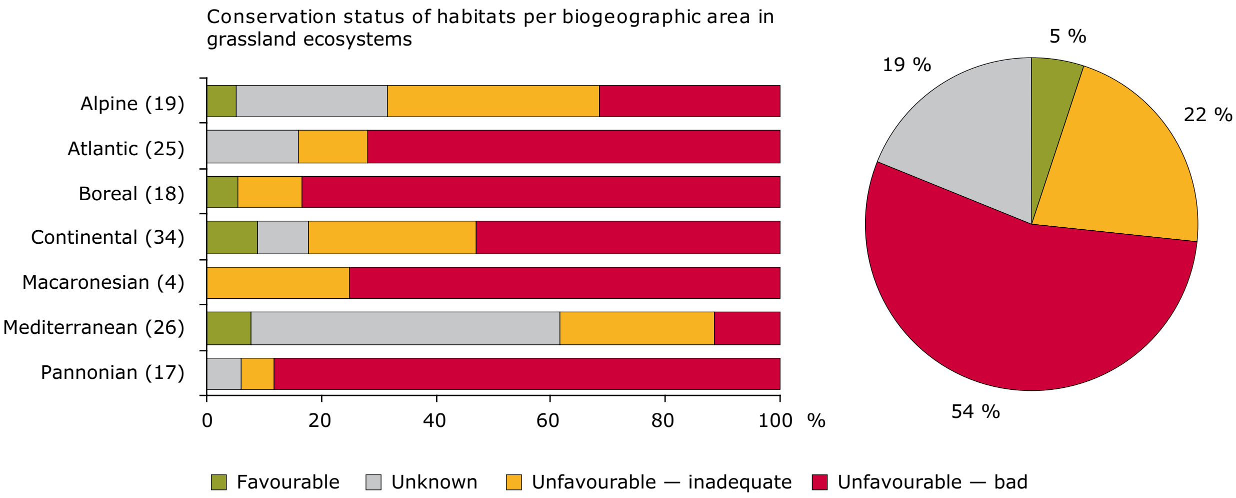
Note: Geographical coverage: EU except Greece and the United Kingdom.

Source: Corine land cover.

(15) CLC 1990–2000 is based on 24 EU Member States excluding Finland and Sweden; CLC 2000–2006 is based on 25 EU Member States excluding Greece and the United Kingdom (their CLC inventories had not been finalised by Spring 2010). Therefore, comparisons between 1990 and 2006 do not include the four countries mentioned above.

Conservation status of habitats and species of European interest in grassland ecosystems

Figure 4.2 Conservation status of habitat types of European interest in grassland ecosystems (statistics by region on the left, overall statistics on the right)

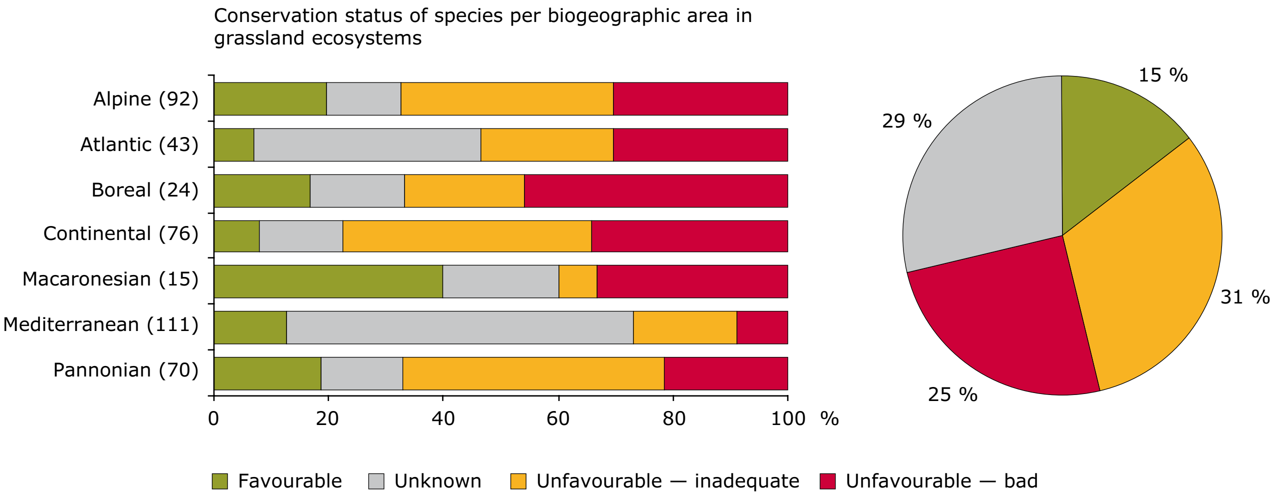


- Seventy-six per cent of the assessments of grassland habitats of European interest are unfavourable.
- Only 5 % of the assessments are favourable.
- The Mediterranean region has the highest percentage of unknown assessments (more than 50 %).
- There are no favourable assessments for the Atlantic, Macaronesian and Pannonian regions.

Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

Figure 4.3 Conservation status of species of European interest in grassland ecosystems (statistics by region on the left, overall statistics on the right)

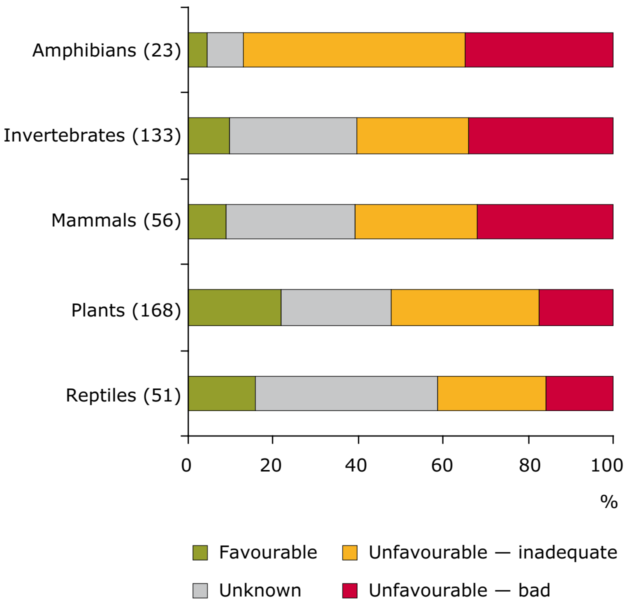


- Fifteen per cent of the assessments of conservation status of grassland species are favourable.
- Some 56 % of the assessments of grassland species are unfavourable.
- In the order of 29 % of the assessments are unknown.
- The Macaronesian region has 40 % favourable assessments, but a relatively small number of grassland species.
- The Mediterranean region has 60 % unknown assessments.

Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

Figure 4.4 Conservation status of species of European interest in grassland ecosystems per group



- More than 80 % of the conservation status assessments for amphibians linked to grassland ecosystems are unfavourable.
- Plants have the highest percentage of favourable assessments (more than 20 %).
- More than 40 % of assessments for reptiles are unknown.

Note: Geographical coverage: EU except Bulgaria and Romania,; number of assessments in brackets.

Source: ETC/BD, 2008.

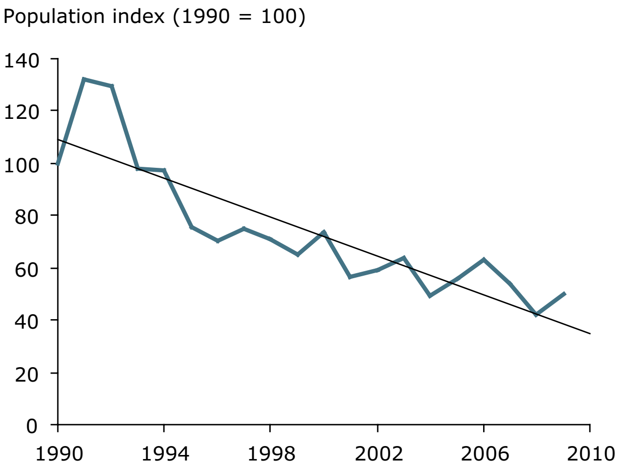
Additional information

- Some 235 species of European interest (Habitats Directive) are linked to grasslands.
- Seventy-one species in the Birds Directive are linked to grasslands.
- Of the amphibians of European interest linked to grassland ecosystems, 28 % are threatened.
- Of the reptiles of European interest linked to grassland ecosystems, 12 % are threatened.
- Of the mammals of European interest linked to grassland ecosystems, 16 % are threatened.
- Of the birds of European interest linked to grassland ecosystems, 23 % are threatened.

Since 1990, Europe's grassland butterflies have declined dramatically (nearly 70 %) and this reduction shows no sign yet of levelling off.

Source: BirdLife, 2004, IUCN, 2007, 2009.

Figure 4.5 Grassland butterflies, population index (1990 = 100)



Source: De Vlinderstichting/Butterfly Conservation Europe/Statistics Nederlands, 2010; SEBI indicators, 2010 — SEBI indicator 1.

Grasslands and Natura 2000

- Grassland ecosystems cover 11 % of the total surface of Natura 2000: 12 % of Special Protection Areas (SPAs) and 10.5 % of Sites of Community Importance (SCIs).

Source: Natura 2000, CLC 2006 for the EU except Greece and the United Kingdom (where CLC 2000 was used).

4.2 Pressures and threats

Agricultural intensification and land abandonment together provide two of the main pressures on biodiversity linked to grassland ecosystems. Habitat fragmentation and conversion to biofuels or forestry represent growing threats.

Conversion of High Nature Value grasslands to other uses such as arable crops, woodland or development is usually irreversible; it not only destroys the biodiversity of the grassland itself but can also contribute to habitat fragmentation and also have impact on local birds and other animals (Veen et al., 2009).

The impact of agricultural intensification continues to result in the loss of high biodiversity grassland. In relation to agricultural intensification, grasslands are adversely affected by fertiliser and nutrient run-off, fertiliser and pesticide drift, and the deposition of atmospheric nitrogen (Bobbink et al., 1998, and Veen et al., 2009). River engineering, such as straightening and canalisation, results in the disconnection of the river from the flood plain and causes related changes in the ecology of flood plain grasslands, which when better drained also become more susceptible to agricultural intensification (Vandewalle et al., 2010 and EEA, 2010).

Abandonment of semi-natural grasslands, particularly species rich swards, generally has a negative impact on biodiversity and vegetation succession; resulting in a structural change from an open to a closed landscape and loss of forest-edge habitats which, in turn, has an impact on the fauna, for example, a decrease in habitat suitable for meadow birds (Veen et al., 2009).

Habitat fragmentation has impacted on grasslands through agricultural intensification and the implementation of improved transport and energy infrastructure. Remaining grasslands often suffer due to intensive land use, irregular management or eutrophication. The increasing demand for biofuels places an additional pressure on grasslands (Vandewalle et al., 2010).

Changes to the breeds and species of domestic grazing animals and grazing intensification can change the quality of the sward and increase the possibility of invasion by weedy or alien species (Veen et al., 2009). Climate change may affect grassland habitats through desertification of steppic habitats, through a rise in sea level in coastal areas and through changing hydrological regimes of flood plain meadows (Veen et al., 2009). There is also evidence that the tree line is 'climbing' in the Alps and Pyrenees, permanently affecting grasslands (EC, 2008). Cultivation and urbanisation of grasslands, and other modifications of grasslands through desertification and livestock grazing can be a significant source of carbon emissions (EC, 2008).

4.3 Services

Grasslands are the basis for providing food from domestic, grazing animals, which, when they are traditional breeds, also conserve valuable genetic resources. The plants which make up the grasslands are also rich in genetic variability. Grasslands sequester significant amounts of carbon, reduce soil erosion and assist in water management; furthermore, they have high aesthetic and cultural value.

The most important and widely recognised ecosystem service provided by grasslands is the provision of food (Vandewalle et al., 2010). Grassland habitats have been used over very long periods of time by local breeds of livestock well adapted to the sometimes harsh conditions, which are an important gene pool (Veen et al., 2009).

Biodiversity-rich grasslands in Europe provide different regulatory services: semi-natural grasslands harbour a diverse community of natural pollinators and, when located within a matrix of agricultural landscapes, they may also provide an important pest regulation service. Grasslands may also play an important role in regulating climate change through carbon sequestration (Vandewalle et al., 2010) and store approximately 34 % of the global stock of carbon in terrestrial ecosystems (EC, 2008). Permanent grassland also prevents soil erosion and lowers the risk that pollutants will leach into water and allows for lower usage of fertiliser, which is one of the main sources of nitrous oxide emissions (Veen et al., 2009).

Grasslands may also provide genetic resources. Traditionally managed European grasslands are extremely rich in species (van der Maarel, 2005; Skórka et al., 2007, in Vandewalle et al., 2010), but also rich in genetic variability within species (Prentice et al., 2006, in Vandewalle et al., 2010). Grasslands have been the seedbeds for the ancestors of major cereal crops, including wheat, rice, barley and sorghum, and they continue to provide genetic material necessary to breed cultivated varieties that are resistant to crop diseases and climate change (EC, 2008).

Figure 4.6 Current state and trends of grasslands ecosystems services

Provisioning

Crops/timber	
Livestock	=
Wild food	↓
Wood fuel	
Capture fisheries	
Aquaculture	
Genetic	↓
Fresh waters	

Regulating

Pollination	=
Climate regulation	
Pest regulation	=
Erosion regulation	=
Water regulation	
Water purification	
Hazard regulation	

Cultural

Recreation	↓
Aesthetic	=

Trend between periods

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

Status for period 1990–present

	Enhanced
	Mixed
	Degraded
	Unknown
	Not applicable

- The majority of the services provided by grasslands have a degraded status, with three of them — wild foods, genetic resources and recreation — showing a negative trend.
- The status and trends of several grassland services are still unknown.

Source: RUBICODE project 2006–2009.

Grassland ecosystems provide multiple cultural services: their diversity in plant, bird and insect species serve as focal points for local tourism and ecotourism, providing the framework for educational activities and enabling to enjoy the aesthetic values (Vandewalle et al., 2010). Some of the supporting services provided by grasslands are, for instance, soil formation and supply of nutrients (Vandewalle et al., 2010).

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5 Heath and scrub ecosystems

In Europe, heathlands and scrublands have been co-evolving for millennia with human societies. They are natural or semi-natural ecosystems that have either been maintained by traditional management (mainly grazing or cutting, in some cases with low to intermediate input of organic fertiliser) or by disturbance events (scrub is characteristically a natural vegetation phase in the succession between bare ground or grassland and forest). They represent a distinctive set of European habitats for their biodiversity and their aesthetic and cultural values (Wessel et al., 2004; Quétier et al., 2007 in Vandewalle et al., 2010).

In this section, the term 'heath and scrub ecosystems' includes both heath and scrub together with sclerophyllous scrubs typical of the Mediterranean region including mattoral, garrigue and phrygana. Most of these habitats are semi-natural and many are also listed under agriculture.

- Three CLC categories are used: Moors and Heathlands (322), Sclerophyllous vegetation (323) and Transitional woodland-shrub (324).
- Some 36 types of heath and scrub habitats listed in Annex I to the Habitats Directive are included: for example, temperate and sclerophyllous, coastal and inland types.

Heath and scrub ecosystems also include the patches of scrub and linear scrub features such as field margins, hedgerows and shelter belts with high biodiversity value that are often associated with farmed landscapes.

5.1 Status and trends

More than 40 % of heath and scrub ecosystem-related species of European interest are in unfavourable status; however, the status of a further 40 % is unknown. The status of just over a quarter of heath and scrub-related habitat types are unknown and a further 60 % are in unfavourable conservation status.

Change in heath and scrub ecosystem areas since 1990 ([19]***)***

Table 5.1 Surface area (km²) of heath and scrub ecosystem in 1990, 2000 and 2006

	1990	2000	2006
Heath/ sclerophyllous vegetation	96 383	94 373	93 701
Transitional land	116 785	121 690	132 712
Total	**213 168**	**216 063**	**226 413**

- In 2006, the total area was almost 226 500 km2: 59 % heath and sclerophyllous vegetation; the remaining 41 %, transitional land.
- In 2006, the total heath and scrub ecosystem area was almost 6 % greater than in 1990 for the same geographical area.
- In 2006, for the same geographical area as surveyed in 1990, the heath and sclerophyllous vegetation had decreased by 2.9 % but the transitional land area had increased by 12 %.

Note: Geographical coverage: EU except Greece, Finland, Sweden and the United Kingdom.

Source: Corine land cover.

([19]) CLC 1990–2000 is based on 24 EU Member States excluding Finland and Sweden; CLC 2000–2006 is based on 25 EU Member States excluding Greece and the United Kingdom (their CLC inventories had not been finalised by Spring 2010). Therefore, comparisons between 1990 and 2006 do not include the four countries mentioned above.

Table 5.2 Changes in surface area (km² and %) since 1990

	1990–2000	2000–2006	1990–2006
Heath/sclerophyllous vegetation	– 2 010 – 2.1 %	– 672 – 0.7 %	– 2 682 – 2.9 %
Transitional land	4 905 4.0 %	11 022 8.3 %	15 927 12.0 %
Total	**2 896** **1.3 %**	**10 350** **4.6 %**	**13 245** **5.9 %**

Between 1990 and 2006:

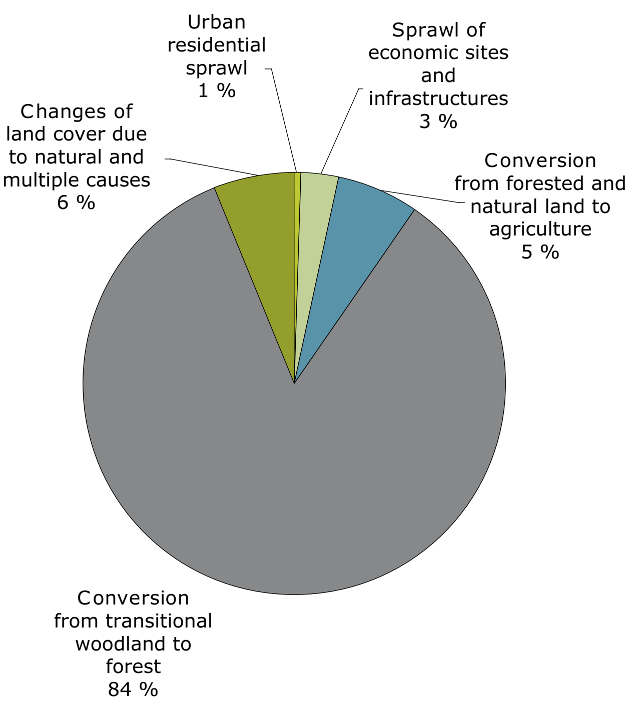
- the area of heath and scrub ecosystems increased by more than 13 000 km² (more than twice the surface of Cyprus);
- heath/sclerophyllous vegetation declined (– 2.9 %), but the rate of loss was less between 2000 and 2006 (– 0.7 %).

Note: Geographical coverage: EU except Greece, Finland, Sweden and the United Kingdom.

Source: Corine land cover.

Causes of loss of heath and scrub ecosystems between 2000 and 2006

Figure 5.1 Causes of loss of heath and scrub



Between 2000 and 2006, 84 % of the change to the area of heath and scrub was due to conversion from transitional woodland to forest. However, in relation to land conversion, the previous coverage of newly developed heathlands and scrublands should be taken into account. For example, when heathlands and scrublands grow on burnt forest areas or abandoned pastures, this might be associated with a loss in biodiversity value.

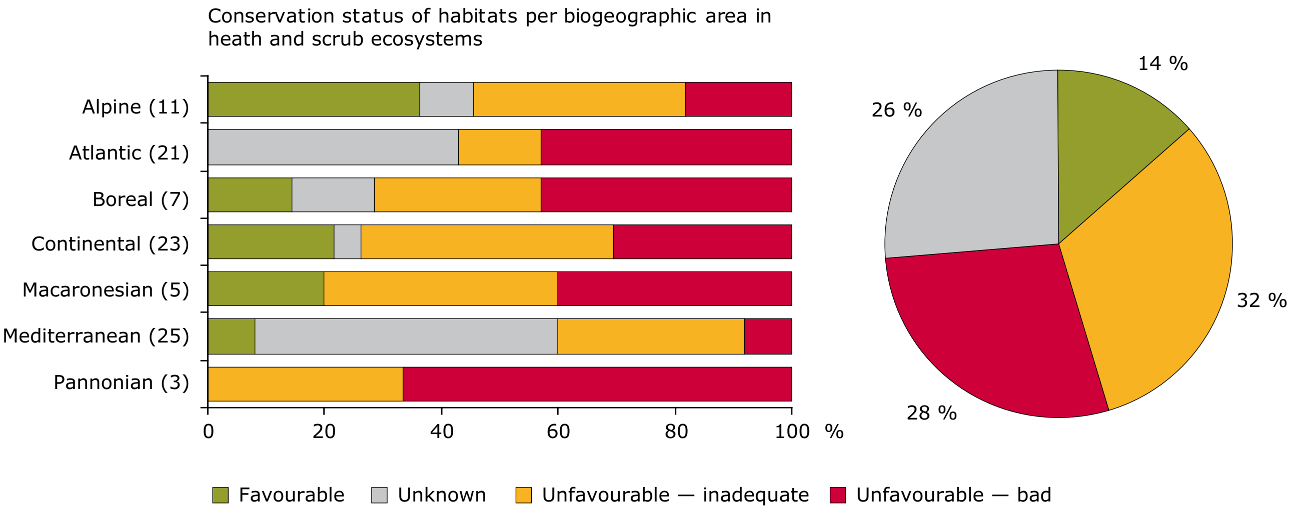
A more detailed analysis of causes of loss focused on heaths and sclerophyllous vegetation shows that 41 % of losses are due to conversions to forests, 22 % due to fires and 21 % due to conversion to agriculture.

Note: Geographical coverage: EU except Greece and the United Kingdom.

Source: Corine land cover.

Conservation status of habitats and species of European interest in heath and scrub ecosystems

Figure 5.2 Conservation status of habitat types of European interest in heath and scrub ecosystems (statistics by region on the left, overall statistics on the right)

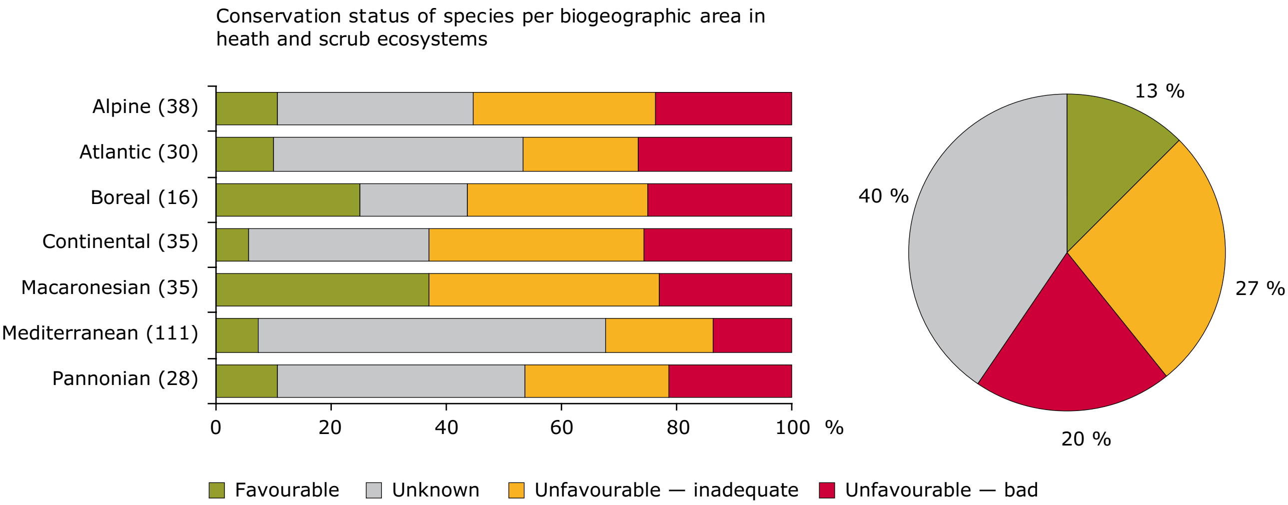


- Some 60 % of the assessments of heath and scrub habitats are unfavourable.
- Overall, 26 % of the assessments are unknown, with significant differences among the regions.
- The Alpine region has the highest percentage of favourable assessments (almost 40 %).
- There are no favourable assessments for the Atlantic and Pannonian regions.

Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

Figure 5.3 Conservation status of species of European interest in heath and scrub ecosystems (statistics by region on the left, overall statistics on the right)

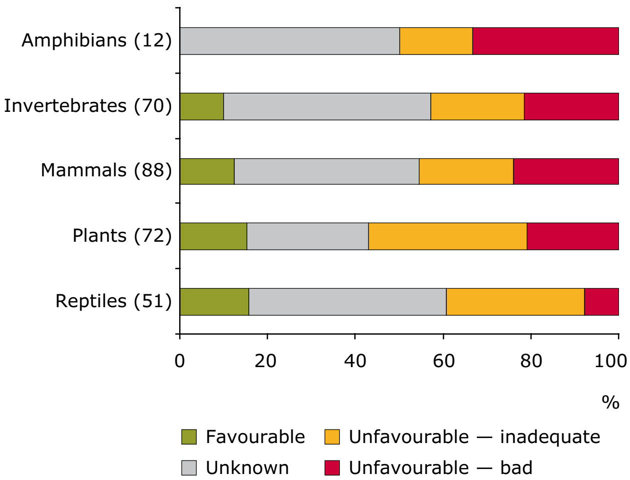


- Forty-seven per cent of the conservation status assessments of heath and scrub species are unfavourable.
- Some 40 % of the assessments are unknown.
- The Boreal and Macaronesian regions have the highest percentage of favourable assessments with 25 % and nearly 40 % respectively.
- The Mediterranean region has more than 60 % of unknown assessments.

Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

Figure 5.4 Conservation status of species of European interest in heath and scrub ecosystems per group



- More than 40 % of assessments for all species groups related to heath and scrub ecosystems are unknown, except for plants.
- Favourable assessments account for less than 20 % for all species groups.
- Amphibians have no favourable assessments.

Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

Additional information

- Nearly 143 species of the Habitats Directive and 59 species from the Birds Directive are linked to heath and scrub ecosystems.
- There are no threatened amphibians of European interest linked to heath and scrub ecosystems.
- Of the reptiles of European interest linked to heath and scrub ecosystems, 8 % are threatened.
- Of the mammals of European interest linked to heath and scrub ecosystems, 21 % are threatened.
- Of the birds of European interest linked to heath and scrub ecosystems, 19 % are threatened.

Source: BirdLife, 2004; IUCN, 2007, 2009.

Heath and scrub and Natura 2000

Heath and scrub ecosystems cover 16 % of the surface of Natura 2000: 15 % of Special Protection Areas (SPAs) and 18 % of Sites of Community Importance (SCIs).

Source: Natura 2000, CLC 2006 but CLC 2000 for Greece and the United Kingdom.

5.2 Pressures and threats

Land-use change related to conversion to agriculture, land abandonment and pollution from atmospheric nitrogen are the main threats to the biodiversity of heath and scrub ecosystems.

Today, heath and scrub ecosystems are threatened as a consequence of large-scale human activities, specifically by land-use changes, atmospheric pollution and climate change. Land clearance for agriculture, the use of artificial fertilisers and pesticides, and the conversion to arable fields have had a particular impact. Grazing and burning are an important component for the conservation of many heath and shrub ecosystems, helping to maintain them in their current state.

Rural abandonment and the natural succession of unmanaged scrub into the forest ecosystems have led to major declines in heath and shrublands and those that are left are further threatened by agricultural policies, pollution, and climate change (Vandewalle et al., 2010).

Exceedance of critical loads of nitrogen leads to both damage and loss of nitrogen-sensitive species' communities, coupled with invasion by nitrogen-loving species of lower conservation value. Examples of such changes include the loss of sensitive shrubs and wild flowers from heathlands and their replacement by grasses (e.g. Pitcairn et al., 2002, in COST, 2009).

5.3 Services

Heath and scrub ecosystems have high cultural value, reduce soil erosion and help to curb desertification. As linear features in agricultural landscapes, they provide habitat and shelter for pollinators and sources of natural pest control and increase connectivity.

A number of shrubs associated with heath and scrub ecosystems can be used for human consumption or in the preparation of foodstuffs; however, these ecosystems are more important in providing grazing (Fliescher and Sternberg, 2006; Rodriguez et al., 2006, in Vandewalle et al., 2010). Shrubby vegetation and turfs (cut from the peaty soils that underlie habitats such as heathlands in certain biogeographic zones) can also be used as a fuel source (Pardo, 2002, in Vandewalle et al., 2010), but this is not in general a sustainable practice.

There is also evidence of heath and scrub ecosystems regulating climate, air, water and erosion, and probably other services, such as seed dispersal by birds and pest regulation (Vandewalle et al., 2010). In shrubland ecosystems, both the shrubs and plant litter have been shown to reduce water run-off and, hence, reduce soil erosion and help curb desertification (Scott et al., 1998, and others in Vandewalle et al., 2010). However, because they burn easily, shrublands may have a negative role in the management of fires (Vandewalle et al., 2010).

Hedges and shelter belts have an important function in reducing soil erosion, provide habitat and shelter for pollinators and sources of natural pest control and increase connectivity (Vandewalle et al., 2010).

European heaths and shrublands have cultural values, are a source of inspiration, education and research services, and are used for leisure activities such as horseback riding, nature hikes, birdwatching and hunting (Vandewalle et al., 2010).

There are several species with high conservation status that increase the recreation and tourism value of heath and shrublands: the wild cat (*Felis sylvestris*) uses shrub cover for hunting and shelter; gorse (*Ulex europaeus*), heather (*Calluna vulgaris*) and bell heather (*Erica cinerea*) provide essential cover, nesting and feeding habitat for many species (Vandewalle et al., 2010).

Figure 5.5 Current state and trends of heath and scrub services

Provisioning

Crops/timber	
Livestock	=
Wild food	
Wood fuel	=
Capture fisheries	
Aquaculture	
Genetic	=
Fresh waters	

Regulating

Pollination	
Climate regulation	=
Pest regulation	
Erosion regulation	=
Water regulation	↑
Water purification	
Hazard regulation	

Cultural

Recreation	↑
Aesthetic	=

Trend between periods

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

Status for period 1990–present

	Enhanced
	Mixed
	Degraded
	Unknown
	Not applicable

- Livestock production and wood fuel provided by heaths and scrubs has a degraded status mainly due to declining of extensive use; the status of other services, such as genetic and erosion regulation, is also degraded.
- Habitat restoration and recreation in the 1990s, partly to fulfil conservation objectives (e.g. Habitats Directive), has meant that some, especially cultural, services are being enhanced in a few regions of Europe.
- The status and trends of many services provided by heath and scrubs remain unknown.

Source: RUBICODE project 2006–2009.

5.4 References

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6 Forest ecosystems

On average, forest covers just over 40 % of the European territory. There is no common definition of forests agreed among the Member States. However, the following working description is used in common by the Food and Agriculture Organisation (FAO), the United Nations Economic Commission for Europe (UNECE) and the Ministerial Conference on the Protection of Forests in Europe (MCPFE):

'Forest': Land with tree-crown cover (or equivalent stocking level) of more than 10 % and area of more than 0.5 ha. The trees should be able to reach a minimum height of 5 m at maturity in situ.

'Other wooded land' (OWL): Land either with tree-crown cover (or equivalent stocking level) of 5–10 % of trees able to reach a height of 5 m at maturity in situ; or a crown cover (or equivalent stocking level) of more than 10 % of trees not able to reach a height of 5 m at maturity in situ and shrub or bush cover (EC, 2010).

In this section, the term 'forest ecosystems' includes woodland vegetation comprising species forming forests of tall trees with typical undergrowth (EC, 2007).

- Four CLC categories are used: Forests (311,312,313) and Transitional woodlan-shrub (324).
- Eighty-three habitat types listed in Annex I to the Habitats Directive, such as broadleaved forests, woodlands, taiga, endemic pine forests, including wooded dunes, are included.

Mattoral and agro-forestry habitats have been excluded.

6.1 Status and trends

EU forests and other wooded areas now cover 176 million ha, more than 42 % of the EU land area (EC, 2010). However, there are significant differences in forest distribution and extent in different regions of the EU (EEA, 2010). Currently, there is no major deforestation in Europe and forest area increased slightly in most countries between 1990 and 2005 (EEA, 2008), partly due to afforestation programmes and natural regeneration on abandoned agricultural or formerly grazed land (EC, 2006).

Based on Corine land cover, the annual increase in forest area in the EU was around 0.5 % between 1990 and 2000 and around 0.1 % between 2000 and 2006. However, this increase is not uniformly distributed. In addition, the spatial forest pattern is changing locally due to different dynamics such as loss of forest areas, fragmentation of forest cover and therefore loss of connectivity (EEA, 2009). The majority of EU forests now consist of semi-natural stands and plantations of indigenous or introduced species (EC, 2010). Half of European forests are predominantly coniferous, a quarter is predominantly broadleaved and a quarter is mixed (MCPFE, 2007).

Forests are a key repository for biological diversity: because of their structural complexity, they provide ideal habitats for a particularly rich array of plants, birds and animals. However, these species are, in many cases, highly dependent on the environmental quality of forests, which has been reduced in the past few decades because of changes such as intensified silvicultural practices, the use of exotic species and the resulting increase in uniformity (EC, 2006).

The conservation status of species and habitats of European interest differs strongly between biogeographical regions, but altogether more than 50 % of species and nearly two thirds of habitats have an unfavourable conservation status.

Change in forest ecosystem areas since 1990 ([20])

Table 6.1 Surface area (km²) of forest ecosystem in 1990, 2000 and 2006

	1990	2000	2006
Forest/transitional land	953 594	957 908	958 972
Total	**953 594**	**957 908**	**958 972**

- In 2006, the total area of forest ecosystems was almost 958 972 km².
- In 2006, the total area of forest ecosystems was 0.6 % more than in 1990 for the same geographical area.

Note: Geographical coverage: EU except Greece, Finland, Sweden and the United Kingdom.

Source: Corine land cover.

Table 6.2 Changes in surface area (km² and %) since 1990

	1990—2000	2000—2006	1990—2006
Forest/ transitional land	4 315	1 063	5 378
Total	**4 315** **0.5 %**	**1 063** **0.1 %**	**5 378** **0.6 %**

Between 1990 and 2006:

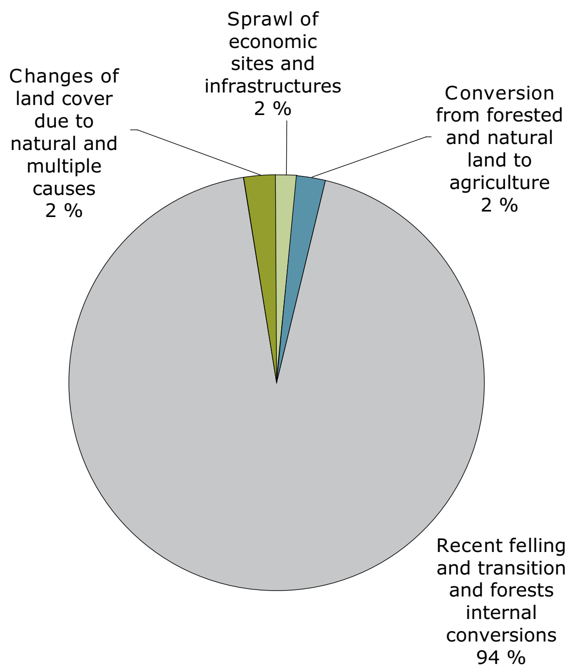
- the area of forest ecosystems increased by almost 5 400 km²;
- the rate of increase 1990–2000 was the highest (0.5 %) and decreased between 2000 and 2006 (0.1 %).

Note: Geographical coverage: EU except Greece, Finland, Sweden and the United Kingdom.

Source: Corine land cover.

Causes of change of forest areas between 2000 and 2006

Figure 6.1 Causes of change of forest areas and transitional woodland shrubs



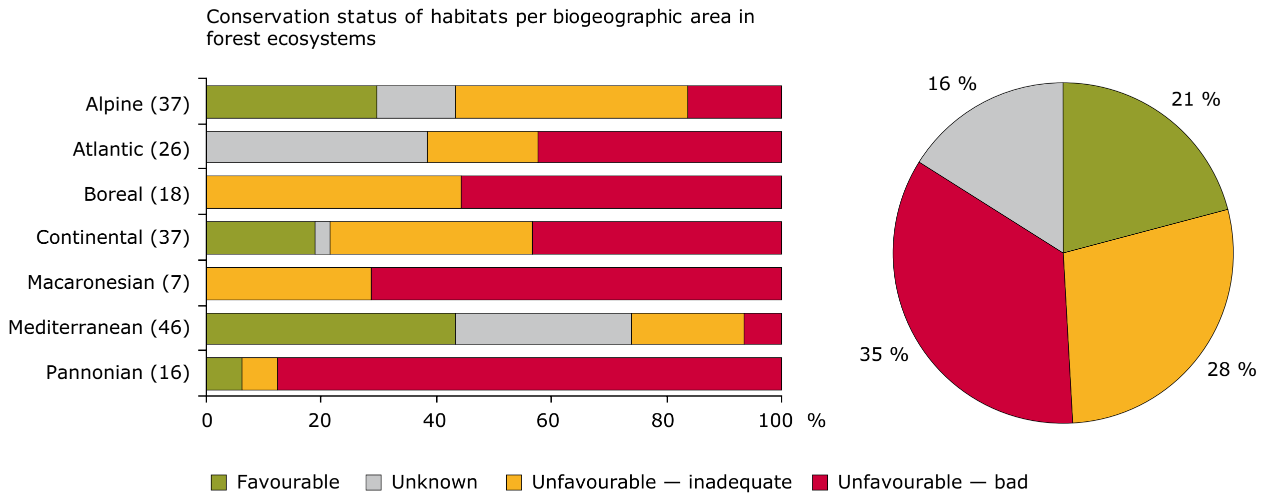
- Between 2000 and 2006, 94 % of change in forests was due to recent fellings and transition, and forest internal conversions (which is the practice of replanting existing forests with other types trees: e.g. coniferous instead of broadleaved trees).

Note: Geographical coverage: EU except Greece and the United Kingdom.

Source: Corine land cover.

([20]) CLC 1990–2000 is based on 24 EU Member States excluding Finland and Sweden; CLC 2000–2006 is based on 25 EU Member States excluding Greece and the United Kingdom (their CLC inventories had not been finalised by Spring 2010). Therefore, comparisons between 1990 and 2006 do not include the four countries mentioned above.

Figure 6.2 Conservation status of habitat types of European interest in forest ecosystems (statistics by region on the left, overall statistics on the right)

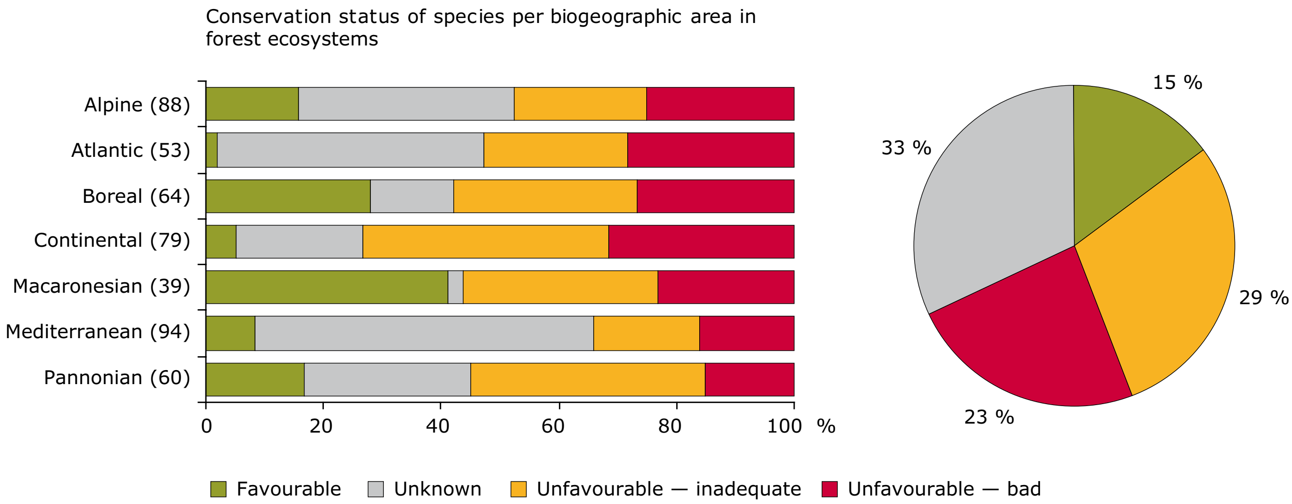


- Twenty-one per cent of the conservation status assessments of forest habitats are favourable.
- Some 63 % of the assessments are unfavourable.
- Sixteen per cent of the assessments are given as unknown.
- The Alpine and Mediterranean regions have the highest percentage of favourable assessments.
- There are no favourable assessments for the Atlantic, Boreal and Macaronesian regions.

Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

Figure 6.3 Conservation status of species of European interest in forest ecosystems (statistics by region on the left, overall statistics on the right)

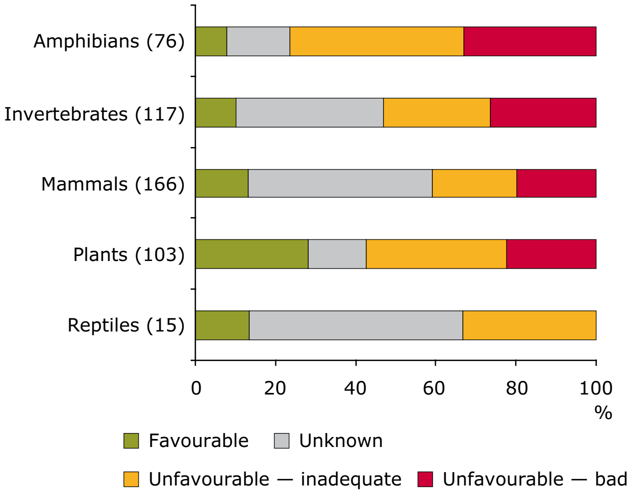


- Only 15 % of the assessments of forest species are favourable.
- Some 52 % of the assessments of forest species are unfavourable.
- Thirty-three of the assessments are unknown.
- The percentage of unknown assessments differs significantly among the different biogeographical regions.
- The Macaronesian and Boreal regions have the highest percentage of favourable assessments (respectively 30 % and more than 40 %).

Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

Figure 6.4 Conservation status of species of European interest in forest ecosystems per group



- More than 70 % of assessments for amphibians linked to forest ecosystems are unfavourable.
- Favourable assessments are less than 20 % for all species groups, except plants.
- More than 40 % of assessments for mammals and more than 50 % for reptiles are unknown.

Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

Additional information

- Nearly 170 species in the Habitats Directive and 82 species in the Birds Directive are linked to forest ecosystems.
- Of the amphibians of European interest linked to forest ecosystems, 8 % are threatened.
- Of the reptiles of European interest linked to forest ecosystems, 10 % are threatened.
- Of the mammals of European interest linked to forest ecosystems, 27 % are threatened.
- Of the birds of European interest linked to forest ecosystems, 11 % are threatened.

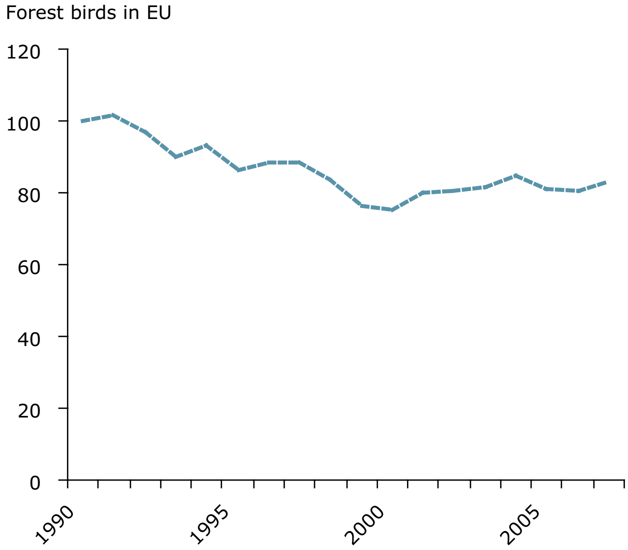
Source: BirdLife, 2004; IUCN, 2007, 2009.

- Of a selection of saproxylic beetles, 14 % are threatened in the EU-27, and 14 % have a declining population: the main impact being logging and wood harvesting.

Source: IUCN, 2010.

Between 1990 and 2007, the European Union's common forest birds declined by 20–25 % ([21]).

Figure 6.5 Trends in the common bird indicators for the European Union, base = 1990



Source: Eurostat, 2010 (env_bio2) — EBCC/RSPB/BirdLife/Statistics, the Netherlands.

Forests and Natura 2000

Forest ecosystems cover about 46 % of the surface of Natura 2000:

- 43 % in Special Protection Areas (SPAs); and
- 48 % in Sites of Community Importance (SCIs).

Source: Natura 2000, CLC 2006 for the EU except Greece and the United Kingdom (where CLC 2000 was used).

6.2 Pressures and threats

Fragmentation, airborne pollution, intensification of management and climate change provide the main pressures on forest biodiversity.

Non-sustainable forest management, fragmentation and climate change are major threats to European forest biodiversity (EEA, 2010). Intensification measures including the drainage of peatlands and wet forest, fertilisation and forest-tree genetic

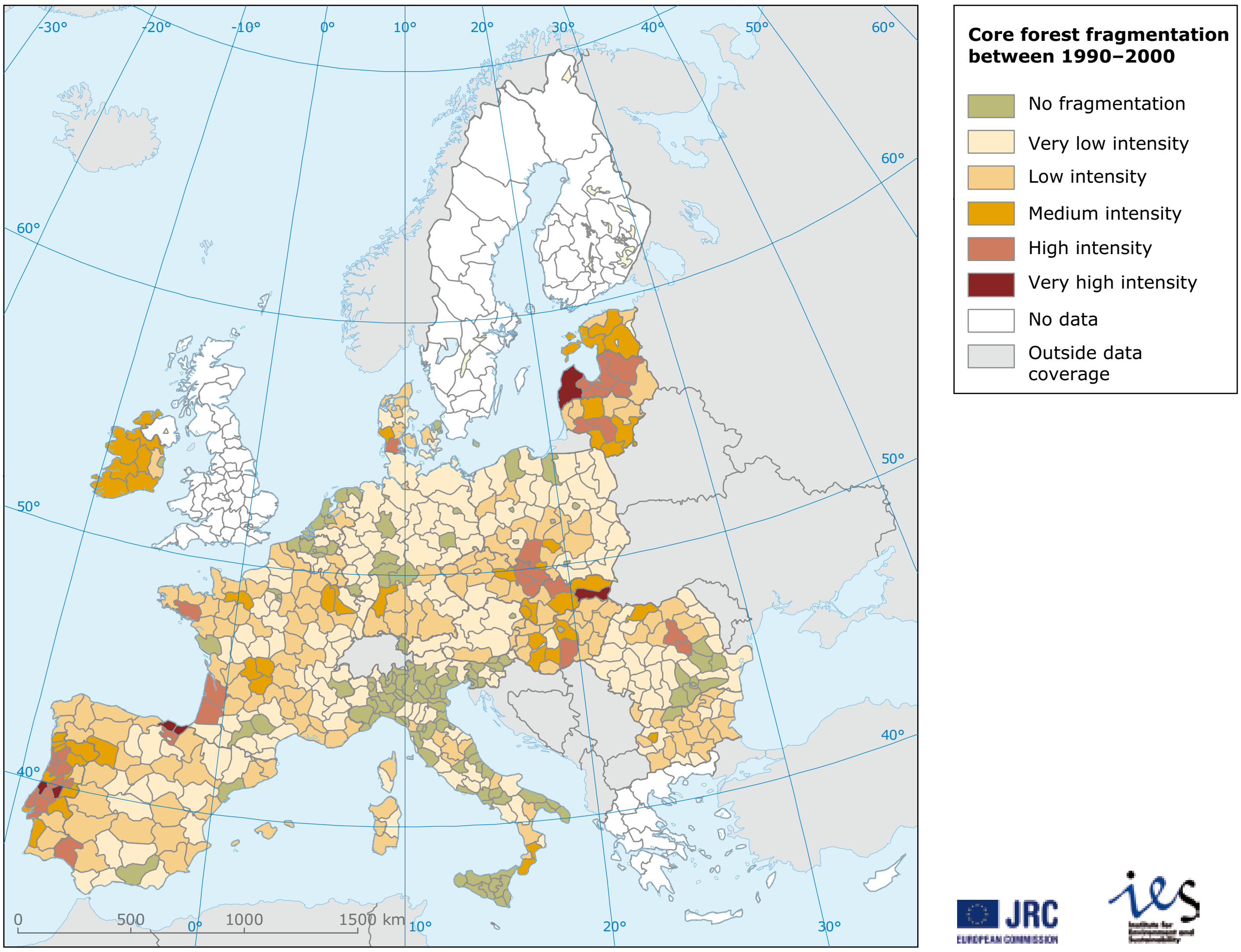
([21]) SEBI2010 indicator 1 — Common birds in Europe — uses a population index of 100 for the year 1980, but its geographical coverage is wider than the European Union.

modification have had a particularly negative effect on the biodiversity values of forests (EEA, 2008).

Whilst forest area is increasing overall in Europe, this expansion is not uniformly distributed. In many places, urban sprawl, expanding transport networks or forest harvesting that breaks core forest areas into smaller parts, have caused the fragmentation of European forest ecosystems. Forest losses to agriculture and artificial surfaces are more frequent in south-western Europe. One of the consequences of fragmentation is the loss of ecological connectivity, which impacts on forest species (EEA, 2009).

So far, efforts to reduce the emissions of nitrogen to the atmosphere have not been as successful as for sulphur, which is considered as one of the most significant international environmental success stories. The rate of defoliation in much of the European forest fluctuates around 15–25 % and shows no indication of loss of tree vitality. However, airborne nitrogen deposition is significantly influencing forest biodiversity towards communities

Map 6.1 Core forest fragmentation between 1990 and 2000



- Between 1990 and 2000, the process of fragmentation, breaking core forest areas larger than 100 ha into smaller units, was significant (very high and high intensity) in western Latvia, some areas of Portugal, the Basque country and Andalucía in Spain, south-western France, the Northern Carpathians and the Tatra mountains (EEA, 2009).

Source: JRC; Estreguil and Mouton, 2009; European Forest Data Centre (JRC EFDAC Map viewer (http://efdac.jrc.ec.europa.eu/)) ([22]); SEBI indicators, 2010 — SEBI indicator 13.

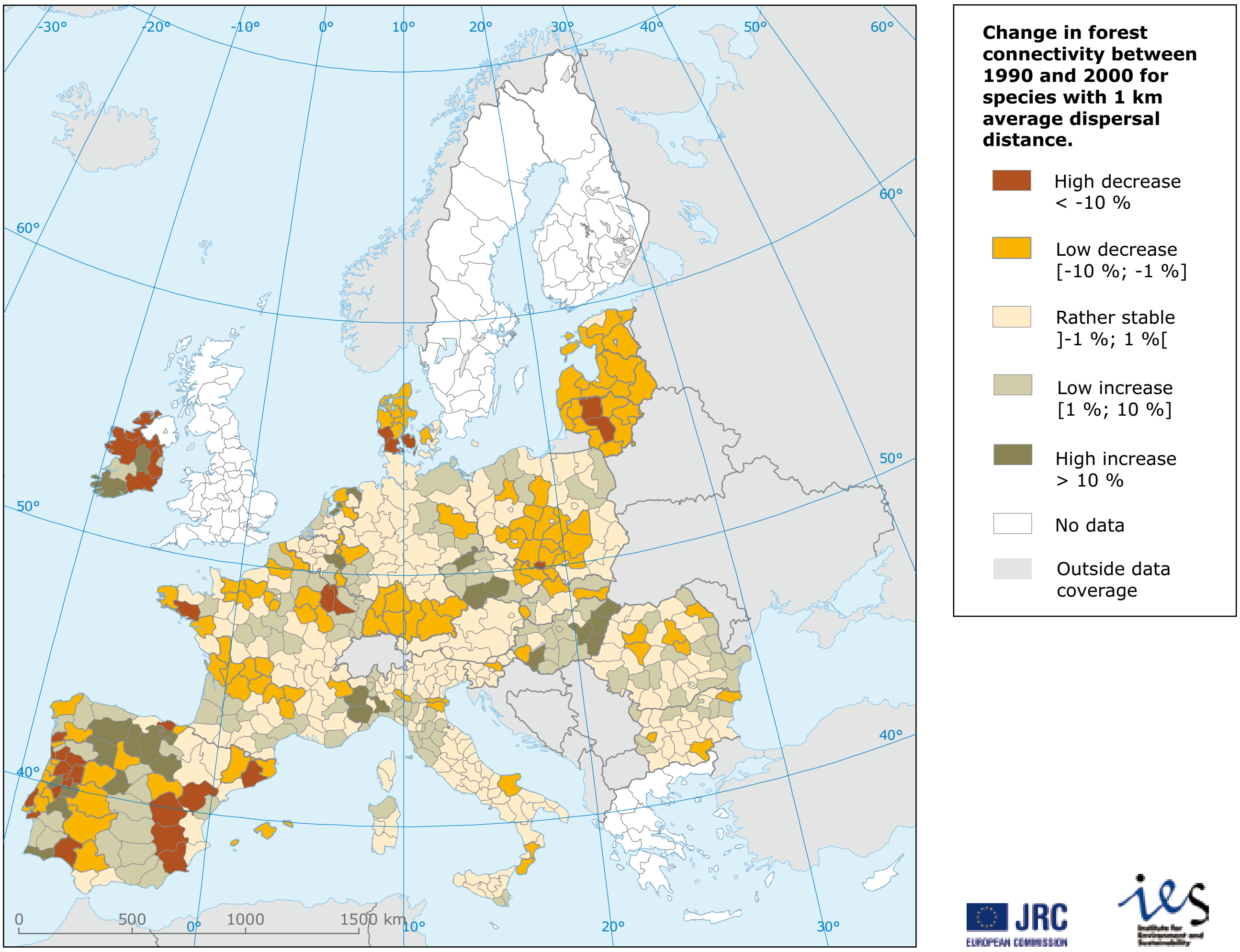
([22]) The data derive from Corine land cover (CLC) for the years 1990 and 2000 and, hence, have the same geographical coverage and forest definition as CLC; core forest from mathematical morphology-based software GUIDOS from Soille and Vogt, 2009, and GIS analysis. Results aggregated at provincial units, NUTS level 2 or 3. Ranges for levels of increase are: very high for above 100 % increase with respect to the total number of core forest patches in 1990; high for 50–100 %; medium for 25–50 %; low for 5–25 %; and very low for below 5 %.

adapted to eutrophic conditions thus threatening other communities (EEA, 2008).

The rate of introduction of problematic invasive alien species (known as 'worst invasives') has been less dramatic in forest ecosystems than in other ecosystems (EEA, 2008). Climate change is likely to increase the levels of damage caused by forest pathogens and pests and bring new exotic infestations, whether introduced by man or migrating naturally (EC, 2010). Climate change can also be expected to alter forest ecosystem conditions through higher mean annual temperatures, changed precipitation patterns and more extreme weather events such as heat waves, forest fires and storms (EEA, 2008).

The practice of favouring high production genotypes narrows the genetic variation in tree populations, impacting on the capacity for adaptation to new conditions such as climate change (EEA, 2008 and 2010).

Map 6.2 Change in forest connectivity between 1990 and 2000



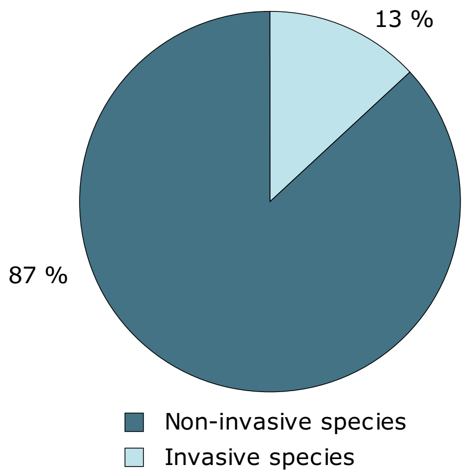
- In the period 1990–2000, the decrease of connectivity was significant in Denmark, France, the Iberian Peninsula, Ireland and Lithuania.
- The connectivity was stable in approximately half of Europe's territory and increasing or decreasing slightly in another 40 % (EEA, 2009).

Source: JRC; Estreguil and Mouton, 2009; Saura, Mouton and Estreguil, 2009; European Forest Data Centre (JRC EFDAC Map viewer (http://efdac.jrc.ec.europa.eu/)) ([23]); SEBI indicators, 2010 — SEBI indicator 13.

([23]) The data derive from Corine land cover (CLC) for the years 1990 and 2000 and, hence, have the same geographical coverage and forest definition as CLC; connectivity derived from Conefor Sensinode software of Saura and Torné 2009, and GIS analysis. Range levels are expressed as % of increase (or decrease) of equivalent connected area in 1990. GIS analysis and results aggregated at provincial units, NUTS level 2 or 3.

Whilst wood harvesting in the EU is largely sustainable (and a significant proportion of the total forest area is certified by certification schemes; e.g. the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification schemes (PEFC)), dead wood in most European countries remains well below optimal levels from a biodiversity perspective. Dead wood is a key indicator for forest biodiversity and the conservation value of a forest and is an important substrate for forest species such as insects and other invertebrates and provides a refuge and nesting place for mammals and birds. Since the middle of the 19th century, intense forest exploitation, widespread burning of small wood pieces and concern about the risk of pests and forest fires had resulted in a strong decrease in the quantities of dead wood in some European forests. However, since 1990, an overall increase has been observed. More forests are now allowed to grow into older development stages, which have positive effects on forest biological diversity (EEA, 2008; 2009).

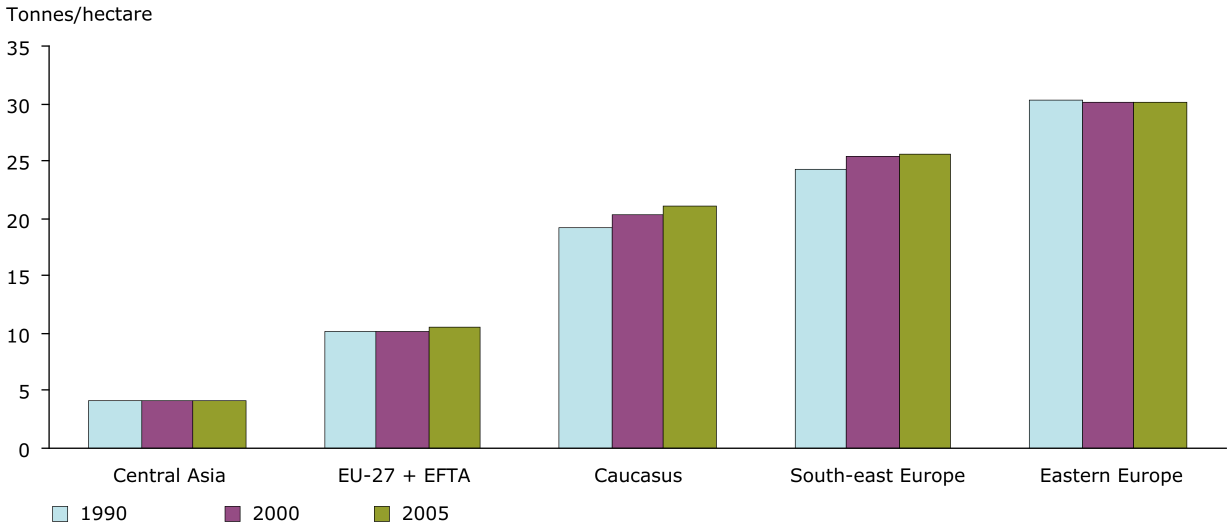
Figure 6.6 Forest area dominated by invasive alien tree species



- Of the forest area dominated by introduced tree species, 13 % have become invasive species with impacts on forest biodiversity conservation (MCPFE, 2007 in EEA, 2008).

Source: MCPFE, 2007 ([24]).

Figure 6.7 Dead wood in pan-European ([25]) forests, 1990–2005



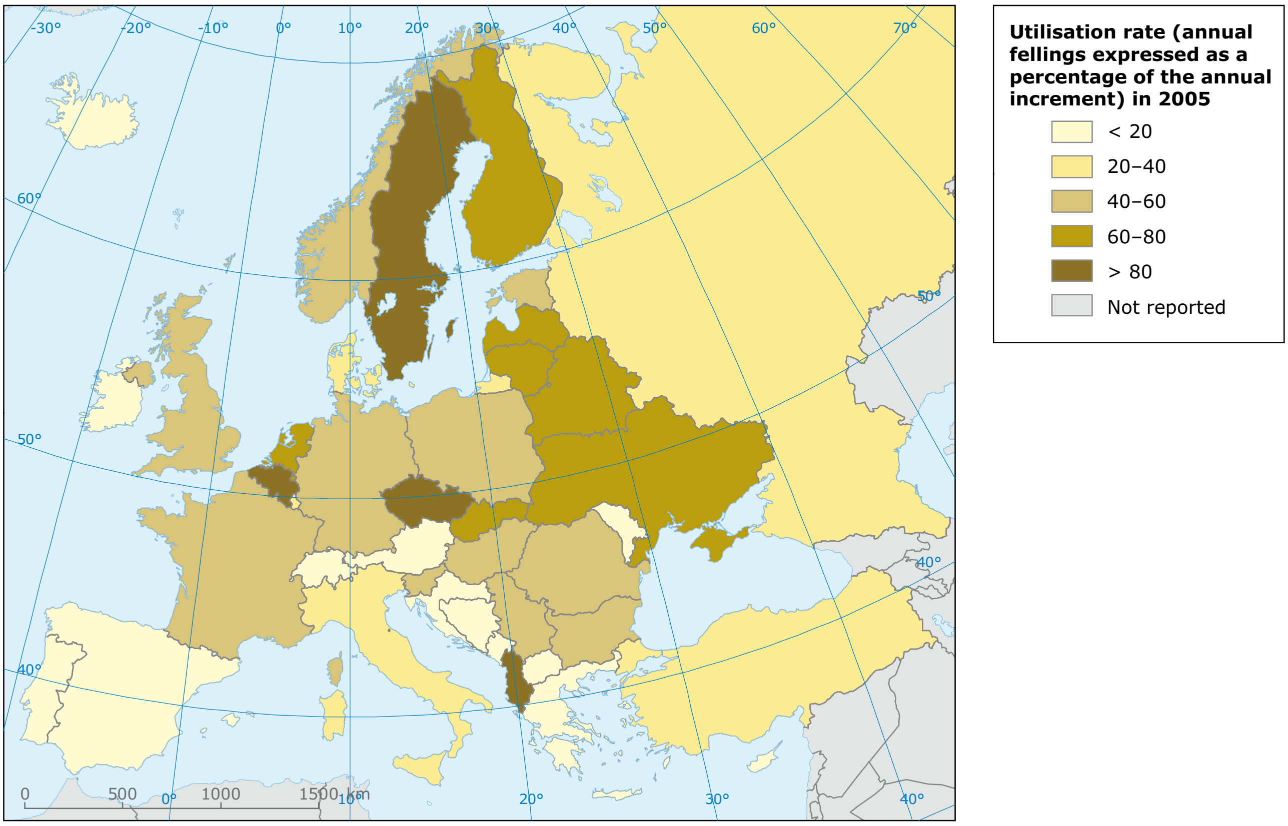
- In the period 1990–2005, an overall increase in dead wood by about 4.3 % was observed in the pan-European region (EEA, 2009), a sign of more biodiversity-friendly management.

Source: FAO, 2005; SEBI indicators, 2010 — SEBI indicator 18.

([24]) Geographical coverage: EFTA4, Albania, Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Hungary, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, San Marino, Slovakia, Slovenia, Sweden, Turkey, the United Kingdom.

([25]) Central Asia comprises Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. EU-27 and EFTA comprises Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, the United Kingdom and Iceland, Liechtenstein, Norway and Switzerland. The Caucasus comprises Armenia, Azerbaijan and Georgia. South-east Europe (SEE) comprises Albania, Bosnia and Herzegovina, Croatia, Montenegro, Serbia, the former Yugoslav Republic of Macedonia and Turkey. Eastern Europe (EE) comprises Belarus, the Republic of Moldova, the Russian Federation and Ukraine.

Map 6.3 Utilisation rate in 2005 (% of annual felling compared with net annual increment in growing stock) for Ministerial Conference on the Protection of Forests in Europe (MCPFE) countries



- The ratio of felling to increment is relatively stable at around 60 %, being higher than 80 % only in Albania, Belgium, Czech Republic and Sweden.
- The utilisation rate varies considerably between countries, but remains generally below the sustainability limit of 100 % (EEA, 2009).

Source: Based on MCPFE, 2007; SEBI indicators, 2010 — SEBI indicator 17.

6.3 Services

As well as providing an important role in the aesthetics of landscapes and high recreational value, forests deliver major services in relation to the provision of building materials and fuel, regulating climate, protecting watersheds and protecting against erosion.

Timber production is a major provisioning service from forest ecosystems which also provide a wide range of non-wood products such as game, resin, cork, fruits, berries, medicinal plants and mushrooms.

Forests play a pivotal role in the hydrological cycle and are associated with the regulation of water through their effects on run-off and water quality, by preventing flooding and forming a buffer against natural hazards (storms, landslides, mudflows, avalanches). They have also been shown to have a regulatory role with regard to soil erosion and to support soil fertility, to purify air and drinking water. (TEEB, 2009; Vandewalle et al., 2010).

The forests of Europe are a large reserve of carbon with 53 gigatonnes of carbon sequestered in forest biomass and dead wood, and they continue to be an important carbon sink (EEA, 2010), taking up about 7–12 % of European carbon emissions (Goodale et al., 2002; Janssens et al., 2003 in Trumper et al., 2009). Old forests are also of singular importance for many specialised plant and animal species (Frank et al., 2009 in EEA, 2010).

Forests also play an important role in the aesthetics of landscapes offer scope for ecotourism and have recreational and cultural values (TEEB, 2009).

Figure 6.8 Current state and trends of forest ecosystems services

Provisioning

Crops/timber	↑
Livestock	=
Wild food	↓
Wood fuel	=
Capture fisheries	
Aquaculture	
Genetic	↓
Fresh waters	↓

Regulating

Pollination	↓
Climate regulation	↑
Pest regulation	
Erosion regulation	=
Water regulation	=
Water purification	
Hazard regulation	

Cultural

Recreation	=
Aesthetic	=

Trend between periods

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

Status for period 1990–present

	Enhanced
	Mixed
	Degraded
	Unknown
	Not applicable

- Increasing regrowth of forests which, combined with reforestation and afforestation programmes across Europe, has resulted in an increased status of crops/timber production and carbon sequestration (climate regulation).
- Livestock production in forest ecosystems has decreased in both time periods due to cessation of forest grazing except for small scale nature conservation purposes.
- The provision of wild foods, fresh water and pollination services have been degraded since 1990 as natural habitats are under increasing pressure and forest condition has generally declined in Europe.
- The status of many other services showed a mixed trend related to afforestation and deforestation patterns which vary between European regions.

Source: RUBICODE project 2006–2009.

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7 Wetland ecosystems

According to the Ramsar Convention ([26]), wetlands are 'areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres'. These wetlands can be grouped into seven common landscape units, indicative of specific geomorphologies: estuaries, open coasts — which are also covered in coastal ecosystem section, flood plains, freshwater marshes, lakes and ponds, bogs and peatlands, and swamp forests (Dugan, 1990, in Vandewalle et al., 2010).

In this section, the term 'wetland' includes nine Corine land cover categories and 47 habitats.

- Nine Corine land cover categories are discussed: Inland (411, 412), Maritime (421, 422, 423, 521, 522), Wetlands and inland waters (511, 512); Sea and ocean (523) are excluded.
- Overall, 47 habitats listed in Annex I to the Habitats Directive are considered as 'wetlands': several salt meadows and salt marshes, several riverine habitats with vegetated banks, humid meadows, raised bogs and mires and fens, bog or alluvial forests and freshwater habitats (freshwater habitats are also treated separately in the section on lake and river ecosystems).

7.1 Status and trends

Wetland ecosystems hold an important part of Europe's biodiversity. They provide ideal conditions for a great diversity of habitats and species and are particularly important for birds, providing nesting and migratory flyway areas (where birds can stop to feed and rest), as well as ideal conditions for other species groups such as dragonflies and amphibians (EC, 2007).

Over 60 % of European wetlands were lost before the 1990s. In 1995, a Communication from the European Commission mentioned that '*despite their value, the loss of wetlands is widespread. Available information indicates that approximately two thirds of all European wetlands existing at the beginning of the [20th] century have since been lost*' (CEC, 1995).

Although the drainage of wetlands has been common practice in Europe for centuries, the extent of this human intervention has increased significantly in the past century and especially in the last 50 years, leading to a substantial decrease in the number, size and quality of wetland areas (EC, 2007). In addition, wetlands continue to be lost to agricultural intensification and development. The main trend however, is for conversion to forest and semi-natural areas. In some cases, this is through the planting of commercial crops but, in others, it is natural succession due to changes in water regimes, consequent drying out and the colonisation of shrub and tree species. Nearly two thirds of wetland-related species of European interest and more than three quarters of all wetland habitats of European interest are in unfavourable status. There are no favourable habitat assessments for the Boreal and Atlantic regions where many of the largest tracts of wetland land surface still remain.

([26]) Convention on Wetlands of International Importance especially as Waterfowl Habitat, Ramsar, Iran 2.2.1971.

Change in wetland ecosystem areas since 1990 (27)

Table 7.1 Surface area (km²) of wetland ecosystem in 1990, 2000 and 2006

	1990	2000	2006
Coastal wetlands	18 299	18 330	18 378
Marshes/bogs	26 365	25 313	25 098
Sub-total	**44 664**	**43 643**	**43 476**
Watercourses/bodies	34 146	35 135	35 726
Total	**78 809**	**78 778**	**79 203**

- In 2006, the total area of wetland ecosystems was over 79 000 km²: 45 % watercourses and water bodies; 32 % marshes and bogs; and 23 % coastal wetlands.
- In 2006, the total area of wetland ecosystems was around 0.5 % smaller than in 1990 for the same geographical area.
- In 2006, for the same geographical area as surveyed in 1990, watercourses and water bodies had increased by 4.4 %; marshes and bogs had decreased by 5.0 %; and coastal wetlands had increased by 0.4 %

Note: Geographical coverage: EU except Greece, Finland, Sweden and the United Kingdom.

Source: Corine land cover.

Table 7.2 Changes in surface area (km² and %) since 1990

	1990—2000	2000—2006	1990—2006
Coastal wetlands	31 0.2 %	49 0.3 %	80 0.4 %
Marshes/bogs	– 1 052 – 4.2 %	– 215 – 0.9 %	– 1 267 – 5.0 %
Sub-total	– 1 021 – 2.3 %	– 166 – 0.4 %	– 1 187 – 2.7 %
Watercourses/bodies	989 2.8 %	592 1.7 %	1 581 4.4 %
Total	– 32 0.0 %	426 0.5 %	394 0.5 %

Between 1990 and 2006:

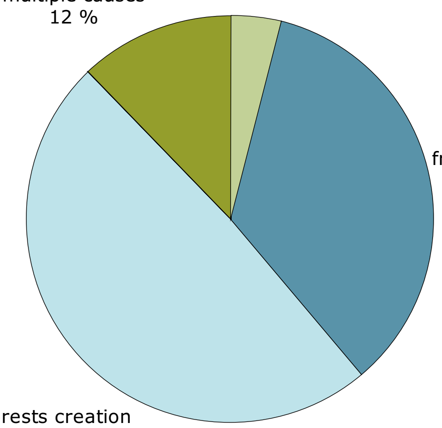
- 394 km² of wetland ecosystems was gained overall and 1 187 km² of wetlands excluding water bodies was lost.
- the highest rate of loss (– 5.0 %) was to marshes and bogs, but the rate of loss was lower between 2000 and 2006 (– 0.9 %).

Note: Geographical coverage: EU except Greece, Finland, Sweden and the United Kingdom.

Source: Corine land cover.

Cause of loss of wetland ecosystems between 2000 and 2006

Figure 7.1 Cause of loss of wetlands



- Some 35 % of the change in wetland areas between 2000 and 2006 was due to conversion to agriculture and 49 % to forest creation and afforestation.
- Of the wetland area converted to other land uses between 1990 and 2000, 2 % were artificialised (e.g. urban areas), 7 % became agricultural, 12 % water bodies, and 79 % forest and semi-natural areas (EEA, 2009).

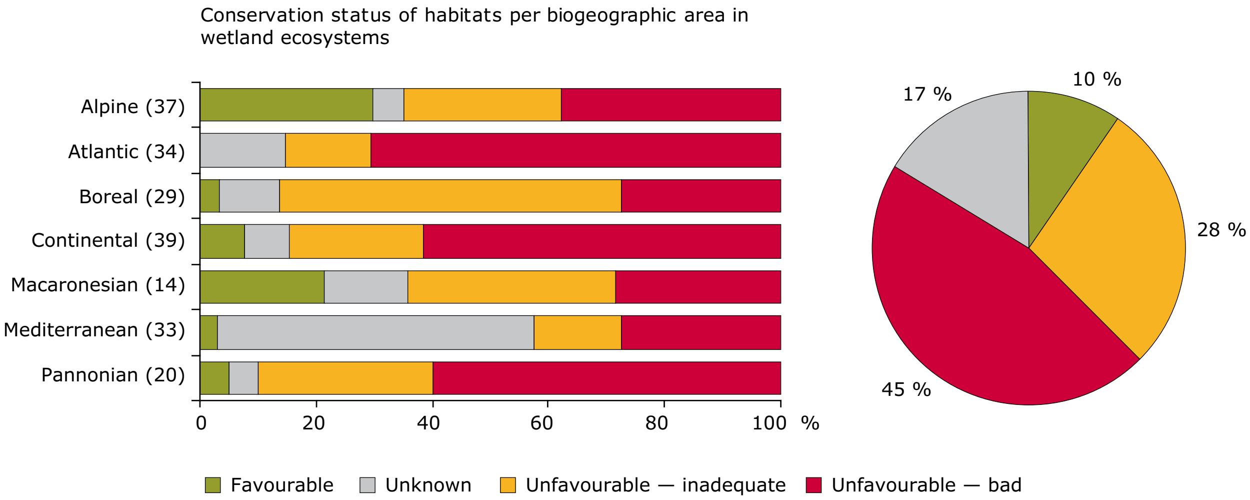
Note: Geographical coverage: EU except Greece and the United Kingdom.

Source: Corine land cover.

(27) CLC 1990—2000 is based on 24 EU Member States excluding Finland and Sweden; CLC 2000–06 is based on 25 EU Member States excluding Greece and the United Kingdom (their CLC inventories had not been finalised by Spring 2010). Therefore, comparisons between 1990 and 2006 do not include the four countries mentioned above.

Conservation status of habitats and species of European interest in wetland ecosystems

Figure 7.2 Conservation status of habitat types of European interest in wetland ecosystems (statistics by region on the left, overall statistics on the right)

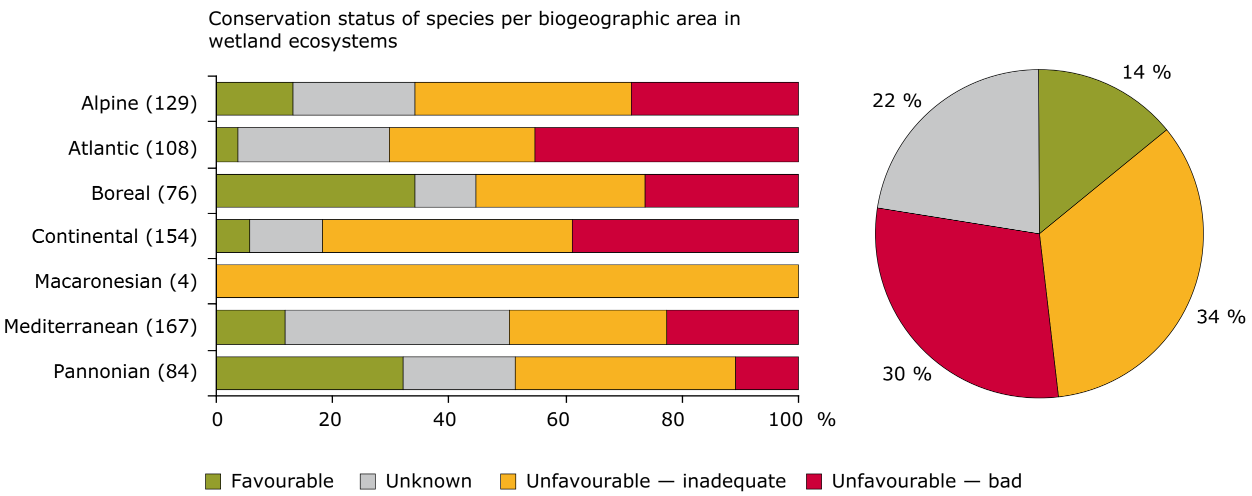


- Ten per cent of the conservation status assessments of wetland habitats are favourable.
- Some 73 % of the assessments are unfavourable.
- Some 17 % of the assessments are unknown.
- The Atlantic, Boreal, Continental and Pannonian regions have more than 80 % of unfavourable assessments.
- There are no favourable assessments for the Atlantic region.

Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

Figure 7.3 Conservation status of species of European interest in wetland ecosystems (statistics by region on the left, overall statistics on the right)

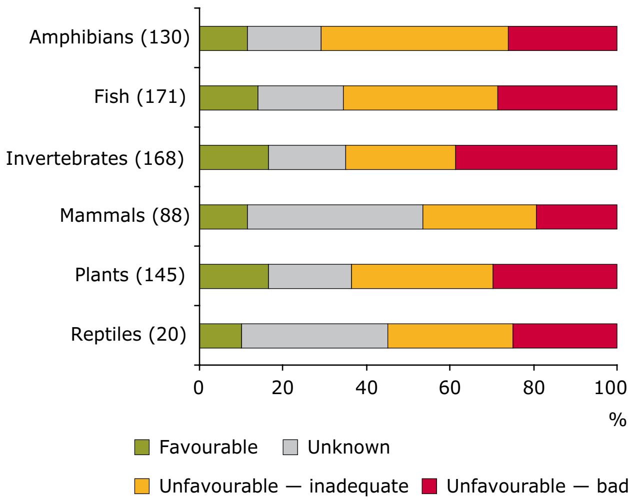


- Of the conservation status assessments of species linked to wetland ecosystems, 14 % are favourable.
- Some 64 % of the assessments are unfavourable.
- Twenty-two per cent of the assessments are unknown.
- The Boreal and Pannonian regions have the highest percentage of favourable assessments.

Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

Figure 7.4 Conservation status of species of European interest in wetland ecosystems per group



- Of assessments for plants, invertebrates, fish and amphibians linked to wetland ecosystems, more than 60 % are unfavourable.
- Mammals have the highest percentage of unknown assessments (more than 40 %), followed by reptiles (close to 40 %).
- Favourable assessments are less than 20 % for all species groups.

Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

Additional information

- Nearly 290 species in the Habitats Directive are linked to wetlands.
- One hundred and seventeen species in the Birds Directive are linked to wetland ecosystems.
- Of the amphibians of European interest linked to wetland ecosystems, 15 % are threatened.
- Of the reptiles of European interest linked to wetland ecosystems, 25 % are threatened.
- Of the mammals of European interest linked to wetland ecosystems, 15 % are threatened.
- Of the birds of European interest linked to wetland ecosystems, 16 % are threatened.

Source: BirdLife, 2004; IUCN, 2007, 2009.

Wetlands and Natura 2000

Wetland ecosystems cover 11 % of the surface of Natura 2000:

- 12 % of Special Protection Areas (SPAs);
- 13 % of Sites of Community Importance (SCIs).

Source: Natura 2000, CLC 2006 for the EU except Greece and the United Kingdom (where CLC 2000 was used).

7.2 Pressures and threats

Heavy modification and pollution of wetlands are two of the main threats to the biodiversity of these ecosystems.

Loss and degradation of wetlands is caused mainly by drainage for agriculture, infrastructure development, afforestation, blocking and extraction of the water inflow and over-exploitation of groundwater resources (EC, 2007). Many inland wetlands have suffered from changes in their water regime as a result of water abstraction to supply agriculture and urban populations. Peatlands are widely exploited by the horticultural industry and (to a lesser extent) for fuel, the former often resulting in the complete destruction of habitat and its associated species. Land take and conversion of wetlands associated with urban, port and harbour development and the subsequent transport and energy infrastructure has been another source of habitat loss and fragmentation.

In addition, pollution from agriculture and industrial sources can increase the levels of nutrients, pesticides or heavy metals, seriously affecting wetland ecological processes (EC, 2007). The increase in invasive alien species is also a threat to wetlands (much as it is to freshwater habitats) (EEA, 2009; 2010).

The impacts of climate change are likely to be complex but, for example, an increase in mean low and high tides and extreme storm events will cause coastal erosion and damage to coastal wetlands. The hard defences which often replace them cause direct habitat loss and indirect effects through changing sedimentation and current regimes. On the other hand, bogs and peatlands are important carbon sinks. However, degradation due to burning, peat extraction and overgrazing can turn these habitats into carbon sources (EC, 2007).

The Water Framework Directive (WFD) ([28]) establishes a framework for Community action in the field of water policy and clearly identifies the need for the protection and restoration of wetlands, offering a platform to address wetland-related issues (EC, 2007). Directive 2007/60/EC of the European Parliament and of the Council of of 23 October 2007 on the assessment and management of flood risks is also of direct relevance to wetlands, since wetlands play a vital role in water retention and act as an important buffer zone in the prevention of flooding. The Directive will be implemented in conjunction with the WFD, notably through the coordination of flood risk management plans and river basin management plans (EC, 2007).

7.3 Services

Wetland ecosystems are particularly important for carbon sequestration. They provide a wide range of other services such as water provisioning, management and purification and flood defence and offer recreational and tourism opportunities. They provide hatching and breeding grounds for fish, nesting and migratory areas for birds, and can be tourism attractions.

Wetlands 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 to combat climate change (EC, 2007). Carbon sequestration is important in bogs and peatlands, which have a huge storage capacity (Trumper et al., 2009).

Water purification and the maintenance of water quality is a significant regulatory service of wetlands. Wetlands help maintain the water cycle by capturing and holding rainfall and snowmelt, retaining sediments and purifying water (TEEB, 2009). Wetlands are very effective at regulating water flows and retain water in periods of flooding (Vandewalle et al., 2010). Wetlands 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 (Vandewalle et al., 2010).

The provisioning services provided by wetlands tend to be associated with the direct exploitation of wetland products for economic gain or subsistence. Agricultural production takes place in and around many wetlands, where crops such as rice, maize and various vegetables and fruit are cultivated. 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 (Scoones, 1991, in Vandewalle et al., 2010). The regulation and storage of water is beneficial in the production of hydroelectric power (Vandewalle et al., 2010).

Wetlands offer important cultural services, spiritual significance and aesthetic values and can be tourism attractions. They can provide primary production services as collectors of nutrients, contributing to nutrient cycling and storage of nutrients, and are important biodiversity areas providing hatching and breeding grounds for fish and nesting and migratory areas for birds.

([28]) The Water Framework Directive (WFD) (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) aims to establish a framework for the protection of fresh water, transitional waters, coastal waters and groundwater in the EU to protect and enhance the status of aquatic ecosystems and promote sustainable water consumption based on long-term protection of available water resources. Its overall objective is to achieve 'good ecological status' of surface waters by 2015. The Directive places the protection of aquatic ecosystems at the centre of its objectives, providing a powerful platform for biodiversity conservation (Tucker and de Soye, 2009).

Figure 7.5 Current state and trends of wetlands services

Provisioning

Crops/timber	Degraded	↓
Livestock	Degraded	↓
Wild food	Mixed	=
Wood fuel	Not applicable	
Capture fisheries	Degraded	=
Aquaculture	Degraded	↓
Genetic	Mixed	=
Fresh waters	Mixed	↑

Regulating

Pollination	Not applicable	
Climate regulation	Degraded	=
Pest regulation	Unknown	
Erosion regulation	Unknown	
Water regulation	Enhanced	↑
Water purification	Mixed	=
Hazard regulation	Mixed	=

Cultural

Recreation	Mixed	↑
Aesthetic	Mixed	↑

Trend between periods

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

Status for period 1990–present

(green)	Enhanced
(yellow)	Mixed
(red)	Degraded
(grey)	Unknown
(white)	Not applicable

- Crops, livestock, fisheries, aquaculture and climate regulation have still a degraded status due to losses of wetlands.
- For other services, mixed status and positive trends are due to restorations projects and specific actions focused on these services.

Source: RUBICODE project 2006–2009.

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8 Lake and river ecosystems

Freshwater systems are aquatic systems which contain water of almost no salt content and include lakes and ponds, rivers, streams and reservoirs.

Freshwater systems are created by water that enters the terrestrial environment as precipitation, and flows both above and below ground towards the sea. These systems encompass a wide range of habitats, including rivers, lakes, and wetlands (not covered in this section), and the riparian (the interface between the water and the land) zones associated with them. Their boundaries are constantly changing with the seasonality of the hydrological cycle. Their environmental benefits and costs are distributed widely across time and space, through the complex interactions between climate, surface and groundwater, and with coastal marine areas (UNEP, 2010).

In this section, the term 'lake and river ecosystems' includes lakes and rivers corresponding to two Corine land cover categories and 19 Annex I habitats.

- Two Corine land cover categories are considered: Watercourses (511) and Water bodies (512).
- Nineteen freshwater habitats listed in Annex 1 to the Habitats Directive including Standing water (3.1) and Running water (3.2) are covered.

However, lake and river ecosystems do not include other ecosystems such as marshes and peatlands, which are presented in the wetland ecosystems section.

8.1 Status and trends

Whilst trends in the status of species and habitats have seen declines up to this point, it should be noted that in general water quality has been improved during recent decades as a result of the impact of the Urban Waste Water Treatment Directive ([29]) the Water Framework Directive ([30]), the implementation of the Nitrates Directive ([31]) and the introduction of set-aside measures and as a result of political reforms, reducing the environmental pressures on soil, water and air (EEA, 2009). However, pollution by micropollutants — such as pharmaceuticals, endocrine disruptors, and personal care products — is still a major concern.

([29]) The Urban Waste Water Treatment Directive (Council Directive 91/271/EEC of 21 May 1991 concerning urban wastewater treatment) aims to reduce the pollution of freshwater, estuarial and coastal waters by domestic sewage, industrial waste water and rainwater run-off. The Directive requires high standards of treatment for discharges to particularly sensitive areas, including waters subject to eutrophication (Tucker and de Soye, 2009).

([30]) The Water Framework Directive (WFD) (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) aims to establish a framework for the protection of fresh water, transitional waters, coastal waters and groundwater in the EU to protect and enhance the status of aquatic ecosystems and promote sustainable water consumption based on long-term protection of available water resources. Its overall objective is to achieve 'good ecological status' of surface waters by 2015. The Directive places the protection of aquatic ecosystems at the centre of its objectives, providing a powerful platform for biodiversity conservation (Tucker and de Soye, 2009).

([31]) The Nitrates Directive (Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources) seeks to reduce or prevent the pollution of water caused by the application and storage of inorganic fertiliser and manure on farmland. It is intended both the safeguard drinking water supplies and to prevent wider ecological damage in the form of eutrophication of freshwater and marine waters generally (Tucker and de Soye, 2009).

Change in lake and river ecosystem areas since 1990 (32)

Table 8.1 Surface area (km²) of lake and river ecosystem in 1990, 2000 and 2006

1990	2000	2006
34 146	35 135	35 726

- In 2006, the total area of lake and river ecosystems was close to 36 000 km².
- In 2006, the total area of lake and river ecosystems was 4.4 % more than in 1990 for the same geographical area; this is mainly due to artificial water bodies created by new dams.

Note: Geographical coverage: EU except Greece, Finland, Sweden and the United Kingdom

Source: Corine land cover.

Table 8.2 Changes in surface area (km² and %) since 1990

1990—2000	2000—2006	1990—2006
989 2.8 %	591 1.7 %	1 581 4.4 %

Between 1990 and 2006:

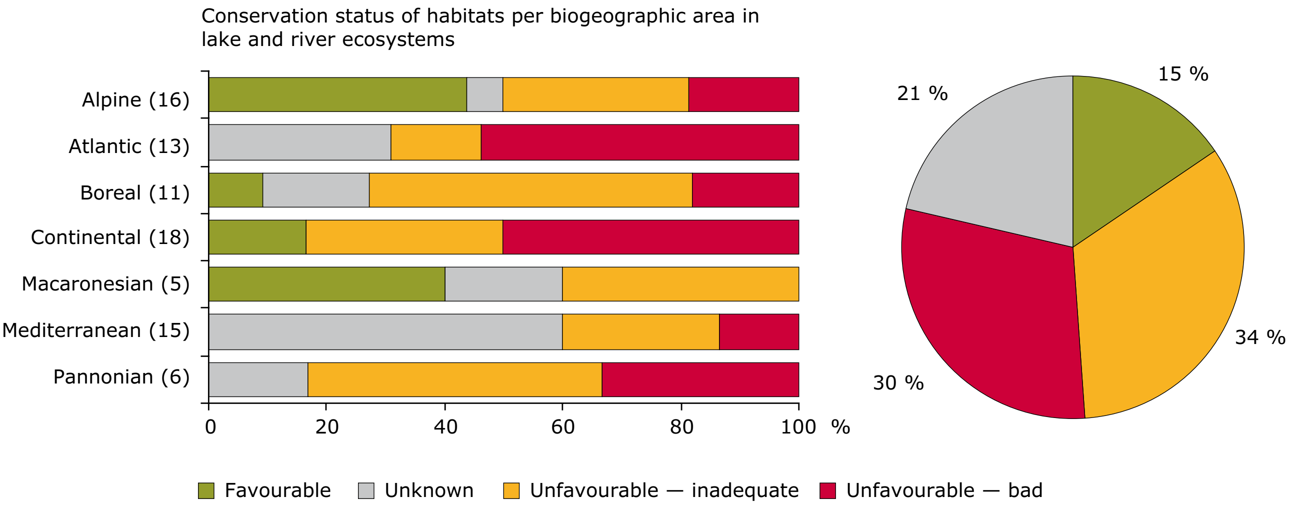
- the area of lake and river ecosystems increased by 1 581 km²;
- the highest rate of gain (2.8 %) was 1990—2000 increasing less between 2000 and 2006 (1.7 %).

Note: Geographical coverage: EU except Greece, Finland, Sweden and the United Kingdom.

Source: Corine land cover.

Conservation status of habitats and species of European interest in lake and river ecosystems

Figure 8.1 Conservation status of habitat types of European interest in lake and river ecosystems (statistics by region on the left, overall statistics on the right)



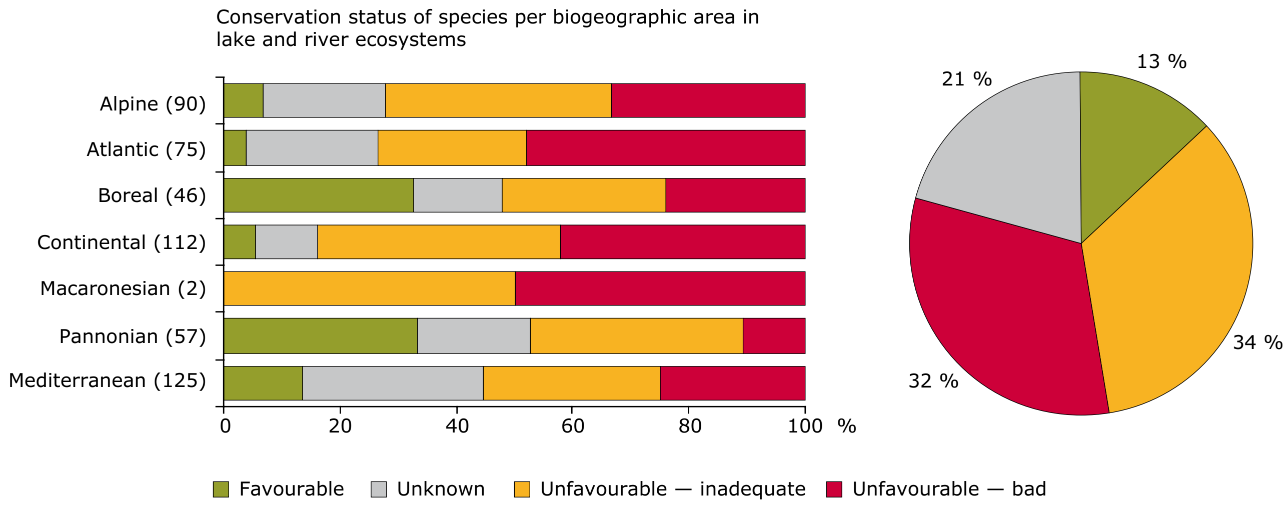
- Fifteen per cent of the conservation status assessments of lake and river habitats are favourable.
- Some 64 % of the assessments are unfavourable.
- Twenty-one per cent of the assessments are unknown.
- The Macaronesian and Alpine regions have the highest percentage of favourable assessments (around 40 %).
- There are no favourable assessments for the Atlantic, Mediterranean and Pannonian regions.

Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

(32) CLC 1990–2000 is based on 24 EU Member States excluding Finland and Sweden; CLC 2000–06 is based on 25 EU Member States excluding Greece and the United Kingdom (their CLC inventories had not been finalised by Spring 2010). Therefore, comparisons between 1990 and 2006 do not include the four countries mentioned above.

Figure 8.2 Conservation status of species of European interest in lake and river ecosystems (statistics by region on the left, overall statistics on the right)

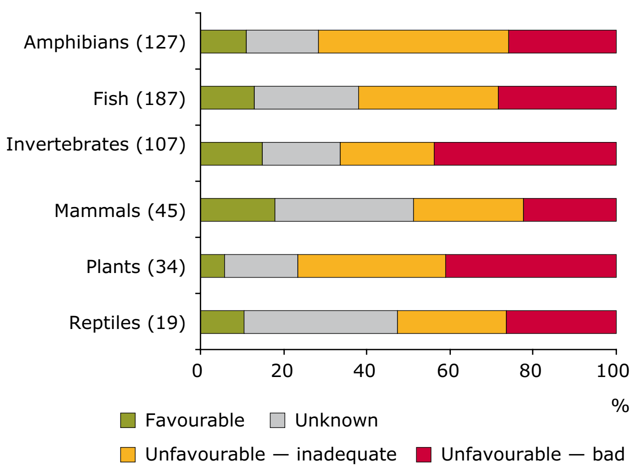


- Some 13 % of the conservation status assessments of lake and river-related species are favourable.
- Sixty-six per cent of the assessments are unfavourable, of which 31 % are unfavourable-bad.
- Some 21 % of the assessments are unknown.
- The Pannonian and Boreal regions have the highest percentage of favourable assessments.

Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

Figure 8.3 Conservation status of species of European interest in lake and river ecosystems per group



- More than 60 % of assessments for plants, invertebrates, fish and amphibians linked to lake and river ecosystems are unfavourable.
- Less than 20 % of assessments for all species groups are favourable.
- More than 30 % of assessments for reptiles and mammals are unknown.

Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

Additional information

- Nearly 200 species in the Habitats Directive and 72 species in the Birds Directive are linked to lakes and river ecosystems.
- Of the amphibians of European interest linked to lake and river ecosystems, 15 % are threatened.
- Of the reptiles of European interest linked to lake and river ecosystems, 33 % are threatened.
- Of the mammals of European interest linked to lake and river ecosystems, 22 % are threatened.
- Of the birds of European interest linked to lake and river ecosystems, 15 % are threatened.

Source: Based on IUCN, 2007, 2009; BirdLife, 2004.

- Of the dragonflies present in the EU linked to lake and river ecosystems, 16 % are threatened.

Source: Based on IUCN, 2010.

- Some 38 % of freshwater fish are threatened at pan-European level.

Source: Kottelat, 2007.

Lake and river ecosystems and Natura 2000

Lake and river ecosystems cover at least 4 % of the surface of Natura 2000, both Special Protection Areas (SPAs) and Sites of Community Importance (SCIs). This is likely to be an underestimate due to the linear character of many sites, which reduce the accuracy of the GIS analysis.

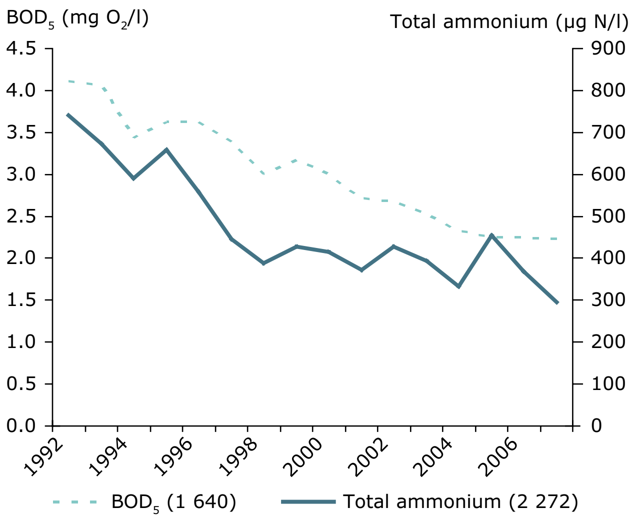
Source: Natura 2000, CLC 2006 for the EU except Greece and the United Kingdom (where CLC 2000 was used).

8.2 Pressures and threats

Pollution and heavy modification to watercourses are two of the main threats to the biodiversity of lakes and rivers.

Man-made pollution of lakes and rivers is decreasing mainly through the implementation of the Urban Waste Water Treatment Directive, the Water Framework Directive and the Directive concerning Integrated Pollution Prevention and Control. There has been a general improvement of wastewater and organic matter treatment in European rivers and an associated reduction in Biochemical Oxygen Demand (BOD) and total ammonium concentration. The largest declines in BOD are evident in the rivers of Western Europe, while the biggest drops in ammonium are apparent in the eastern European countries. BOD and ammonium concentrations are generally highest in eastern, south-east and south-eastern European rivers (EEA, 2009). Phosphorus concentrations in European rivers and lakes decreased during the period 1992–2007, reflecting the general improvement in wastewater treatment and reduced phosphate content of detergents over this period. However, agricultural inputs of phosphorus are still significant in lakes and rivers. However, pollution by micropollutants — such as pharmaceuticals, endocrine disruptors, and personal care products — is still a major concern in the aquatic environment (Musolff, 2009).

Figure 8.4 Biochemical Oxygen Demand (BOD_5) and total ammonium concentrations between 1992 and 2007



- Between 1992 and 2007 BOD5 decreased from 4 to 2 mg O_2/l. Ammonium declined from 700 to 300 µg N/l (SEBI indicators, 2010).

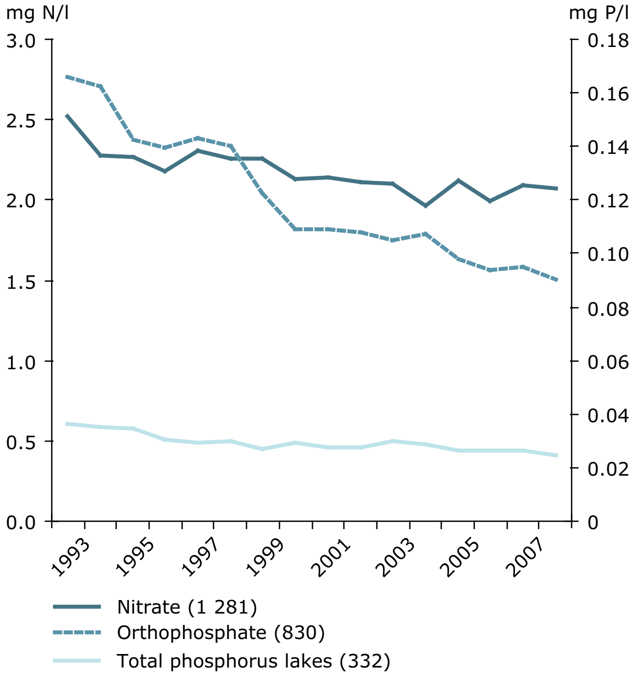
Note: Geographical coverage: Albania, Austria, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Latvia, Lithuania, Luxembourg, Macedonia, the former Yugoslavian Republic of, Norway, Poland, Slovakia, Slovenia, Spain, Sweden, the United Kingdom.

Source: Waterbase Version 9; SEBI indicators, 2010 — SEBI indicator 16.

Agriculture is responsible for over 50 % of the total nitrogen discharge to surface waters in most Member States leading to eutrophication of coastal waters and the seas. However, action programmes under the Nitrates Directive have led to reduced nutrient pressures from agriculture (EC, 2010). European air emissions of nitrogen oxides have decreased by one third over the last 15 years and the deposition of nitrogen on inland surface waters has also declined (EEA, 2009).

The overall reductions in pollution and nutrients in rivers, lakes and groundwater generally has reduced the stress on freshwater biodiversity and improved the ecological status. However, the threat to freshwater ecosystems posed by hydro-morphological degradation — building of dams, canalisation — is significant and there are increasing impacts from climate change and invasive species. In the context of climate change, the impacts are likely to be complex. Some of them have already been observed, such as harmful algal blooms, shifted ranges of freshwater species to higher altitudes and latitudes, changes in plant flowering and fish spawning and distribution and increase in invasive alien species. Many alien species have been recorded from lake and river ecosystems in Pan-Europe including around 300 freshwater invertebrates and more than 130 fish; an analysis of trends made for 11 countries shows an important increase in the number of alien species (EEA, 2009; 2010a).

Figure 8.5 Concentrations of nitrate and orthophosphate in rivers and total phosphorus in lakes in the period 1992–2007



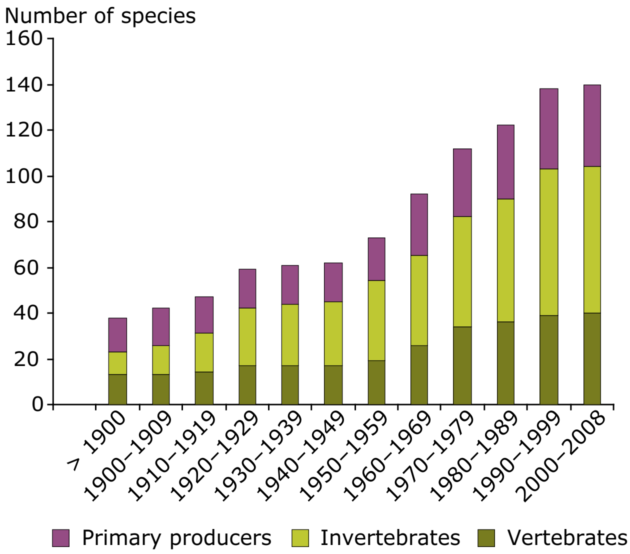
- The average nitrate concentration in European rivers has decreased from 2.5 to 2.1 mg N/l since 1992.
- Nutrient levels in lakes are in general much lower than in rivers, but there has also been a 15 % reduction of the average concentrations in lakes.
- Phosphorus concentrations in European rivers and lakes generally decreased during the last 15 years.
- Between 2004 and 2007 nitrate concentrations in surface water remained stable or fell at 70 % of monitored sites and quality at 66 % of groundwater monitoring points is stable or improving (EU, 2010).

Note: Geographical coverage:

Nitrate in rivers: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Lithuania, Luxembourg, Norway, Poland, Slovakia, Slovenia, Spain, Sweden, Switzerland.
Orthophosphate in rivers: Austria, Belgium, Bulgaria, Denmark, Estonia, Finland, France, Germany, Lithuania, Luxembourg, Norway, Slovakia, Slovenia, Spain, Sweden, Switzerland.
Total phosphorus in lakes: Austria, Denmark, Estonia, Finland, Hungary, Ireland, Lithuania, Latvia, Slovenia, Sweden, Switzerland

Source: Waterbase (version 9); SEBI indicators, 2010 — SEBI indicator 16.

Figure 8.6 Cumulative number of alien species established in freshwater environment in 11 countries ([33])



- The cumulative number of alien species introduced in European freshwater ecosystems has been constantly increasing since the 1900s.
- However, this increase is slowing down for freshwater species (EEA, 2009).

Source: EEA/SEBI2010; NOBANIS; SEBI indicators, 2010 — SEBI indicator 10.

([33]) Geographic coverage: Denmark, Estonia, Finland, Germany, Iceland, Latvia, Lithuania, Norway, Poland, Russia and Sweden.

Fragmentation of rivers, in addition to ecological effects, also brings the increased the risk of flooding (Vandewalle et al., 2010 and EEA, 2010). Many inland waters also suffer from dramatic changes in their water regime, often as a result of modifications to watercourses or water abstraction to supply agriculture, tourism and urban populations, resulting in water scarcity, drought or floods. While there has been progress in mitigating or reducing some of these pressures in recent decades, impacts on fresh water still persist and as such, many EU rivers may not achieve good ecological status, as required by the Water Framework Directive (EEA, 2010).

8.3 Services

Lake and river ecosystems are extremely important for the provision of human drinking water. They support agricultural, fish and shellfish production and provide resources for industry, human sanitation, and also all of the ecosystem types with which they are connected

Rivers and flood plains play an important role within the freshwater cycle (Vandewalle et al.,2010). They provide most global drinking water resources, water resources for agriculture, industry and sanitation, and food such as fish and shellfish; they also provide recreational opportunities and a means of transportation and are a source of energy production (TEEB, 2009).

Rivers provide, regulate and support processes, functions and services to all of the ecosystem types with which they are interconnected, particularly through the provision of fresh water, which is supported and regulated by biodiversity components. The animal and plant communities of rivers play a role in securing fresh water quality (Vandewalle et al., 2010).

The vegetation which grows along the edges of rivers, streams and open water bodies protects and buffers the freshwater ecosystem from sediments, pollutants and nutrients from adjacent areas. Flood plains serve human well-being by preventing flood damage, for instance, by providing an area that can accommodate flood water; they also store water for some time, thereby regulating river discharge; they can also cut off peak flows and balance the behaviour of the river (Vandewalle et al., 2010).

Rivers and flood plains have strong links with cultural and spiritual values and are intensively used for recreational activities (bathing, boating, rafting, canoeing, fishing, hiking, photography and wildlife viewing) (Vandewalle et al., 2010).

Figure 8.7 Current state and trends of lake and river ecosystems services

Provisioning

Crops/timber	
Livestock	
Wild food	
Wood fuel	
Capture fisheries	=
Aquaculture	↓
Genetic	
Fresh waters	↑

Regulating

Pollination	
Climate regulation	=
Pest regulation	
Erosion regulation	
Water regulation	=
Water purification	=
Hazard regulation	=

Cultural

Recreation	=
Aesthetic	=

Trend between periods

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

Status for period 1990–present

	Enhanced
	Mixed
	Degraded
	Unknown
	Not applicable

- Provisioning services such as fisheries and aquaculture as well as most of the regulating services were degraded; this is due to intensified land use causing increased water abstraction, physical modification of river courses, drainage and devastation of flood plains, and eutrophication.

Source: RUBICODE project 2006–2009.

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9 Coastal ecosystems

The coast is the area defined by the coming together of the land and the sea. We differentiate between: the coastal zone, which is defined as the strip of land and sea which follows the coast 10 km inland and 10 km out to sea (EEA, 2006) and coastal ecosystem.

In this section, the term Coastal Ecosystems includes biodiversity characteristic of coastal ecosystems, which includes the habitats which always occur along the coast including marshes, sea cliffs, intertidal habitats and coastal dunes, and some marine habitats which always occur adjacent to the coast, such as large bays. Many terrestrial habitats that can occur at or near the coast (e.g. heaths) have not been included as they are covered in other sections; non-coastal saline habitats (halophytic habitats which only occur inland) are also omitted.

- Six Corine land cover categories are covered: Beaches and dunes, Salt marshes, Salines, Intertidal flats, Coastal lagoons, and Estuaries (331, 421, 422, 423, 521, 522).
- Fifty habitat types listed in Annex I to the Habitats Directive were selected for this section.

9.1 Status and trends

Based on Corine land cover data, in the 24 European costal countries (22 coastal EU Member States plus Iceland and Norway) there are nearly 185 000 km of coastline and 560 000 km^2 of coastal zones (the terrestrial part representing an area approximately the size of Spain). This area corresponds to 13 % of the total land mass of these countries (EEA, 2006).

Between 1990 and 2000, artificial surfaces in coastal zones increased in almost all European countries. The highest increase in artificial surfaces (20–35 %) has been observed in the coastal zones of Spain, Ireland and Portugal. In 2000, the share of area covered by artificial surfaces was 25 % higher on the coast than inland (EEA, 2006).

Mixed agriculture, pasture and natural grassland land cover have all decreased along the European coasts over the past decade. Forest area is increasing slightly in European coastal zones; on the Mediterranean coast, this happens in combination with a withdrawal of traditional farming systems.

Typical coastal ecosystems, such as sand dune habitats, have suffered from degradation and physical destruction throughout Europe. Sub-tidal ecosystems, such as seagrasses, have also been significantly altered and their surface area and/or density has been reduced (EEA, 2006).

Change in coastal ecosystem areas since 1990 (34)

Table 9.1 Surface area (km^2) of coastal ecosystem in 1990, 2000 and 2006

	1990	2000	2006
Dunes/salt marshes/ salines	5 582	5 556	5548
Intertidal flats/coastal lagoons/ estuaries	15 440	15457	15 482
Total	**21 021**	**21 013**	**21 030**

- In 2006, the total area of coastal ecosystems was 21 030 km^2: 26 % dunes, salt marshes and salt pans; the remaining 74 %, intertidal flats, lagoons and estuaries.
- In 2006, the total coastal ecosystem area was almost unchanged since 1990.
- In 2006, for the same geographical area as surveyed in 1990, the dunes, salt marshes and salt pans had decreased by 0.6 % but the intertidal flats, lagoons and estuaries had increased by 0.3 %.

Note: Geographical coverage: EU except Greece, Finland, Sweden and the United Kingdom

Source: Corine land cover.

(34) CLC 1990–2000 is based on 24 EU Member States excluding Finland and Sweden; CLC 2000–06 is based on 25 EU Member States excluding Greece and the United Kingdom (their CLC inventories had not been finalised by Spring 2010). Therefore, comparisons between 1990 and 2006 do not include the four countries mentioned above.

Table 9.2 Changes in surface area (km² and %) since 1990

	1990—2000	2000—2006	1990—2006
Dunes/salt marshes/salines	– 25 – 0.5 %	– 8 – 0.2 %	– 34 – 0.6 %
Intertidal flats/lagoons/estuaries	17 0.1 %	26 0.2 %	43 0.3 %
Total	**– 8 0.0 %**	**17 0.1 %**	**9 0.0 %**

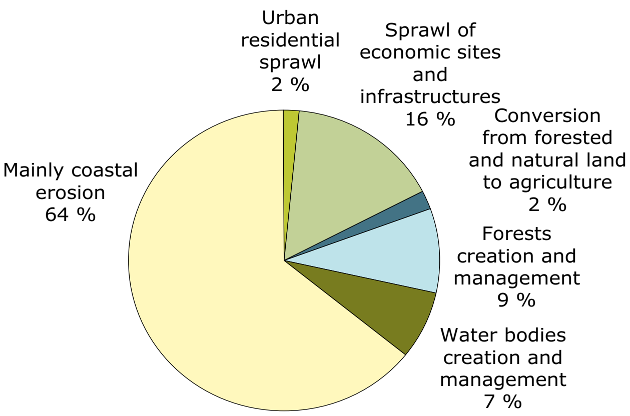
Between 1990 and 2006, there was a small net increase of coastal ecosystems (ca. 9 km²): intertidal flats, lagoons and estuaries increased by 0.3 % whilst dunes, salt marshes and salines lost 0.6 % of their 1990 area.

Note: Geographical coverage: EU except Greece, Finland, Sweden and the United Kingdom.

Source: Corine land cover.

Causes of loss of coastal ecosystems between 2000 and 2006

Figure 9.1 Causes of loss of coastal ecosystems



Between 2000 and 2006:

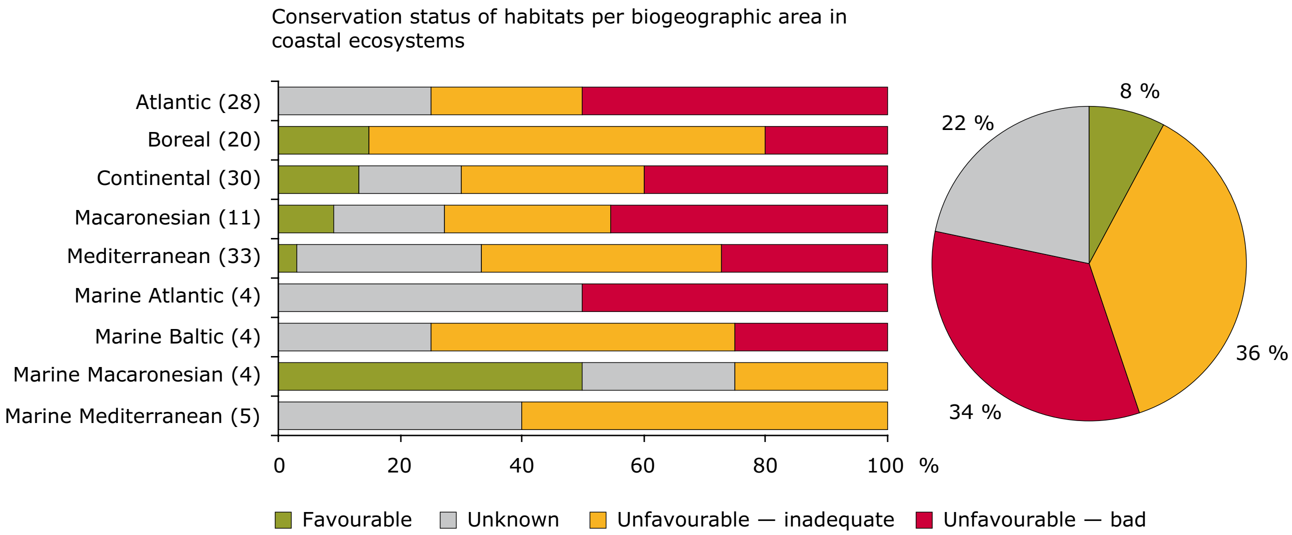
- 8 km² of coastal ecosystems (dunes, salt marshes and salines) were lost with around 65 % of the change due to coastal erosion and 16 % due to sprawl of economic sites and infrastructure such as airports;
- 26 km² of coastal ecosystems (intertidal flats, lagoons and estuaries) were gained through the creation and management of water bodies.

Note: Geographical coverage: EU except Greece and the United Kingdom.

Source: Corine land cover.

Conservation status of habitats and species of European interest in coastal ecosystems

Figure 9.2 Conservation status of habitat types of European interest in coastal ecosystems (statistics by region on the left, overall statistics on the right)

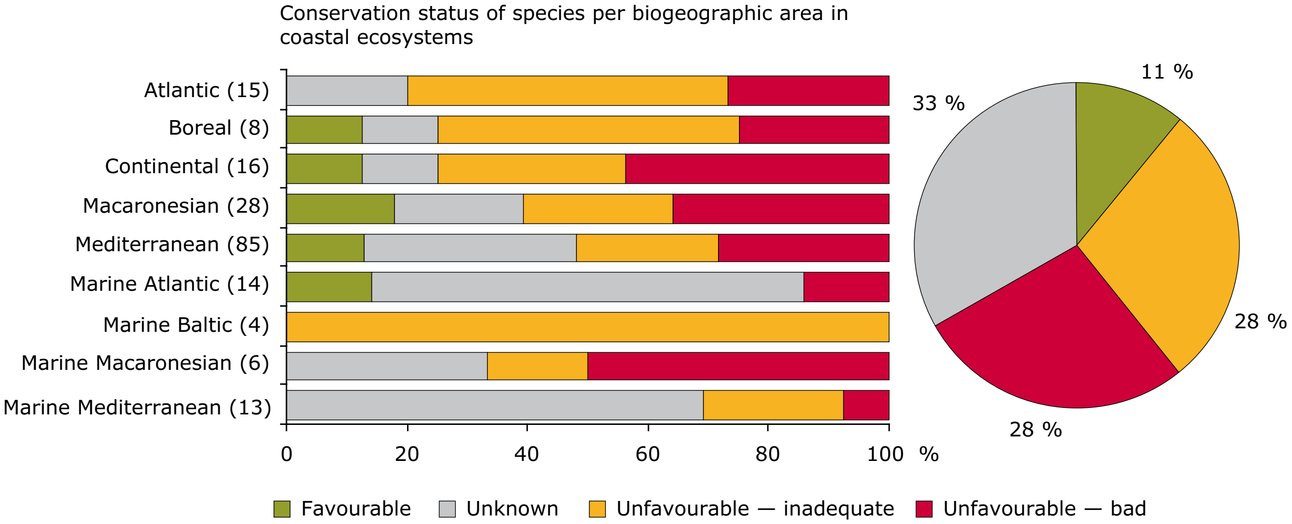


- Some 70 % of the assessments of conservation status of coastal habitats are unfavourable.
- Twenty-two per cent of the assessments are unknown.
- The Marine Macaronesian region has the highest percentage of favourable assessments (around 50 %).
- There are no favourable assessments for the Atlantic, Marine Atlantic, Marine Baltic and Marine Mediterranean regions.

Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

Figure 9.3 Conservation status of species of European interest in coastal ecosystems (statistics by region on the left, overall statistics on the right)

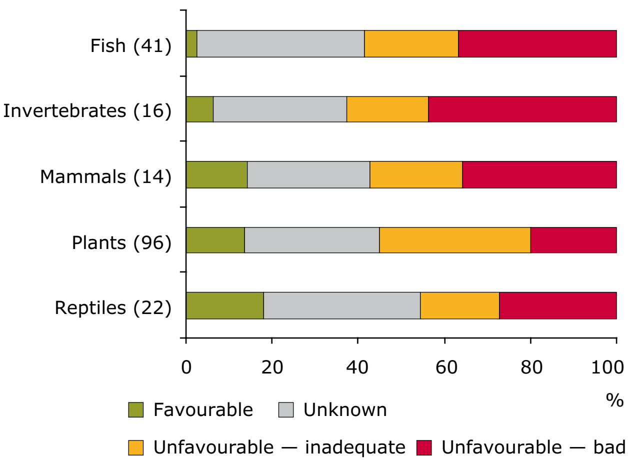


- Some 56 % of the conservation status assessments of coastal species are unfavourable.
- Thirty-three per cent 33 % of the assessments are unknown.
- The percentage of unknown assessments differs significantly among the different regions.
- The Macaronesian region has the highest percentage of favourable assessments, but also a significant percentage of unknown assessments.
- There are no favourable assessments in the Atlantic, Marine Baltic, Marine Macaronesian and Marine Mediterranean regions.

Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

Figure 9.4 Conservation status of species of European interest in coastal ecosystems per group



- More than 60 % of assessments for invertebrates linked to coastal ecosystems are unfavourable.
- Favourable assessments account for less than 20 % for all species groups.
- More than 20 % of assessments for all species groups are unknown.

Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

Additional information

- Around 130 species in the Habitats Directive are linked to coastal ecosystems.
- Fifty-two species in the Birds Directive are linked to coastal ecosystems.
- Of the reptiles of European interest linked to coastal ecosystems, 16 % are threatened.
- Of the mammals of European interest linked to coastal ecosystems, 20 % are threatened.
- Of the birds of European interest linked to coastal ecosystems, 12 % are threatened.

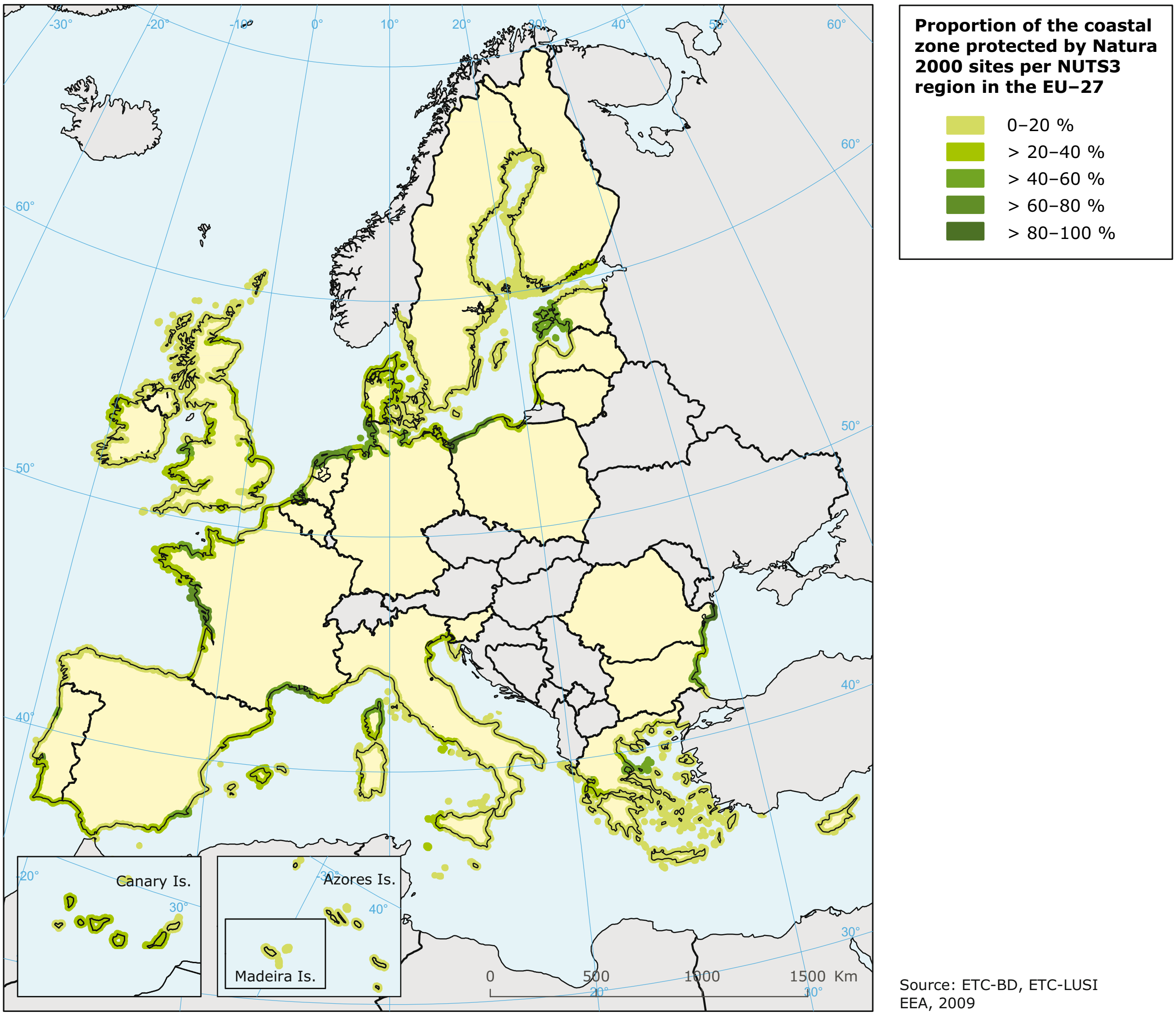
Source: Based on IUCN, 2007, 2009; BirdLife, 2004.

Coastal ecosystems and Natura 2000

- Coastal ecosystems cover 3 % of the surface of Natura 2000, approximately 4 % corresponding to Special Protection Areas (SPAs) and about 3.5 % of Sites of Community Importance (SCIs).

Source: Natura 2000, CLC 2006 for the EU except Greece and the United Kingdom (where CLC 2000 was used).

Map 9.1 Coastal zone protected by Natura 2000 sites, 2009



- The highest proportion of coastal zone covered by Natura 2000 sites is located on Germany's Baltic coast, the Baltic States coast, Denmark's western coast, Ireland's north-western coast, France's eastern Atlantic coast, western and south-western of the Iberian Peninsula, coast of Almeria, northern Catalan coast, northern and central Adriatic coast of Italy, western Crete and Thrace (Greece).

Note: In this assessment the coastal zone is determined from the Corine land cover database. Percentage of the coastal zone within 10 km landwards and seawards by NUTS 3 region in the EU-27, which are protected by Natura 2000 sites.

Source: Adapted from ETC/LUSI, 2009.

9.2 Pressures and threats

Intensive human use of coasts together with invasive alien species are two of the main pressures and threats to the biodiversity of coastal zones.

There is growing evidence that Europe's coastal ecosystems are suffering widespread and significant degradation from eutrophication, pollution, invasive alien species and a certain amount of habitat loss. Intensive human use of coasts and the overall increase in offshore activities in regional sea areas have impacted on water quality parameters and marine biodiversity (EEA, 2006).

Artificial surfaces in the coastal zone spread by 190 km^2 per year between 1990 and 2000 and 250 km^2 per year between 200 and 2006. Due to the irreversible nature of this form of land cover, these changes are seen as one of the main threats to the sustainability of coastal zones with consequent impacts on coastal ecosystems. Road infrastructure leads to the fragmentation and/or isolation of habitats and impacts, through airborne pollutants, on the surface and coastal waters. Pollution from vessels, harbours and oil spills that arise because of the expansion of maritime transport still remains a threat to coastal biodiversity (EEA, 2006).

In general, nitrogen and phosphorus loads in coastal waters have been decreasing and wastewater treatment has improved significantly since the 1980s in all parts of Europe, mainly because of the impact of the Urban Waste Water Treatment Directive ([35]) (EEA, 2006). However, the reduction of nutrient inputs from diffuse sources, in particular from agriculture, remains a challenge.

In addition, pollution due to environmental chemicals on coastal areas affects the coastal food web and accumulates in species at the higher trophic level, including birds (OSPAR, 2009).

Eutrophication, which is an excess in the concentrations of nutrients received by a water body that stimulates plant and algal growth (often called algal bloom), causes negative effects such as reductions in the dissolved oxygen in the water, fish and other animal populations and has been recognised over many years as one of the most important problems facing European coastal waters. The impact of eutrophication on submerged coastal ecosystems can easily be assessed by monitoring the persistence of turbid conditions (reduced water transparency) in coastal and transitional waters. Examples of such an impact include the decline of seagrass meadows (EEA, 2006).

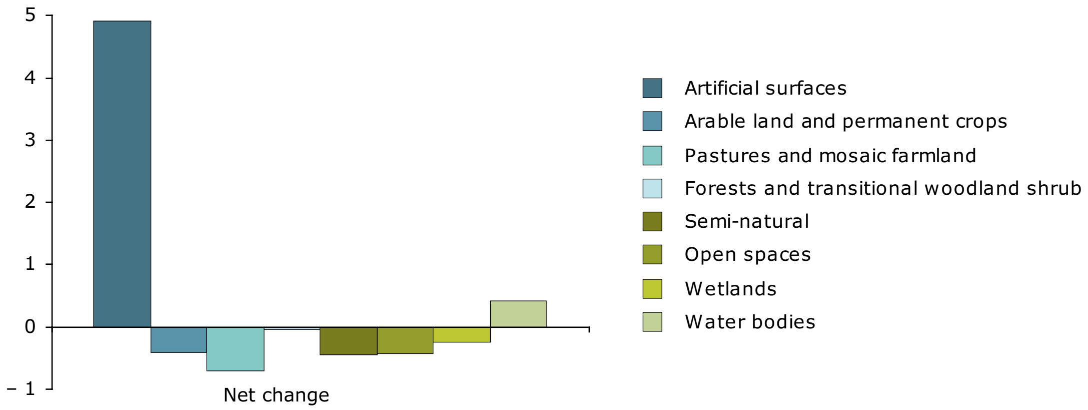
The intensive use of coastal zones for aquaculture farms, which has increased in the EU since 1990, brings problems such as the release of nutrients causing eutrophication, especially in estuaries or in coastal waters around the installations. The implementation of the Water Framework Directive ([36]) will help to address these issues (EEA, 2006). Moreover, in many places aquaculture is identified as one of the major causes of alien species introduction, which has a strong impact on local ecosystems and biodiversity (EEA, 2006).

Invasive species also pose a great threat to ecosystems on the coast, including marine and wetland ecosystems. Changes in the ecosystem structure caused by climate change, over-exploitation of resources or eutrophication have left the ecosystem more vulnerable to the invasion from alien species (EEA, 2006).

([35]) The Urban Waste Water Treatment Directive (Council Directive 91/271/EEC of 21 May 1991 concerning urban wastewater treatment) aims to reduce the pollution of freshwater, estuarial and coastal waters by domestic sewage, industrial waste water and rainwater run-off. The Directive requires high standards of treatment for discharges to particularly sensitive areas, including waters subject to eutrophication (Tucker and de Soye, 2009).

([36]) The Water Framework Directive (WFD) (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) aims to establish a framework for the protection of fresh water, transitional waters, coastal waters and groundwater in the EU to protect and enhance the status of aquatic ecosystems and promote sustainable water consumption based on long-term protection of available water resources. Its overall objective is to achieve 'good ecological status' of surface waters by 2015. The Directive places the protection of aquatic ecosystems at the centre of its objectives, providing a powerful platform for biodiversity conservation (Tucker and de Soye, 2009).

Figure 9.5 **Relative change (%) of land cover within the 0–10 km coastal zone from 2000—06 of 27 European coastal countries, including 20 EU Member States (data not available for Greece or the United Kingdom)**



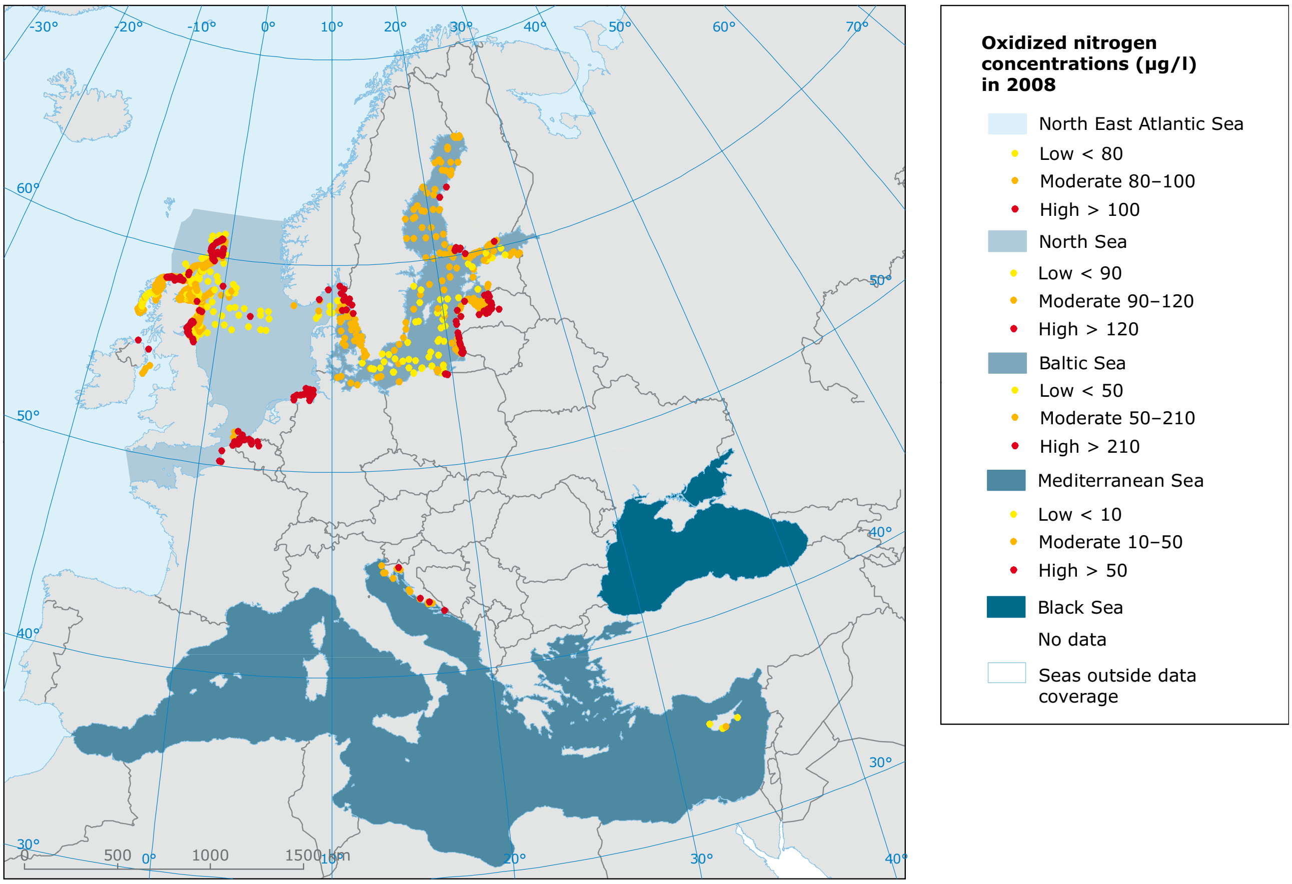
Between 2000 and 2006 three main types of coastal land-use trends occurred:

- artificial surfaces increased by almost 1 500 km^2 (slightly smaller than the surface of Tenerife);
- pasture and mixed farmland showed a major decrease of more than 500 km^2;
- arable lands and permanent crops decreased by 400 km^2.

These figures should be read in conjunction with those for Coastal ecosystems (Figure 9.1). It can be seen that the general impacts in the (wider) coastal zone are greater as a proportion of area to those specifically within coastal ecosystems.

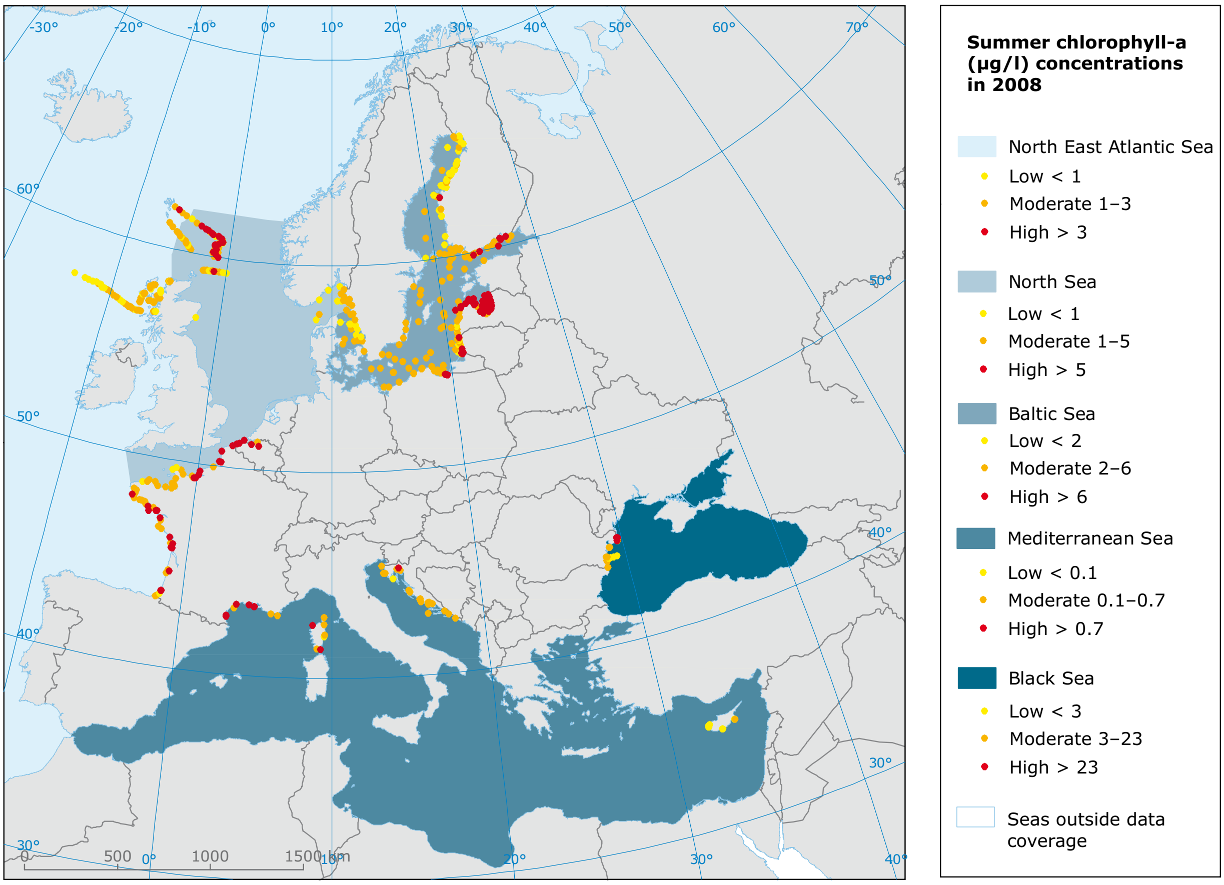
Source: Corine land cover 2000, 2006.

Map 9.2 **Map of winter oxidised nitrogen concentrations observed in 2005**



Source: CSI21 Nutrients in transitional, coastal and marine waters — Assessment published Jan 2009 (http://themes.eea.europa.eu/IMS/ISpecs/ISpecification20041007132008/IAssessment1204714151163/view_content).

Map 9.3 Map of summer chlorophyll a concentrations observed in 2005



Eutrophication can be followed according to types of measurements: concentrations of winter oxidised nitrogen and concentrations of summer chlorophyll.

- Observations in 2005 showed that most of coastal waters stations contain high and medium concentrations for both measurements.
- Trends in both concentrations are stable for the majority of these stations.

Source: CSI23 Chlorophyll in transitional, coastal and marine waters — Assessment published Jan 2009 (http://themes.eea.europa.eu/IMS/ISpecs/ISpecification20041007132031/IAssessment1205412447537/view_content).

9.3 Services

Coastal ecosystems provide food and play an important role as fish nursery habitats; they also provide natural filters for pollution and storage of carbon, a buffer against coastal erosion, natural hazards and storms, a source of green energy and are important places for tourism and recreation.

Coastal ecosystems provide a wide range of services to human beings (MEA, 2005 in EEA, 2006). Coastal waters play an important role as fish nursery habitats, being the place where many sea species reproduce and live before going back to the open sea. Intertidal flats and coastal wetlands are pollution filters and carbon stores, and buffer against coastal erosion, natural hazards and storms. Coasts also provide important cultural and amenity services, such as tourism and recreation (EEA, 2010).

The rich biodiversity of coastal zones, particularly fish and shellfish, is a major source of food for Europe (EEA, 2010). Historically, fishing has been a main coastal activity, but during the last decade the sector has experienced a serious decline due to overfishing and stock collapse.

Agriculture in coastal areas continues to be extremely relevant because it plays and essential role for production, supporting the multifunctionality of coastal areas. It also has a crucial role in the maintenance of coastal rural landscapes and low-input agricultural systems can be beneficial for the conservation of biodiversity. Areas of mixed farming, pasture and wetlands promote biodiversity and also maintain traditional practices as part of coastal management (EEA, 2006).

Coastal areas can offer a great potential for the generation of green energies such as coastal and offshore wind farms, wave power, tides and currents energy. However, they can pose problems for the protection of ecosystems (EEA, 2006).

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10 Marine ecosystems

Europe's land mass is surrounded by five sea basins, the: Mediterranean Sea, Black Sea, Baltic Sea, North Sea, and North Atlantic Ocean (EEA, 2010a). Oceans and seas cover more than half of the territory of the EU-27. Marine ecosystems are diverse: some are highly productive; all are important ecologically and economically to mankind, providing numerous vital goods and services, as well as supporting the processes that sustain the biosphere (EEA, 2010b).

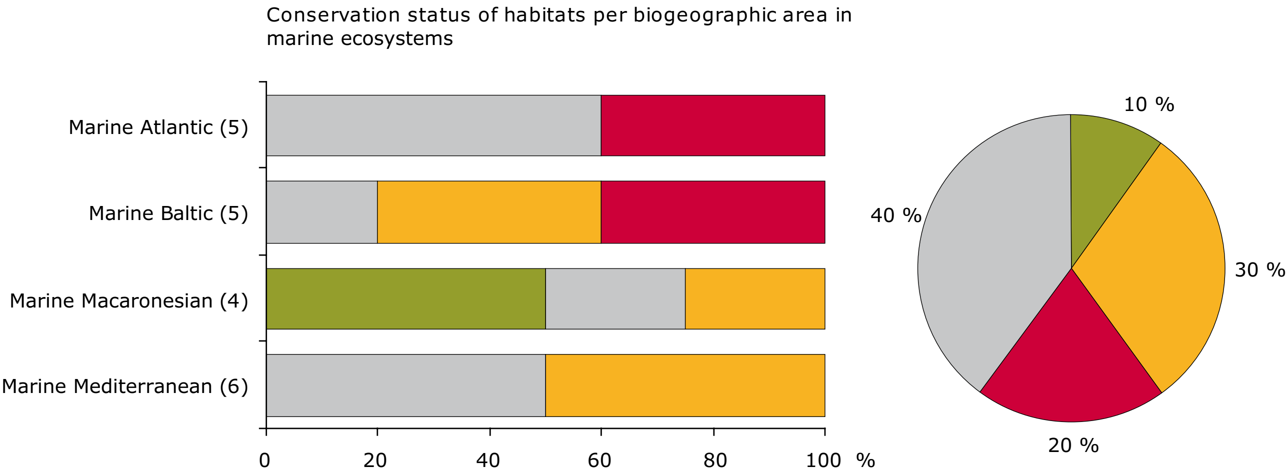
In this section, the term 'marine ecosystems' includes marine waters and habitats up to the low water tide line.

- The Corine land cover category 'Sea and Ocean' (523) is discussed.
- Six habitat types listed in Annex I to the Habitats Directive were selected for this section: reefs, sandbanks, Posidonia meadows, shallow inlets and bays, submarine structures, and sea caves.

Marine ecosystems are a complex of habitats defined by the wide range of physical, chemical, and geological variations that are found in the sea. Habitats range from highly productive near-shore regions to the deep sea floor inhabited only by highly specialised organisms (EEA, 2010b).

Conservation status of habitats and species of European interest in marine ecosystems

Figure 10.1 Conservation status of habitat types of European interest in marine ecosystems (statistics by region on the left, overall statistics on the right)



- Some 50 % of the assessments of habitats linked to marine ecosystems are unfavourable.
- Forty per cent of the assessments are unknown.
- The Marine Macaronesian region has about 50 % favourable assessments.
- The Marine Atlantic and Marine Mediterranean regions have the highest percentage of unknown assessments (more than 50 %).
- There are no favourable assessments for the Marine Atlantic, Marine Baltic and Marine Mediterranean regions.

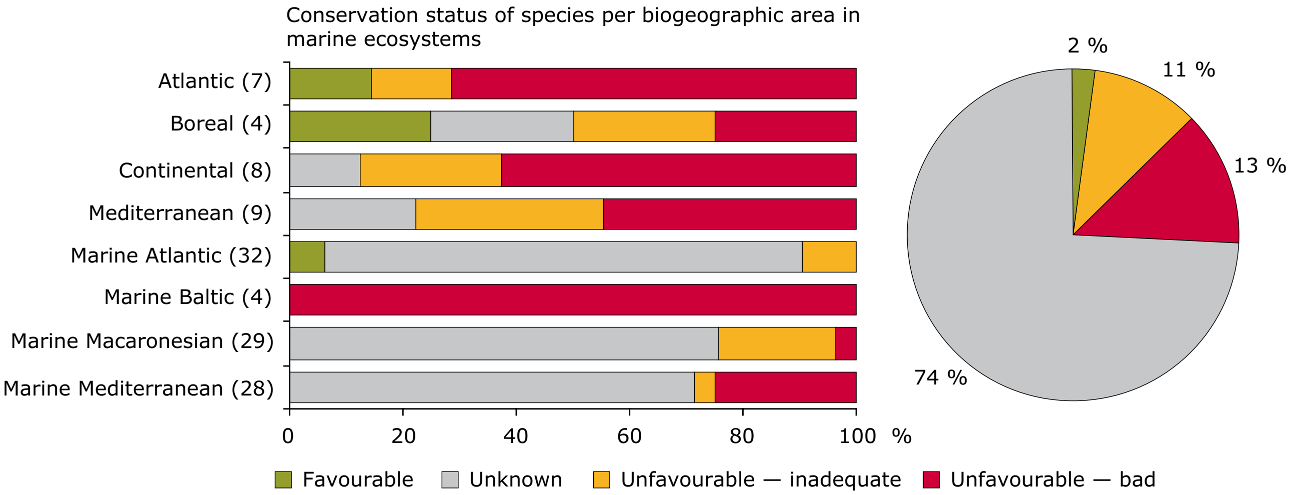
Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

10.1 Status and trends

The conservation status of more than 70 % of the species and 40 % of the habitats of European interest in marine ecosystems is unknown. Of those that have been assessed, only 2 % of species are in favourable conservation status. In relation to habitats, there are no favourable assessments for the Marine Mediterranean, Marine Baltic and Marine Atlantic regions; although it should be noted that 60 % of habitat assessments within the Marine Atlantic region are unknown. The number of fully or partly marine areas proposed or classified under the Birds and Habitats Directives is less than 2 000 and they cover a marine area of approximately 167 000 km^2 (about twice the terrestrial area of Austria). Currently, most of the marine Natura 2000 sites are near-shore areas and a coherent network in the offshore areas, in particular, is absent (EEA, 2010b).

Figure 10.2 Conservation status of species of European interest in marine ecosystems (statistics by region on the left, overall statistics on the right)

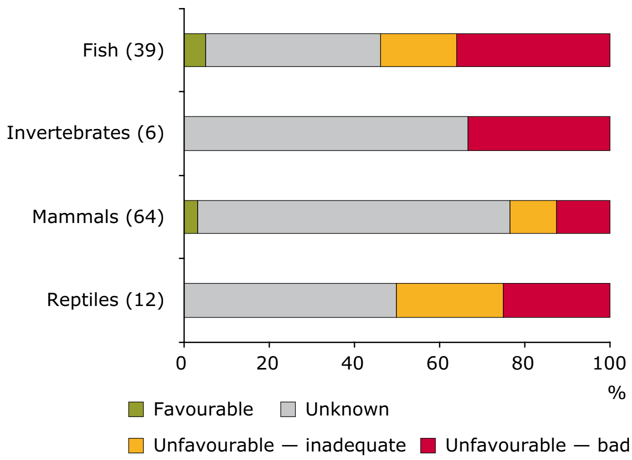


- Some 74 % of the assessments of marine species linked to marine ecosystems are unknown.
- Twenty-four per cent of the assessments are unfavourable.
- Only 2 % of the assessments are favourable and are represented only in the Atlantic, Boreal and Marine Atlantic regions.
- The Atlantic, Continental and Marine Baltic regions have more than 80 % of unfavourable assessments.
- The Marine Atlantic, Marine Macaronesian and Marine Mediterranean regions have the highest percentage of unknown assessments (more than 70 %).

Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

Figure 10.3 Conservation status of species of European interest in marine ecosystems per group



- Nearly 70 % of assessments for mammals and invertebrates linked to marine ecosystems are unknown.
- Reports on reptiles and fish show around 50 % unfavourable assessments.
- There are no favourable assessments for marine reptiles (turtles) and invertebrates.

Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

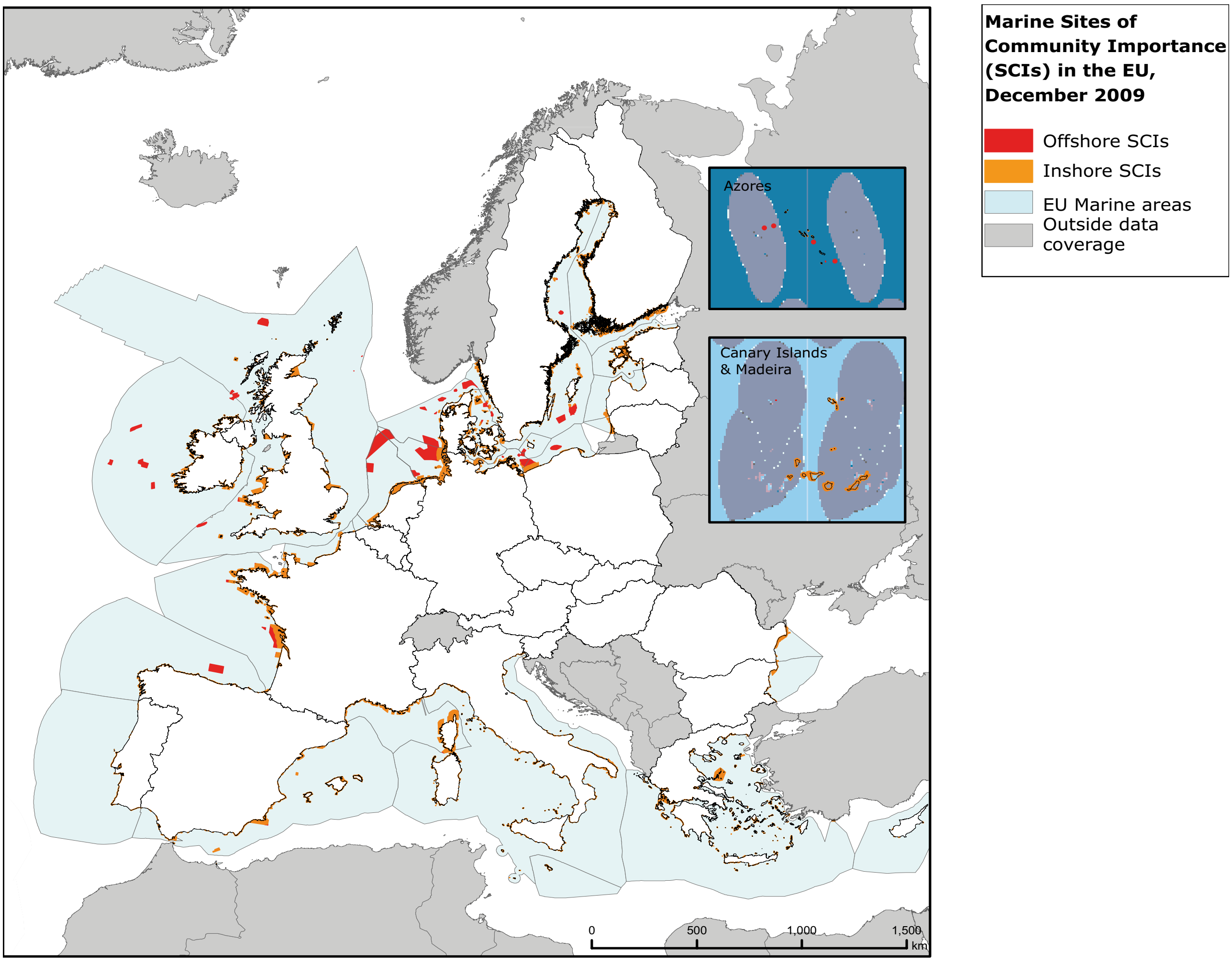
Additional information

- Nearly 65 species in the Habitats Directive and 42 species in the Birds Directive are linked to marine ecosystems.
- Of the mammals of European interest linked to marine ecosystems, 15 % are threatened and 44 % are in the category 'Data Deficient'.
- Of the birds of European interest linked to marine ecosystems, 12 % are threatened.

Source: IUCN, 2007; BirdLife, 2004
Marine ecosystems and Natura 2000.

In the last few years, there has been a rapid increase in the number of marine Natura 2000 sites; however, the level of coverage is not yet as extensive as for terrestrial habitats. By December 2009, the marine area in Natura 2000 (fully or partially marine sites) was about 167 000 km^2 (a bit less than the combined size of Estonia, Latvia and Lithuania).

Map 10.1 Marine Sites of Community Importance in the European Union, December 2009



- Currently, most of the marine SCIs are near-shore areas and a coherent network of offshore areas is absent for the time being (EEA, 2010b).

Source: Natura 2000, December 2009.

10.2 Pressures and threats

Overfishing, climate change, acidification of the sea and invasive alien species are the main threats to marine biodiversity. Eutrophication and pollution continue to be major problems.

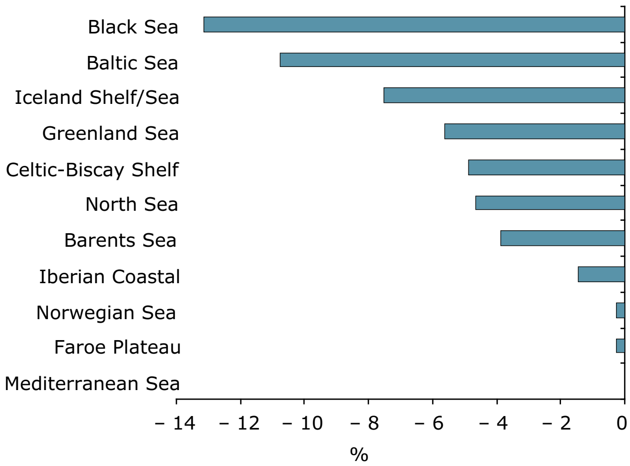
Over-exploitation of fish stocks is still widespread in the pan-European region with 88 % of Community fish stocks fished beyond their maximum sustainable yields: less fishing pressure now would allow these stocks to recover. However, 46 % of community fish stocks are overfished outside safe biological limits and their recovery is not assured (EEA, 2010b). The consequences include increased vulnerability to other pressures, especially pollution and climate change (EEA, 2007 in EEA, 2010b).

Climate change impacts include acidification, which leads to serious adverse impacts on the marine environment, particularly as carbon dioxide (CO_2) emissions continue to increase, affecting the capacity of marine ecosystems to act as global carbon sinks (EEA, 2010b).

The highest numbers of invasive alien species are found in the Mediterranean Sea (740). The collapse of the Black Sea ecosystem in the 1990s demonstrates how alien species can aggravate other pressures and cause great economic losses (EEA, 2007). Changes in the structure of marine ecosystems caused by climate change, over-harvesting of resources or eutrophication have left the ecosystems more vulnerable to invasion from alien species (EEA, 2006).

Eutrophication and pollution continue to be major problems, affecting most of the European seas. Point source nutrient pollution has reduced in some regions, but diffuse pollution sources, especially from intensive agriculture, continue to be a problem (EEA, 2010b). Eutrophication due to nitrogen and phosphorus enrichment can result in a chain of undesirable effects, starting with excessive growth of planktonic algae, which increases the amount of organic matter settling to the seabed. The consequent increase in oxygen consumption can cause oxygen depletion, creating 'dead zones' where other forms of life cannot survive, changes in community structure and death of the benthic fauna (EEA, 2009). Concentrations of hazardous substances in European seas have been decreasing. However, the persistence and the amounts of such substances already released mean that the negative effects will continue for decades (EEA, 2010b).

Figure 10.4 Marine Trophic Index ([37]) change between 1950 and 2004

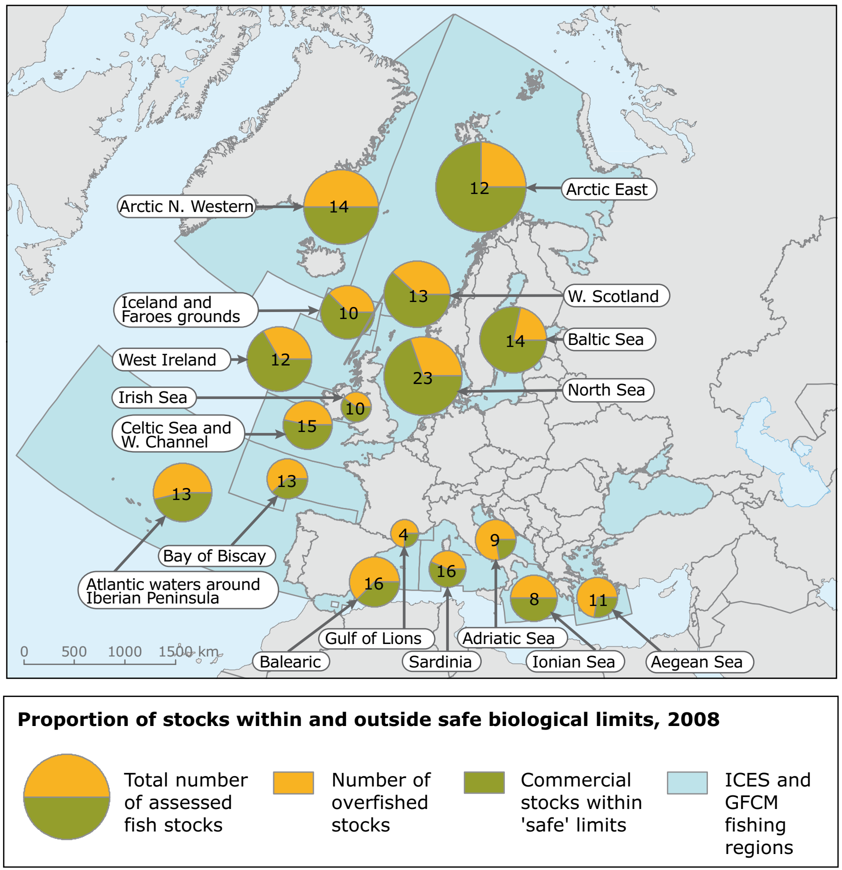


- In the majority of European seas, the Marine Trophic Index (MTI) has been declining since the mid 1950s, which means that populations of predatory fish are declining and populations of smaller fish and invertebrates are increasing; this indicates that fisheries are not exploiting the resources sustainably (EEA, 2009).
- There are significant differences in the decline in MTI rates in the different seas (EEA, 2009).

Source: Sea Around Us Project (www.seaaroundus.org), SEBI indicators, 2010 — SEBI indicator 12.

([37]) The Marine Trophic Index (MTI), or mean trophic level of fisheries landings, was established to investigate the impact of fisheries on the world's marine ecosystems. The MTI expresses the average position of marine creatures in the food chain. Fisheries target first the most valuable species which are usually large predators that occupy high positions on the food chain. Overfishing of these species progressively moves catches down to the food chain to invertebrates and smaller fish. This is reflected in a decrease in the MTI.

Map 10.2 Status of fish stocks in the International Council for the Exploration of the Sea (ICES) and General Fisheries Commission for the Mediterranean (GFCM) fishing regions of Europe, 2008 ([38])



- About 46 % of the assessed European commercial fish stocks are outside safe biological limits (SBL).
- Of the assessed commercial fish stocks in the North-East Atlantic Ocean, 25 % (Arctic Sea) to 62 % (Bay of Biscay) are outside SBL.
- In the Baltic Sea, 21 % of fish stocks are outside SBL.
- In the Mediterranean Sea, the percentage of stocks outside SBL ranges from 50 % to 78 %, with the Adriatic Sea in the worst condition.

Source: GFCM, 2005 and ICES, 2008; SEBI indicators, 2010 — SEBI indicator 21.

10.3 Services

Marine ecosystems provide a wide range of services such as climate regulation and act as a carbon sink, provide food and offer recreational and tourism opportunities

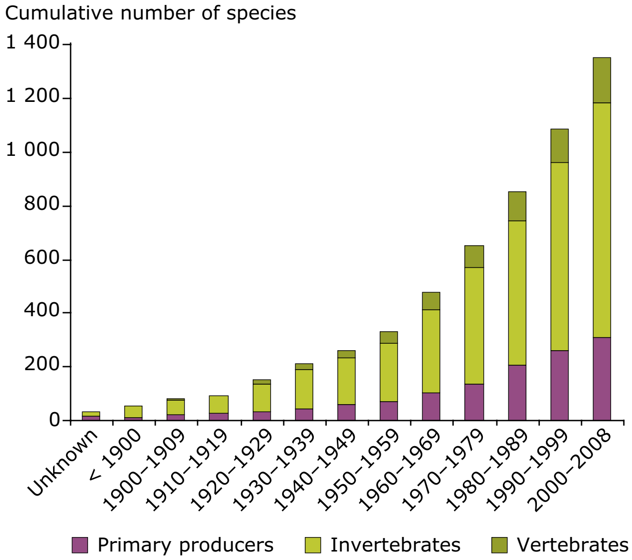
One of the ocean's major ecosystem services is in regulating the Earth's climate system and its role as the second largest sink for human-generated carbon dioxide after the atmosphere itself (Iglesias-Rodriguez et al., 2008, in Trumper et al., 2009). Healthy marine and coastal ecosystems are essential for the maintenance of life on Earth (EEA, 2010b). Other services include the production of oxygen, nutrient cycles, the stabilisation of coastlines, bioremediation of waste and a variety of aesthetic and cultural values (MARBEF, 2008 in EEA, 2010b).

Marine protected areas maintain food security. Thus, several studies have found that fish populations, size and biomass all dramatically increase inside marine reserves, in particular when a policy of 'no take' is applied; this has allowed 'spillover' to nearby fishing grounds with a consequent revitalisation of catches and benefits for coastal fishing communities and fishing fleets (TEEB, 2009).

Living marine flora and fauna can play a valuable role in the defence of coastal regions and prevent the impact of tidal surges, storms and floods (TEEB, 2009).

([38]) The chart shows the proportion of assessed stocks that are overfished (red) and stocks within safe biological limits (blue). The numbers in the circles indicate the number of stocks assessed within the given region. The size of the circles is proportional to the magnitude of the regional catch.

Figure 10.5 Alien species in European marine/estuarine waters (39)



- The cumulative number of alien species introduced in Europe has been constantly increasing since the 1900s.
- In the 2000s, the total number of marine alien species increased to more than 1 300 species (EEA, 2009).

Note: Alien species in European marine/estuarine waters (October 2008) — the indicator on the cumulative number of alien species established in Europe includes data from all European countries with marine/estuarine waters, as well as non-European countries bordering European seas.

Source: SEBI 2010 Expert Group on invasive alien species, based on national data sets (Belgium, Denmark, Germany, Malta and the United Kingdom) available online; review papers (the Netherlands and Turkey); NEMO database for the Baltic; Black Sea database; HCMR data base for the Mediterranean; project reports (ALIENS, DAISIE); and the contributions of experts from France, Spain and Russia made during a dedicated workshop; SEBI indicators, 2010 — SEBI indicator 10.

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(39) Geographic coverage: all European countries with marine/estuarine waters. Casual records are to some extent included (casual records before 1920 are excluded, as well as casual records that have later not been found again and therefore assumed extinct). For an additional 31 species (15 primary producers, 16 invertebrates), the date of establishment is unknown.

11 Threats to biodiversity

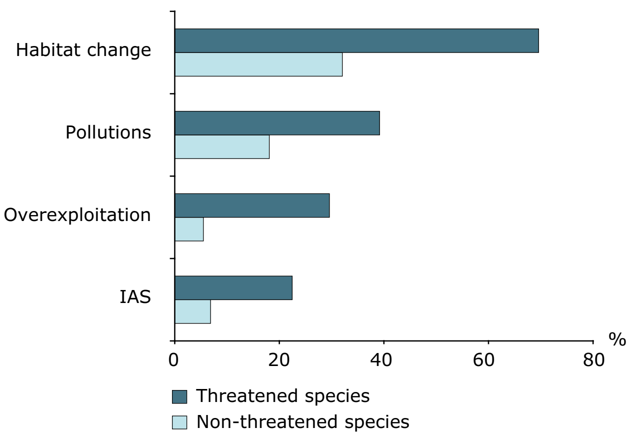
The main pressures and drivers causing biodiversity loss are well known and embodied in the HIPOC acronym: Habitat loss or change, Introduced species, Pollution, Over-exploitation, Climate change. The principal pressure is habitat fragmentation, degradation and destruction due to land-use change; pollution, over-exploitation, spread of invasive alien species and climate change are the other key pressures. The relative importance of these pressures varies from place to place and very often several pressures act in concert (CEC, 2006).

The above is confirmed by recent IUCN analysis: the most impacting threats for amphibians, reptiles, mammals, butterflies and dragonflies present in the EU, are:

- habitat change
- pollution
- over-exploitation
- invasive alien species.

In the following figures showing the impacts of the main threats collectively and individually, the threats were coded using the IUCN Major Threats Authority File. Summaries of the relative importance of the different threat processes is shown as a percentage of the species impacted.

Figure 11.1 Main Impacts on threatened and non-threatened species at EU level



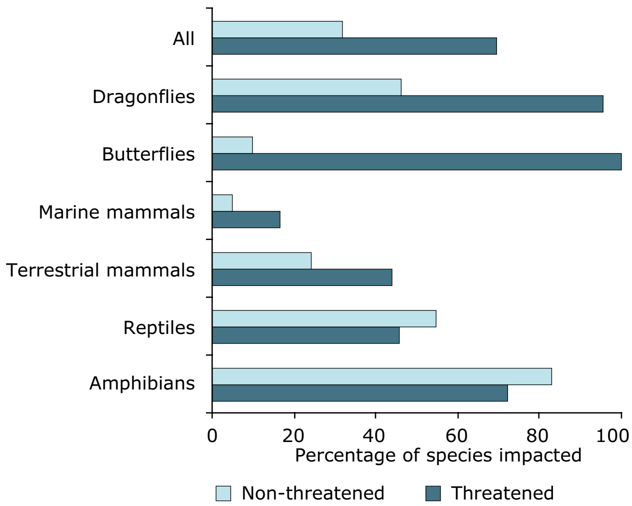
- Habitat change has the greatest impact on nearly 70 % of the species evaluated as threatened and over 30 % of the non-threatened species.

Source: IUCN, 2007, 2009, 2010.

11.1 Habitat change

Habitat loss (the outright destruction of a habitat as a result of a process of land-use change in which a natural habitat type is removed and replaced by another habitat type), habitat fragmentation (the breaking-up of habitats into discontinuous, isolated patches) and habitat degradation (the diminishment of habitat quality which results in a reduced ability to support biological communities) together make habitat change one of the main causes of biodiversity loss (CBD, 2010b).

Figure 11.2 Impact of habitat change on species at EU level



- Threatened dragonflies (95 % of species) and butterflies (100 % of species) are the groups most impacted by habitat change.
- Proportionately, threatened species (100 %) are impacted more than non-threatened species (10 %) in butterflies; significantly more than in any other group.
- For reptiles (just under 55 %) and amphibians (over 80 %) non-threatened species are impacted by habitat change proportionately more than threatened species.

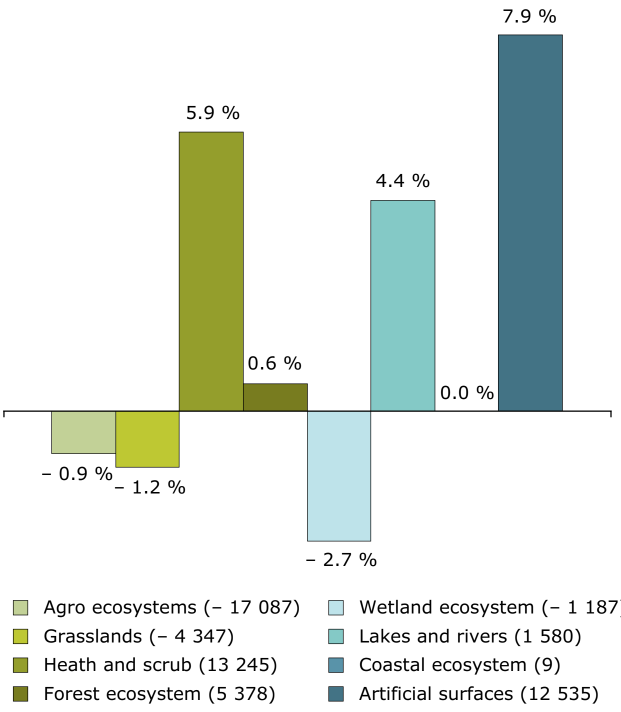
Source: IUCN, 2007, 2009, 2010.

Habitat loss results from land-use change, mainly through conversion to agriculture as well as urban, industrial and infrastructure development. As a result, many habitats are now becoming increasingly fragmented into small patches that are often ecologically isolated from other areas or are too small to hold viable populations (Fahrig, 2003, in Tucker and de Soye, 2009).

European ecosystems are literally 'cut to pieces' by urban sprawl, rapidly expanding transport infrastructure and energy networks. The increase of mixed natural landscape patterns due to the spread of artificial and agricultural areas into what used to be core natural and semi-natural landscapes is currently more significant in south-western Europe (EEA, 2009).

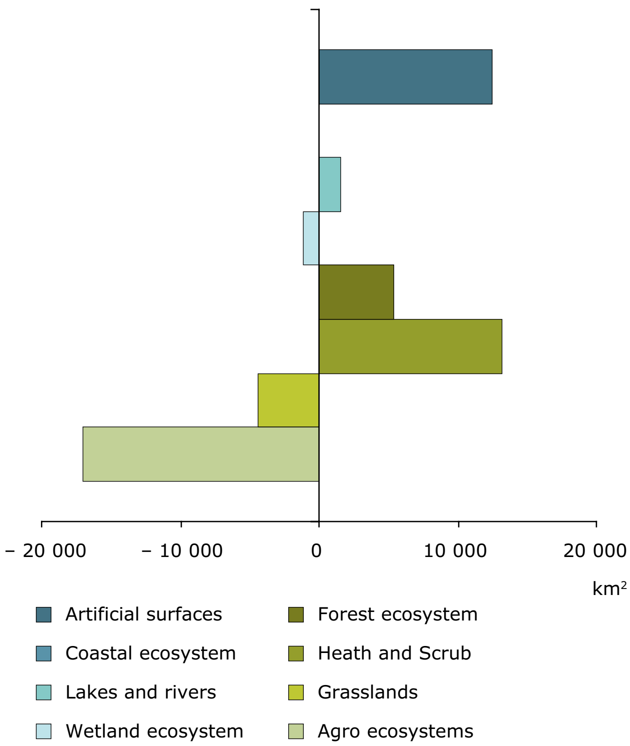
Land cover change between 1990 and 2006: area change for major habitat classes

Figure 11.3 CLC changes between 1990 and 2006 as a percentage of total area of each habitat/land class



Source: EEA, 2010 — EU-27 except Greece, Finland, Sweden and the United Kingdom.

Figure 11.4 CLC changes between 1990 and 2006 (km^2)



- Artificial surfaces (building development, infrastructure, etc.) increased the most between 1990 and 2006 as a proportion of total area.
- Heath and scrub habitat increased (+ 5.9 %; more than 13 000 km^2) and grassland decreased (– 1.2 %; more than 4 000 km^2): both changes can be linked to land abandonment.
- Wetlands decreased (– 2.7 %; more than 1 000 km^2 in total) as a proportion of their total area whilst rivers and lakes increased (+ 4.4 %; more than 1 500 km^2).

Source: EEA, 2010 — EU-27 except Greece, Finland, Sweden and the United Kingdom.

Fragmentation

Fragmentation — the breaking up of a habitat into discontinuous portions — is increasingly affecting biodiversity and ecosystems.

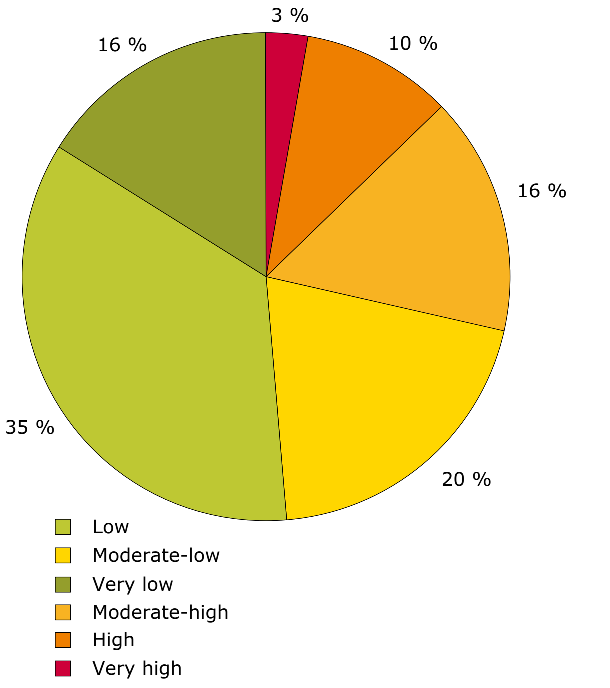
There are different methodologies being developed to measure and assess fragmentation. The following figure shows the percentage of terrestrial EU land in given fragmentation levels from 'very high' to 'very low'; this was prepared by EEA's European Topic Centre on Land Use and Spatial Information (ETC/LUSI-GISAT) as part of an ongoing project on fragmentation.

The definition of the six fragmentation levels is:

- 6: Urban, > 100 meshes per 1 000 km² (very high fragmentation);
- 5: Ex-urban or highly dissected areas, 50–100 meshes per 1 000 km² (high fragmentation);
- 4: Combination of ex-urban and rural areas, 20–50 meshes per 1 000 km² (moderate high fragmentation);
- 3: Rural (agriculture), 10–20 meshes per 1 000 km² (moderate low fragmentation);
- 2: Rural (rangeland or low agriculture), 2–10 meshes per 1 000 km² (low fragmentation);
- 1: Remote areas with low population density, < 2 meshes per 1 000 km² (very low fragmentation).

The fragmentation of nearly 30 % of EU land is moderately-high to very high, mostly due to urban sprawl and infrastructure development.

Figure 11.5 Fragmentation as percentage of total EU terrestrial area



Note: Based on the effective mesh density (Seff) calculated using TeleAtlas Q42009 data

Source: © TeleAtlas.

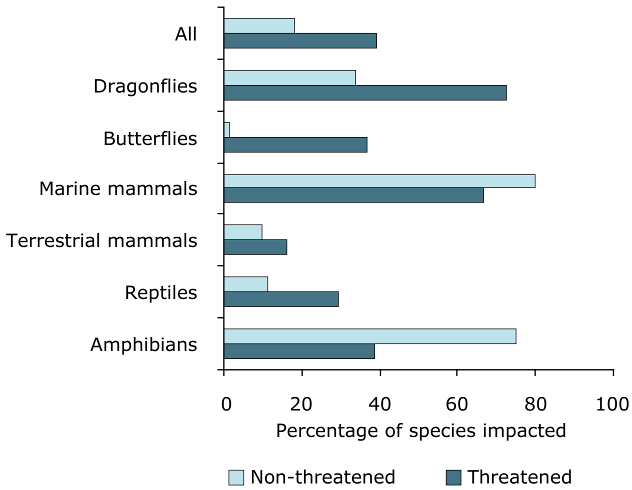
11.2 Pollution

All forms of pollution pose a serious threat to biodiversity but, in particular, nutrient loading, primarily of nitrogen and phosphorus, which is a major and increasing cause of biodiversity loss and ecosystem disfunction (CBD, 2010a).

Atmospheric nitrogen deposition represents a major threat to European biodiversity and a serious challenge for the conservation of natural habitats and species under the Habitats Directive. In addition, nitrogen compounds can lead to eutrophication of ecosystems. Eutrophication is an excess in the concentrations of nutrients received by a water body that stimulates growth of plants and algae (often called algal bloom), causing negative effects such as reductions in the dissolved oxygen in the water and damaging changes to fish, other animal and plant populations.

For many European ecosystem types, studies have concluded that nitrogen deposition results in loss of species richness. Peatland ecosystems provide an example of how species replacement, resulting from nitrogen deposition, may alter the functionality of ecosystems. For example, the carbon sequestration

Figure 11.6 Impacts of pollution on species at EU level



- Non-threatened marine mammals (80 % of species) and threatened dragonflies (more than 70 % of species) and are the groups most impacted by pollution.
- Proportionately, threatened species (more than 30 %) are impacted more than non-threatened species (less than 5 %) in butterflies; significantly more than in any other group.
- For amphibians (over 70 %) and marine mammals (80 %) non-threatened species are impacted by pollution proportionately more than threatened species.

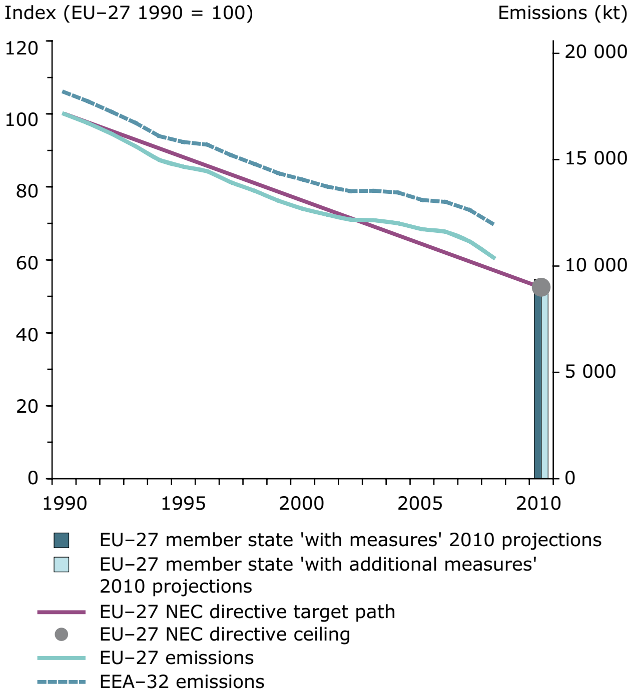
Source: IUCN, 2007, 2009, 2010.

capacity of rain-fed bog ecosystems decreases when subjected to elevated nitrogen inputs (COST, 2009).

In relation to marine ecosystems, pollution continues to be a major problem affecting most of the European seas, in spite of the reduction in point sources (e.g. sewage outfall pipes, fish-farm effluents, etc.) of nutrients in some areas. This indicates that measures to counter it, such as the Nitrates Directive ([40]), are either insufficient or poorly implemented in some parts of Europe (EEA, 2005a, 2005b; EC, 2007 in EEA, 2010c); even if the contribution of nitrogen loads from agriculture to surface waters is decreasing in many Member States (EC, 2010). Nitrogen and phosphorus enrichment can result in a chain of undesirable effects, starting with excessive growth of planktonic algae, which increases the amount of organic matter settling to the seabed. This accumulation may be associated with changes in species composition and altered functioning of the food web. The consequent increase in oxygen consumption can cause oxygen depletion, creating 'dead zones' where other forms of life cannot survive, changes in community structure and death of the benthic fauna (EEA, 2009).

Regarding fresh water, man-made pollution is decreasing mainly through the implementation of the Urban Waste Water Treatment Directive ([41]) and will further decrease through the influence of the Water Framework Directive ([42]). In addition, there has been a general improvement of wastewater and organic matter treatment in European rivers and an associated reduction in biochemical oxygen demand (BOD) and total ammonium concentration The overall reductions in pollution and nutrients in rivers, lakes and groundwater generally has reduced the stress on freshwater biodiversity and improved the ecological status (EEA, 2009). However, pollution by micropollutants — such as pharmaceuticals, endocrine disruptors, and personal care products — is still a major concern in the aquatic environment (Musolff, 2009).

Figure 11.7 Emission trends of nitrogen oxides (EEA member countries, EU-27 Member States)



- In 1990, the total emissions of nitrogen oxides to the air in the EU were around 17 000 kt.
- Between 1990 and 2006, the total emissions of nitrogen oxides have steadily declined.

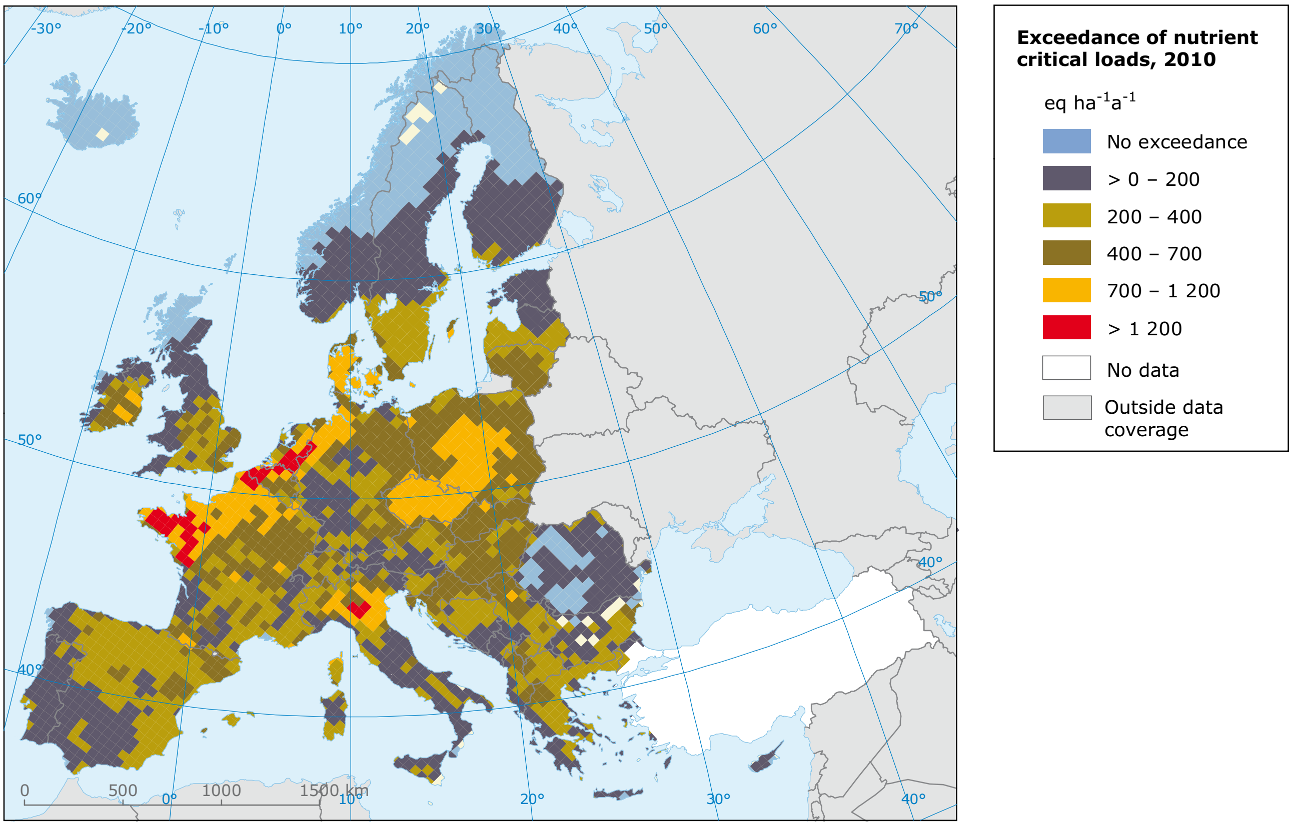
Source: EEA, 2009.

([40]) The Nitrates Directive (Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources) seeks to reduce or prevent water pollution caused by the application and storage of inorganic fertiliser and manure on farmland. It is intended both to safeguard drinking water supplies and to prevent wider ecological damage in the form of eutrophication of freshwater and marine waters (Tucker and de Soye, 2009).

([40]) The Urban Waste Water Treatment Directive (Council Directive 91/271/EEC of 21 May 1991 concerning urban wastewater treatment) seeks to reduce the pollution of freshwater, estuarial and coastal waters by domestic sewage, industrial waste water and rainwater run-off. The Directive requires high standards of treatment for discharges to particularly sensitive areas, including waters subject to eutrophication (Tucker and de Soye, 2009).

([41]) The Water Framework Directive (WFD) (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) aims to establish a framework for the protection of fresh water, transitional waters, coastal waters and groundwater in the EU to protect and enhance the status of aquatic ecosystems and promote sustainable water consumption based on long-term protection of available water resources. Its overall objective is to achieve 'good ecological status' of surface waters by 2015. The Directive places the protection of aquatic ecosystems at the centre of its objectives, providing a powerful platform for biodiversity conservation (Tucker and de Soye, 2009).

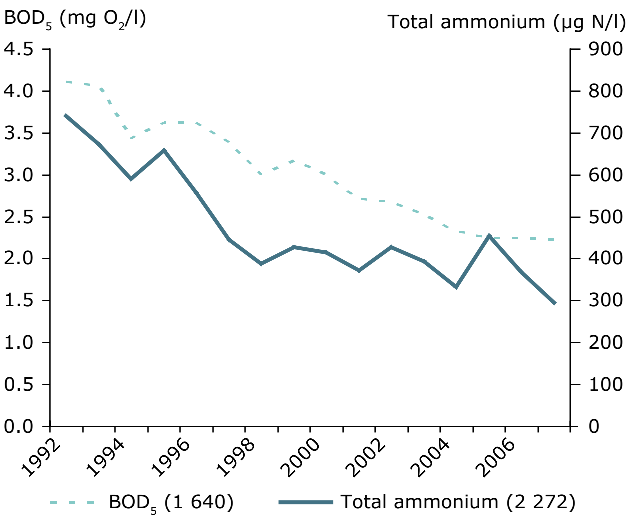
Map 11.1 Exceedance of critical loads ([43]) for eutrophication due to the deposition of nutrient nitrogen in 2010



- The critical load of nutrient nitrogen is exceeded by more than 1 200 equivalents nitrogen per hectare and year in western France, some parts of Belgium, the Netherlands, and the North of Italy.

Source: Coordination Centre for Effects (CCE), European Critical Loads Database 2008; SEBI indicators, 2010 — SEBI indicator 09 ([44]).

Figure 11.8 Biochemical oxygen demand (BOD_5) and total ammonium concentrations between 1992 and 2007



- Between 1992 and 2007, BOD5 decreased from 4 to 2 mg O_2/l; ammonium declined from 700 to 300 µg N/l (SEBI indicators, 2010).

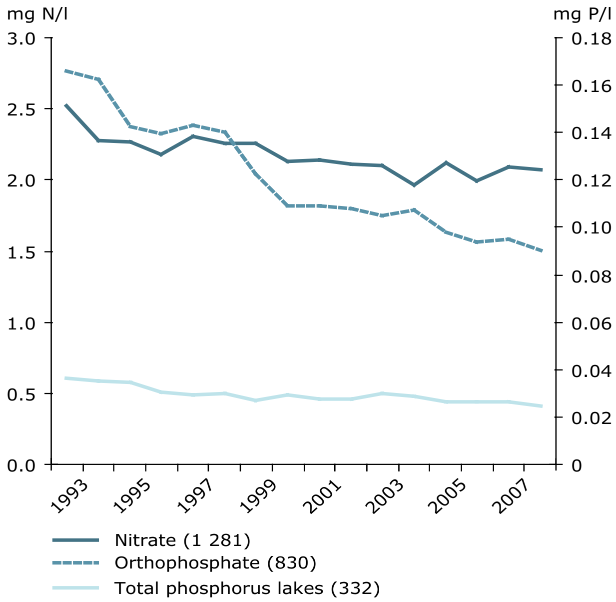
Note: Geographical coverage: Albania, Austria, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Latvia, Lithuania, Luxembourg, the former Yugoslavian Republic of Macedonia, the Netherlands, Norway, Poland, Slovakia, Slovenia, Spain, Sweden, the United Kingdom.

Source: Waterbase Version 9; SEBI indicators, 2010 — SEBI indicator 16.

([43]) The critical load of nutrient is defined as 'the highest deposition of nitrogen as NO_X and/or NH_Y below which harmful effects in ecosystem structure and function do not occur according to present knowledge' (ICP, M&M, 2004 in EEA, 2009).

([44]) www.eea.europa.eu/data-and-maps/figures/exceedance-of-critical-loads-for-eutrophication-due-to-the-deposition-of-nutrient-nitrogen-in-2010

Figure 11.9 Concentrations of nitrate and orthophosphate in rivers and total phosphorus in lakes in the period 1992–2007



- The average nitrate concentration in European rivers has decreased from 2.5 to 2.1 mg N/l since 1992.
- Nutrient levels in lakes are in general much lower than in rivers, but there has also been a 15 % reduction of the average concentrations in lakes.
- Phosphorus concentrations in European rivers and lakes generally decreased during the last 15 years.
- Between 2004 and 2007, nitrate concentrations in surface water remained stable or fell at 70 % of monitored sites; quality at 66 % of groundwater monitoring points is stable or improving (EU, 2010).

Source: EBI indicators, 2010.

Note: Total number of stations in parenthesis. Concentrations are expressed as weighted means of annual mean concentrations for rivers and lakes. Only stations with time series consisting of a minimum of seven years are included.

Geographical coverage:

Nitrate in rivers: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Lithuania, Luxembourg, Norway, Poland, Slovakia, Slovenia, Spain, Sweden, Switzerland.

Orthophosphate in rivers: Austria, Belgium, Bulgaria, Denmark, Estonia, Finland, France, Germany, Lithuania, Luxembourg, Norway, Slovakia, Slovenia, Spain, Sweden, Switzerland.

Total phosphorus in lakes: Austria, Denmark, Estonia, Finland, Hungary, Ireland, Lithuania, Latvia, Slovenia, Sweden, Switzerland.

Source: Waterbase (version 9); SEBI indicators, 2010 — SEBI indicator 16.

11.3 Over-exploitation

The unsustainable use of natural resources and over-exploitation which occurs when harvesting exceeds reproduction of wild plant and animal species, continues to be major a threat to biodiversity (CBD, 2010b).

The consumption of resources and the generation of waste by Europeans create indirect drivers that lead to habitat loss or damage, over-exploitation, pollution, invasion by alien species, and climate change. Thus, the ultimate drivers of threats to biodiversity are human demands for food, fibre and timber, water, energy, and area on which to build infrastructure. The **Ecological Footprint** measures the demands that the consumption of resources places on the regenerative capacity of productive ecosystems (BIP, 2010). It does this by assessing the biologically productive land and marine area required to produce the resources consumed and to absorb the corresponding waste, using available technology (TEEB, 2009).

Overall, biological resources use and waste emission is well above the biological capacity available within Europe, showing that the continent cannot sustainably meet its consumption demands within its own borders. The EU-27 on its own has a Footprint of 4.7 global ha per person, twice the size of its biocapacity (EEA, 2009). Europe's high per capita consumption and waste production means that its impact also extends well beyond its borders (EC, 2008).

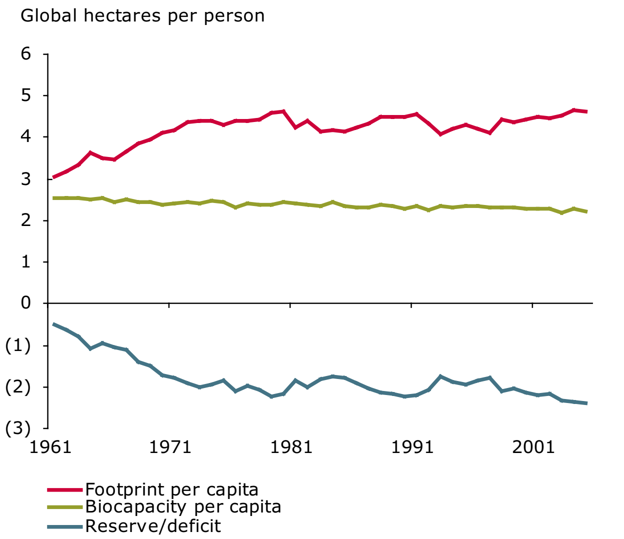
Overfishing is still widespread across the pan-European region with 88 % of Community fish stocks fished beyond maximum sustainable yields (meaning that less fishing pressure now would allow stocks to recover); 46 % of Community fish stocks are overfished outside safe biological limits that may not allow their recovery (EEA, 2010c). The consequences include increased vulnerability to other pressures, especially pollution and climate change (EEA, 2007 in EEA, 2010c).

Non-sustainable forest management, intensification measures, the drainage of peatlands and wet forest, fertilisation and forest-tree genetic 'improvement' have had a particularly negative effect on the biodiversity values of forests (EEA, 2008b). Whilst wood harvesting in the EU is largely sustainable, dead wood (which is a key indicator for forest biodiversity and the conservation value of a forest) remains well below optimal levels from a biodiversity perspective in most European countries (EEA, 2009). On the other hand, game populations are so dense in many continental forests due to game management practices that large areas of forest are subject to damage by wildlife and grazing, affecting young tree populations and forest regeneration (EEA, 2008b).

Intensive agriculture, as practiced in many parts of Europe, is centred on crop monoculture with minimisation of associated species. These systems offer high yields of single products, but depend on high rates of use of fertilisers and pesticides. The maintenance of high productivity over time is unlikely to be sustainable in the face of disturbance, disease, soil erosion and overuse of natural capital (for example water). In relation to soil erosion, current agriculture methods accelerate soil loss rates to as high as 4 mm per year, up to 100 times faster than the rate of soil production (EASAC, 2009).

Pressures on European water resources have increased in recent decades and, in many locations, agriculture, public water supply, hydropower and tourism pose a threat to water resources, with demand often exceeding availability. The increase in artificial storage volumes in turn reduces the share of water allocated to natural systems and increases their fragmentation because of damming. Over-abstraction and prolonged periods of low rainfall or drought have frequently reduced or dried out river flows, lowered lake and groundwater levels and dried up wetlands. In addition, salt water increasingly intrudes into 'over-pumped' aquifers throughout Europe (EEA, 2010a).

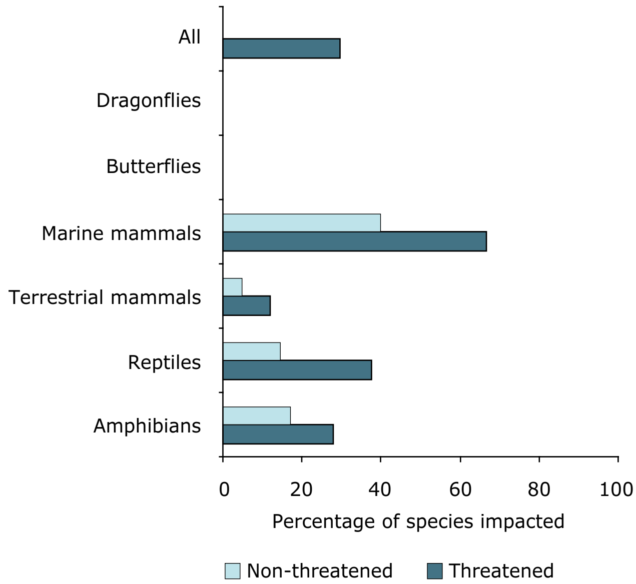
Figure 11.10 European Ecological Footprint, biocapacity and reserve or deficit



- The average per capita Ecological Footprint in the European Union has increased more than 50 % since 1961.
- Europe is currently consuming double what its land and seas can produce.

Source: Global Footprint Network, National Footprint Accounts 2009 Edition;
SEBI indicators, 2010 — SEBI indicator 23.

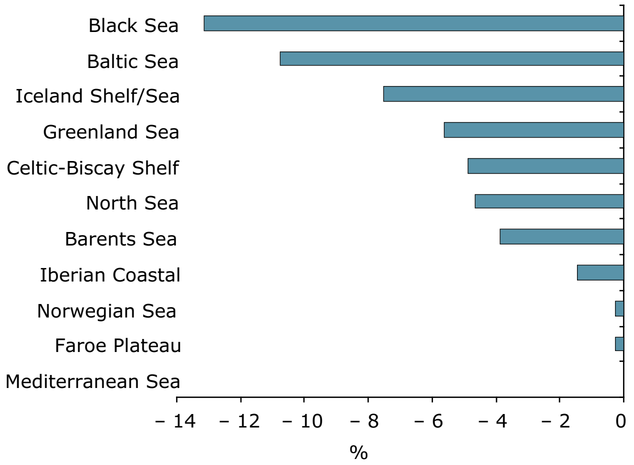
Figure 11.11 Impact of over-exploitation on species at EU level



- Nearly 70 % of threatened marine mammals are impacted by over-exploitation (although indirectly, e.g. by-catch) (Temple et al., 2007).
- Proportionately, threatened species (nearly 40 %) are impacted more than non-threatened species (just under 15 %) in reptiles, significantly more than in any other group.
- At present, there is no European Fish Red list.

Source: IUCN, 2007, 2009, 2010.

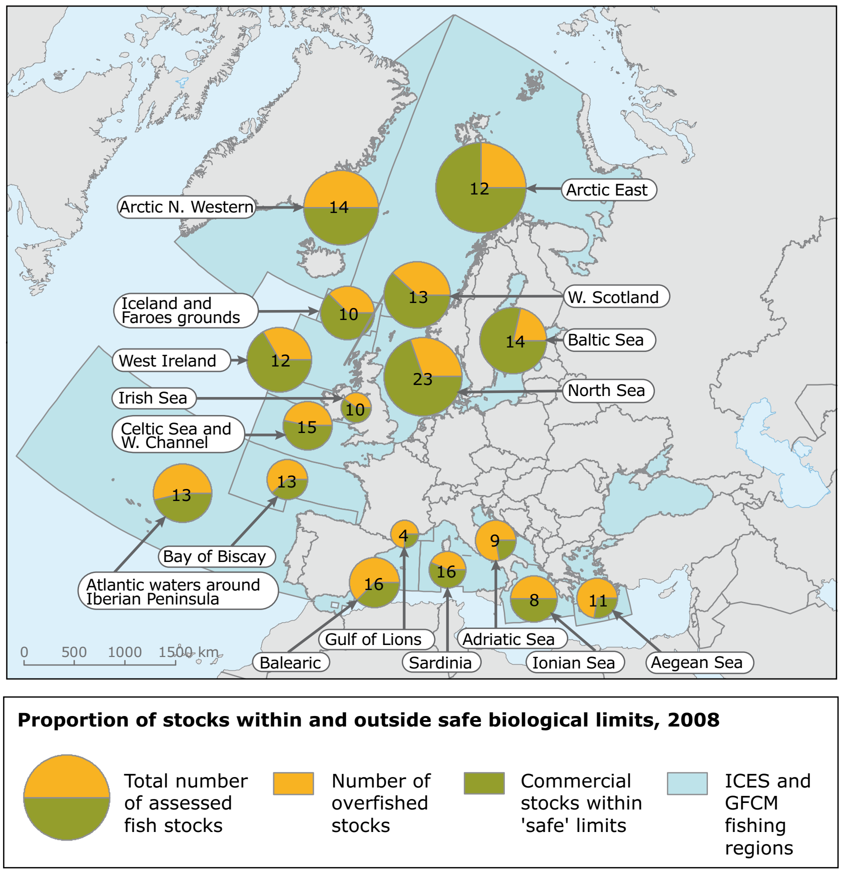
Figure 11.12 Marine Trophic Index (45) change between 1950 and 2004



- In the majority of European seas, the Marine Trophic Index has been declining since the mid 1950s, which means that populations of predatory fish are declining and populations of smaller fish and invertebrates are increasing and fisheries are not exploiting the resources sustainably (EEA, 2009).

Source: Sea Around Us Project (www.seaaroundus.org); SEBI indicators, 2010 — SEBI indicator 12.

Map 11.2 Status of fish stocks (46) in International Council for the Exploration of the Sea (ICES) and General Fisheries Commission for the Mediterranean (GFCM) fishing regions of Europe in 2008



- About 46 % of the assessed European commercial fish stocks are outside safe biological limits (SBL).
- Of the assessed commercial fish stocks in the North-East Atlantic Ocean, 25 % (Arctic Sea) to 62 % (Bay of Biscay) are outside SBL.
- In the Baltic Sea, 21 % of fish stocks are outside SBL.
- In the Mediterranean Sea, the percentage of stocks outside SBL ranges from 50 % to 78 %, with the Adriatic Sea in the worst condition.

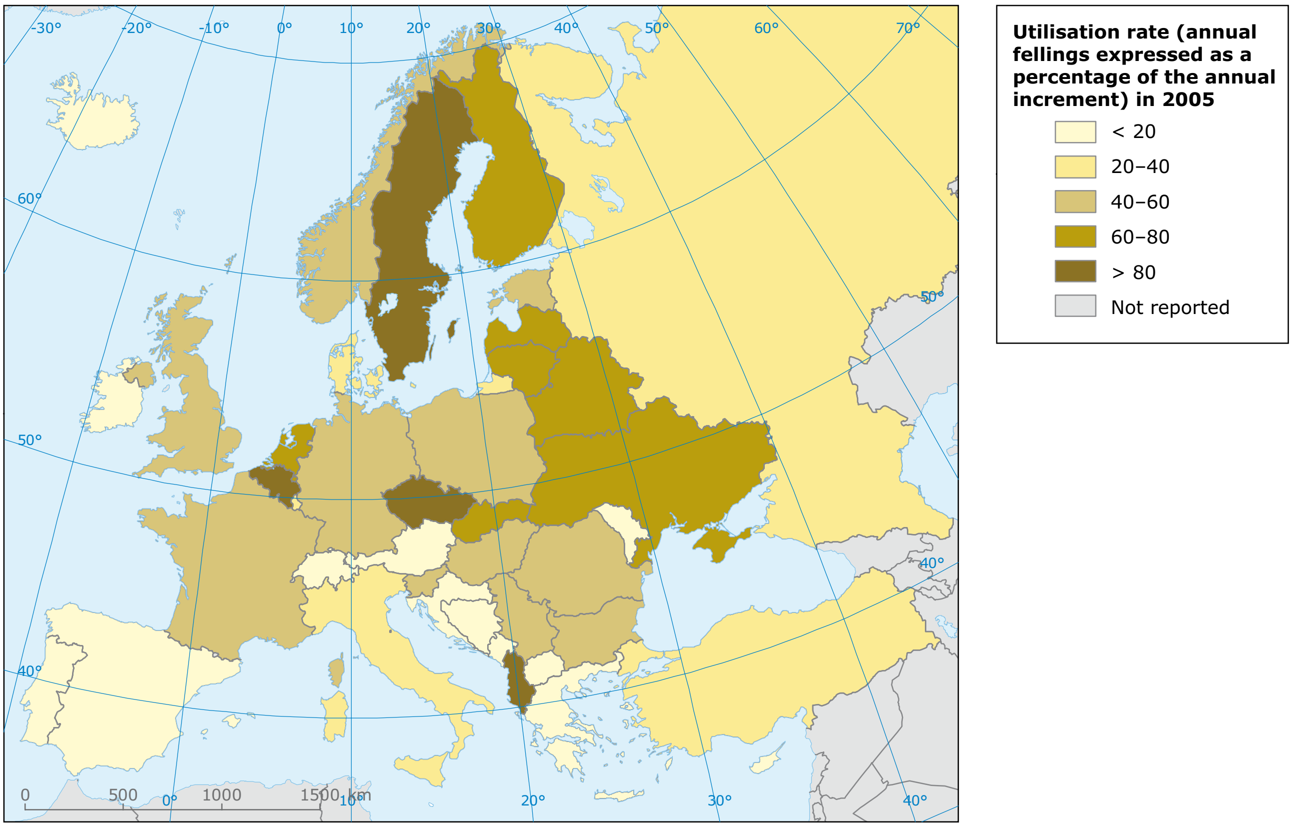
Note: The chart shows the proportion of assessed stocks that are overfished (red) and stocks within safe biological limits (blue). The numbers in the circles indicate the number of stocks assessed within the given region. The size of the circles is proportional to the magnitude of the regional catch.

Source: GFCM (2005) and ICES (2008); SEBI indicators, 2010 — SEBI indicator 21.

(45) The Marine Trophic Index (MTI), or mean trophic level of fisheries landings, was established to investigate the impact of fisheries on the world's marine ecosystems. The MTI expresses the average position of marine creatures in the food chain. Fisheries target first the most valuable species which are usually large predators that occupy high positions on the food chain. Overfishing of these species progressively moves catches down to the food chain to invertebrates and smaller fish. This is reflected in a decrease in the MTI.

(46) The chart shows the proportion of assessed stocks that are overfished (red) and stocks within safe biological limits (blue). The numbers in the circles indicate the number of stocks assessed within the given region. The size of the circles is proportional to the magnitude of the regional catch.

Map 11.3 **Utilisation rate in 2005 (% of annual felling compared with net annual increment in growing stock) for Ministerial Conference on the Protection of Forests in Europe (MCPFE) countries**



- The ratio of felling to increment is relatively stable at around 60 %, being higher than 80 % only in Albania, Belgium, the Czech Republic and Sweden.
- The utilisation rate varies considerably between countries, but remains generally below the sustainability limit of 100 % (EEA, 2009).

Source: Based on MCPFE, 2007; SEBI indicators, 2010 — SEBI indicator 17.

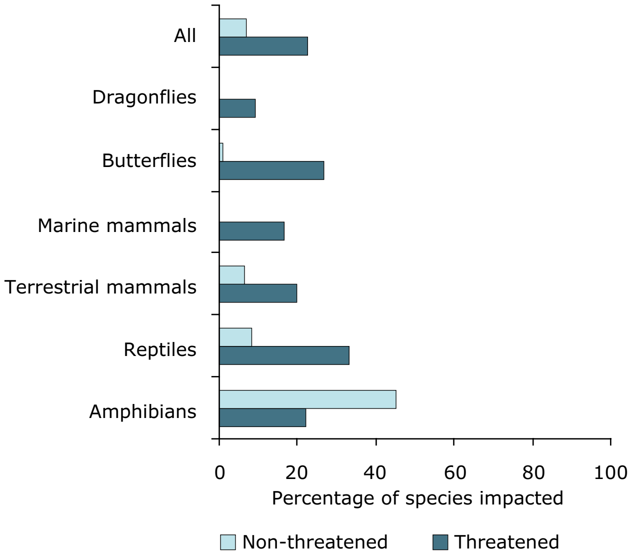
11.4 Invasive alien species

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 (after direct habitat loss or destruction) (Shine et al., 2009); even though from Figure 11.1, it can be seen that in the EU habitat loss and degradation and pollution are currently more impacting than IAS.

About 10 000 alien species have been registered in terrestrial, freshwater and marine/coastal ecosystems in Europe. This number includes species native in some European countries but not native in other European countries. It also includes species introduced for reasons of agricultural and timber production. However, a proportion of the alien species established can potentially cause significant damage to native biodiversity and can be classified as invasive alien species according to the Convention on Biological Diversity (EEA, 2009). Invasive species can cause great damage to native species by competing with them for food, eating them, spreading diseases, causing genetic changes through inter-breeding with them and disrupting various aspects of the food web and the physical environment (EEA, 2010b).

There is an upward trend in the establishment of new species, with impacts on biodiversity expected to increase because of the growing number of species involved, and an increasing vulnerability of ecosystems to invasions, which results from other pressures such as habitat loss, degradation, fragmentation, over-exploitation and climate change (EEA, 2009).

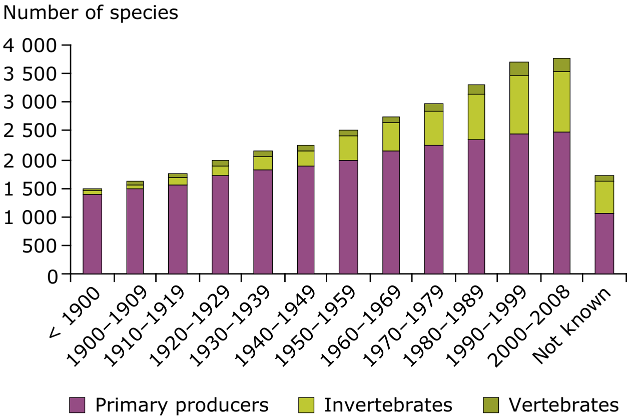
Figure 11.13 Impacts of invasive alien species on species at EU level



- Threatened reptiles (almost 35 % of species) and butterflies (more than 25 % of species) are the threatened groups most impacted by invasive alien species.
- Invasive alien species impact exclusively on threatened species in the marine mammals and the dragonflies.
- Concerning amphibians, non-threatened species (approximately 45 %) are impacted by invasive alien species proportionately more than threatened species.

Source: IUCN, 2007, 2009, 2010.

Figure 11.14 Cumulative number of alien species established in terrestrial environment in 11 countries ([47])



- The cumulative number of alien species present in Europe has been constantly increasing since the 1900s.
- In the 2000s, the total number of terrestrial alien species reached more than 3 500 species (EEA, 2009).

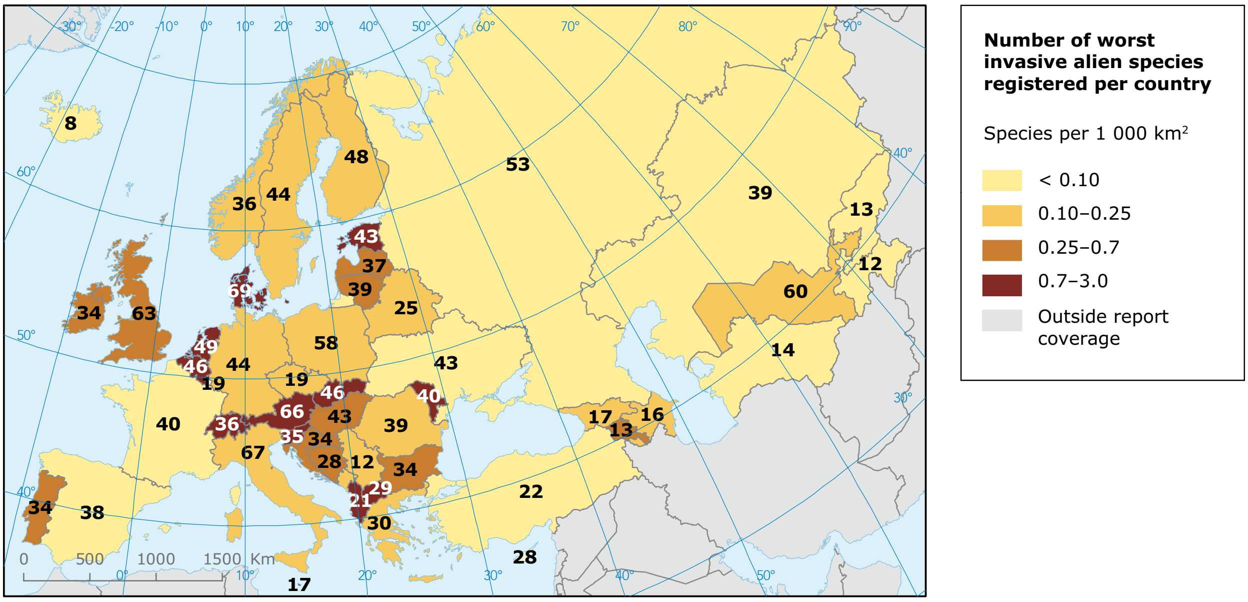
Source: EEA/SEBI2010; NOBANIS; SEBI indicators, 2010 — SEBI indicator 10.

Globalisation, particularly increased trade and tourism, has resulted in an upsurge in the number and type of alien species arriving in Europe. Marine and coastal areas are being affected as a result of increased shipping and the building of canals between isolated seas; the Suez Canal remains a major source of new species entering the Mediterranean Sea. Released ballast water from ships is such a major source of new organisms that the International Convention for the Control and Management of Ships Ballast Water and Sediments has been established to 'prevent, minimise and ultimately eliminate the transfer of harmful aquatic organisms and pathogens' (EEA, 2010b).

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, 2010b).

([47]) Geographic coverage: Denmark, Estonia, Finland, Germany, Iceland, Latvia, Lithuania, Poland, Norway, Russia and Sweden.

Map 11.4 **Number ([48]) of species listed as 'worst invasive alien species threatening biodiversity in Europe' per country**



- Denmark, Italy, Austria and the United Kingdom have the highest number of worst invasive species with more than 60 species registered per country.

Source: EEA/SEBI2010, 2006; SEBI indicators, 2010 — SEBI indicator 10.

11.5 Climate change

Climate change impacts on biodiversity and ecosystems are now considered likely to be greater than initial forecasts; it aggravates the impacts from other pressures and creates additional problems, many of which not yet fully evaluated. Although scientists indicate that ecosystems will be able to adapt to a certain extent to rising temperatures, the combination of human-induced pressures and climate change will increase the risk of losing numerous systems (TEEB, 2009).

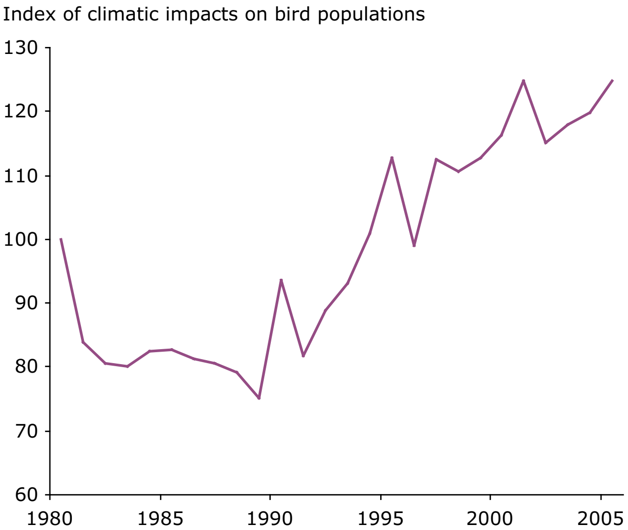
According to reports submitted by 25 EU Member States under Article 17 of the Habitats Directive, climate change is having a negative impact on the conservation status of 42 habitat types (19 %) and 144 species (12 %) included in the Annexes. Wetland habitats, such as bogs, mires and fens, are among the most affected by climate change, with dune habitats also affected negatively. Six of the 12 bog, mire and fen habitat types protected by the Habitats Directive are reported by the Member States to be affected by climate change (ETC/BD, 2009a in EEA, 2010a). Of the major groups of species, amphibians react most strongly to climate change (EEA, 2010a).

Climate change, in particular milder winters, is responsible for the observed northward and uphill distribution shifts of many European plant species. By 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 60 % of mountain plant species may face extinction. The timing of seasonal events in plants is also changing across Europe, due mainly to changes in climatic conditions (EEA, 2008a).

European birds, insects, mammals, freshwater species and other groups are moving northwards and uphill, largely in response to observed climate change. 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, 2008a).

([48]) The numbers in the map indicate how many species from the list are present in each country.

Figure 11.15 Climatic impact indicator ([49]) for European birds



- The impact of climate change on widespread bird populations has increased strongly in the past 20 years.
- The number of bird species whose populations are observed to be negatively impacted by climate change is three times larger than those observed to be positively affected by climate warming in the set of widespread European land birds (EEA, 2009).

Note: Geographical coverage: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, the Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, the United Kingdom.

Source: Gregory et al., 2009; SEBI indicators, 2010 — SEBI indicator 11.

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([49]) The Climatic Impact Indicator (CII) measures the divergence between the population trends of bird species projected to expand their range and those predicted to shrink their range due to climate change (EEA, 2009).

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12 Ecosystem services

'Ecosystem services' are the direct and indirect contributions of ecosystems to human well-being (TEEB, 2009). They support directly or indirectly our survival and quality of life (Harrison and the RUBICODE consortium, 2009).

The current knowledge and data on ecosystem services at EU level (and globally!) is not sufficient to provide comprehensive facts and figures, thus does not allow the fixing a baseline; however, recent research provides valuable information on their qualitative status and trends, which is sufficient to target future policy priorities and action.

Ecosystem services can be categorised in four main types:

- provisioning services
- regulating services
- habitat services ([50])
- cultural services.

Provisioning services are the products obtained from ecosystems such as food, fresh water, wood, fibre, genetic resources and medicines. Regulating services are defined as the benefits obtained from the regulation of ecosystem processes such as climate regulation, natural hazard regulation, water purification and waste management, pollination or pest control. Habitat services highlight the importance of ecosystems to provide habitat for migratory species and to maintain the viability of gene-pools. Cultural services include non-material benefits that people obtain from ecosystems such as spiritual enrichment, intellectual development, recreation and aesthetic values.

There are few studies valuating ecosystem services in Europe, but several are available for other continents and regions ([51]). For Europe, the RUBICODE project has produced some qualitative and quantitative valuations, which have been used in this report.

Table 12.1 List of ecosystem services according to TEEB

Main service-types	
	Provisioning services
1	Food (e.g. fish, game, fruit)
2	Water (e.g. for drinking, irrigation, cooling)
3	Raw materials (e.g. fibre, timber, fuel wood, fodder, fertiliser)
4	Genetic resources (e.g. crop improvement and medicinal purposes)
5	Medicinal resources (e.g. biochemical products, models and test organisms)
6	Ornamental resources (e.g. artisan work, decorative plants, pet animals, fashion)
	Regulating services
7	Air quality regulation (e.g. capturing (fine) dust, chemicals, etc.)
8	Climate regulation (included carbon sequestration, influence of vegetation on rainfall, etc.)
9	Moderation of extreme events (e.g. storm protection and flood prevention)
10	Regulation of water flows (e.g. natural drainage, irrigation and drought prevention)
11	Waste treatment (especially water purification)
12	Erosion prevention
13	Maintenance of soil fertility (including soil formation)
14	Pollination
15	Biological control (e.g. seed dispersal, pest and disease control)
	Habitat services
16	Maintenance of life cycles of migratory species (including nursery services)
17	Maintenance of genetic diversity (especially gene pool protection)
	Cultural services
18	Aesthetic information
19	Opportunities for recreation and tourism
20	Inspiration for culture, art and design
21	Spiritual experience
22	Information for cognitive development

Source: TEEB, 2009.

([50]) Also designated as 'supporting services', namely in the framework of the Millennium Ecosystem Assessment.
([51]) Millennium Ecosystem Assessment (www.millenniumassessment.org/en/Multiscale.aspx) and TEEB (www.teeb.org).

Managed ecosystems such as agro-ecosystems, forests, lakes and rivers mainly offer provisioning services (food, livestock, biofuels, wood and fresh water); agro-ecosystems in Europe have a total annual economic value of around EUR 150 billion (Gallai et al., 2009 in Harrison et al., 2010) and European roundwood production in 2007 was 728 million m^3 (33.8 % of global production). Semi-natural ecosystems such as grasslands, heath and scrub ecosystems and forests are key providers of genetic resources. 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).

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 fresh water; flood plains retain floods and regulate excess of nutrients from agricultural practices (Harrison et al., 2010).

Grasslands, forests, wetlands, heath and scrub and lake and river ecosystems are key providers of cultural services such as aesthetic values and sense of place, recreation and ecotourism.

Regarding human use, 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 (Harrison et al., 2010).

The majority of ecosystem services show either a degraded or mixed (i.e. degraded in some regions, enhanced in other) status across Europe. However, there are some exceptions such as timber production and climate regulation in forests.

Human use and the status of crops and livestock increased significantly between 1950 and 1990. However, from 1990 to the present, there has been a mixed trend for the status of crops and livestock production across Europe. The status of wild foods, genetic resources, pollination, pest regulation and cultural services in **agro-ecosystems** was degraded from 1950 to 1990; pollination, pest regulation and cultural services have had mixed trends since 1990.

Over 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). However, the importance of wild pollinators for agricultural production is being increasingly recognised and wild pollinators may also interact with managed bees to increase crop productivity (Greenleaf and Kremen, 2006; Kremen et al., 2007, in TEEB, 2009); to support this argument, there is strong evidence that loss of pollinators reduces crop yield (EASAC, 2009). Conserving pollinators in habitats adjacent to agriculture improves both the level and the stability of pollination services (Klein et al., 2003 in TEEB, 2009).

Habitat destruction and deterioration with the increased use of pesticides has diminished the abundance and diversity of many insect pollinators (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 may occur when when their habitat is destroyed to such an extent (reducing landscape diversity and increasing land-use intensity) that a population crash in multiple pollinators may be realised (TEEB, 2009).

Timber production in Europe has increased since 1950. **Forest** status has, in general, been enhanced since 1990, which, in combination with reforestation and afforestation across Europe, has resulted in an increase in carbon sequestration. However, the provision of wild foods, freshwater and pollination services has been degraded since 1990. Livestock production in forest ecosystems has decreased since the 1950s and other services such as wood fuel, erosion and water regulation and cultural services show a mixed trend.

All ecosystem services provided by **grasslands** show a degraded status since 1990. The number and size of semi-natural grasslands have declined in Europe since the 1950s resulting in a decreased or mixed trend in their human use.

Losses in **heath and scrub** area in Europe have led to a degraded status of many of the services provided

Figure 12.1 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)	(Not applicable)	(Not applicable)	↓ (Degraded)	(Not applicable)
Livestock	↓ (Mixed)	= (Degraded)	= (Degraded)	= (Degraded)	↓ (Degraded)	(Not applicable)
Wild Foods	= (Degraded)	↓ (Degraded)	↓ (Degraded)	(Unknown)	= (Mixed)	(Unknown)
Wood fuel	(Not applicable)	= (Mixed)	(Not applicable)	= (Degraded)	(Not applicable)	(Not applicable)
Capture fisheries	(Not applicable)	(Not applicable)	(Not applicable)	(Not applicable)	= (Degraded)	= (Degraded)
Aquaculture	(Not applicable)	(Not applicable)	(Not applicable)	(Not applicable)	↓ (Degraded)	↓ (Degraded)
Genetic	= (Degraded)	↓ (Mixed)	↓ (Degraded)	= (Degraded)	= (Mixed)	(Unknown)
Fresh water	(Not applicable)	↓ (Degraded)	(Unknown)	(Unknown)	↑ (Mixed)	↑ (Mixed)
Regulating						
Pollination	↑ (Mixed)	↓ (Degraded)	= (Degraded)	(Unknown)	(Not applicable)	(Not applicable)
Climate regulation	(Not applicable)	↑ (Enhanced)	(Unknown)	= (Mixed)	= (Degraded)	= (Degraded)
Pest regulation	↑ (Mixed)	(Unknown)	= (Degraded)	(Not applicable)	(Unknown)	(Not applicable)
Erosion regulation	(Not applicable)	= (Mixed)	= (Degraded)	= (Degraded)	(Unknown)	(Unknown)
Water regulation	(Unknown)	= (Mixed)	(Unknown)	↑ (Mixed)	↑ (Enhanced)	= (Degraded)
Water purification	(Not applicable)	(Unknown)	(Unknown)	(Unknown)	= (Mixed)	= (Degraded)
Hazard regulation	(Not applicable)	(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.

by those ecosystems since the 1950s; including livestock production, wood fuel, genetic resources and erosion regulation. However, since the 1990s, there has been a mixed trend in climate regulation, water regulation and recreation services.

Large decreases in the surface area of **wetlands** across Europe between 1950 and 1980 decreased their ability to provide and store fresh water and regulate the climate; the use of fisheries declined as well before 1990. In contrast, agricultural production in wetland ecosystems increased. More recent changes in wetland areas show a regionally mixed trend in their use and the status of their services. Water retention has been enhanced in a number of cases through restoration measures and recreation and aesthetic values in wetlands have increased since the 1950s. Livestock, crop production and aquaculture show a degraded status since 1990.

The status of almost all services associated with **lake and river ecosystems** has been degraded since the 1950s. Demand for flood protection, water regulation, recreation and ecotourism has increased significantly in Europe since the 1950s, but key regulating services such as water purification and flood control continue to be degraded. The use of fresh water from rivers and lakes in Europe has increased since the 1950s. In spite of the trend having slightly reversed since 1990, the total freshwater abstraction is still at a high level in Europe. Regarding freshwater capture fisheries and aquaculture, its use increased from 1950 to 1990 and then decreased slightly (Harrison et al., 2010).

Some examples of key services provided by ecosystems are now described.

- **Climate regulation** is one of the most important ecosystem services both globally and on a European scale. European ecosystems play a major role in climate regulation, since Europe's terrestrial ecosystems represent a net carbon sink of some 7–12 % of the 1995 human-generated emissions of carbon. Peat soils contain the largest single store of carbon and Europe has large areas in its boreal and cool temperate zones (EASAC, 2009) and wetlands may account for as much as 40 % of the global reserve of terrestrial carbon (Sheng et al., 2004 and Silva et al., 2007 in Harrison et al., 2010). However, the climate-regulating function of peatlands depends on land use and intensification (such as drainage and conversion to agriculture) which is likely to have profound impacts on the soil capacity to store carbon and on carbon emissions (great quantities of carbon are being lost from drained peatlands).

Considering the area of drained peatlands, peatland restoration may represent an important factor in enhancing carbon sequestration (EASAC, 2009). In addition, the carbon sequestration capacity in cultivated soils in Europe could be enhanced by increasing organic matter inputs on arable land, the expansion of organic and low-input farming, raising of water tables in farmed peatland and the introduction of zero or conservation tillage (EASAC, 2009). Indeed, increased stocks of carbon in agricultural systems can represent a win-win situation 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).

- Water purification in ecosystems has a high importance for Europe because of the heavy pressure on water from a relatively densely populated region. Both vegetation and soil organisms have profound impacts on water movements: vegetation is a major factor in controlling floods, water flows and water quality; vegetation cover in upstream watersheds can affect quantity, quality and variability of water supply; soil micro-organisms are important in water purification; and soil invertebrates influence soil structure, decreasing surface run-off (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).

- Cultural services provided by ecosystems are also very important to EU citizens. Evidence can be found in the scale of membership of conservation organisations. For example, in the United Kingdom the Royal Society for the Protection of Birds has a membership of over one million and an annual income of over GBP 50 million (EASAC, 2009).

- Although most people associate them mainly with nature conservation and tourism, well-managed protected areas can provide vital ecosystem services. For example, marine protected areas maintain food security by increasing resource productivity and sustainability. Several studies have found that fish populations, size and biomass all dramatically increase inside marine reserves, in particular when a policy of 'no take' is applied; this has allowed 'spillover' to nearby fishing grounds with a consequent revitalisation of catches and benefits for coastal fishing communities and fishing fleets (TEEB, 2009). In addition, protected areas can also generate benefits: thus in Scotland, the public benefits of protecting the Natura 2000 network of protected areas are estimated to be more than three times greater than the costs, including direct management and opportunity costs (Jacobs, 2004 in TEEB, 2009).

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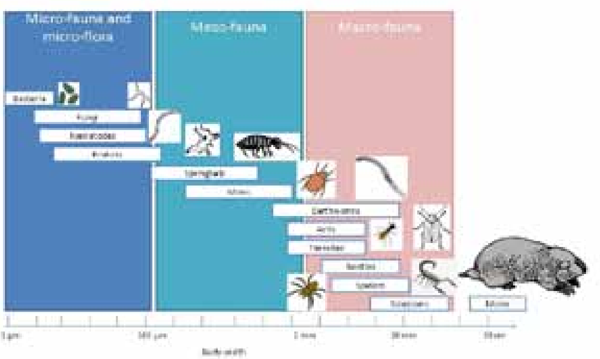
13 Soil biodiversity

Soil biodiversity is defined by the variation in soil life, from genes to communities, and the variation in soil habitats, from micro-aggregates to entire landscape.

Soil represents one of the most important reservoirs of biodiversity. Indeed, the biological diversity in soils, specific or genetic, is several orders of magnitude higher than that found above ground (Heywood and Baste, 1995). Over one quarter of all living species on Earth are strict soil or litter dwellers (Decaens, Jimenez et al., 2006).

The soil depends on the presence of a vast community of living organisms to stay fertile. These organisms constitute soil biodiversity. When supplied with sufficient raw material (dead organic matter), they get to work decomposing the waste to produce humus — complex organic matter containing the nutrients necessary to sustain plants. Humus cannot be made by man: it is created by soil biodiversity. Soil organisms work the sand, clay or silt, forming new structures and habitats which aerate the soil and allow water to permeate through it. The work done by soil organisms also enables soil to store and release carbon, helping to regulate the flux of greenhouse gases and thus the global climate system. A similarly vital role of soil biodiversity is to purify and store water. As water infiltrates the ground, contaminants are absorbed by soil particles, making the water both clean and safe. However, this purification capacity depends on the soil being rich in micro-organisms, which perform the work.

Figure 13.1 Main soil inhabitants, by size



Source: Soil biodiversity: functions, threats and tools for policymakers, Bio-Intelligence Service, IRD, and NIOO, Report for the European Commission (Directorate-General for the Environment), (http://ec.europa.eu/environment/soil/biodiversity.htm).

13.1 Status and trends

Data on soil biodiversity status are limited and non-exhaustive. Some of the ongoing initiatives at European level have been described by Gardi et al. (2009). In the Netherlands, for instance, a detailed characterisation of soil biodiversity, for the main soil and agricultural land-use types, has been carried out (Rutgers et al., 2008). In France, the project ECOMIC-RMQS assessed the soil bacterial diversity over the entire country (Dequiedt et al., 2009).

Despite these individual initiatives, one of the major differences between above ground and below ground biodiversity is that a majority of soil organisms are still unknown (see Table 13.1). For instance, it has been estimated that the currently described fauna of Nematoda, Acari and Protozoa represents less than 5 % of the total number of species (Wall et al., 2001).

The inventory activities are extremely important because they could represent the first step of a monitoring process. The main aspect, in fact, is to follow the dynamics of soil organisms' communities over time, outlining possible areas subject to decline.

In terms of research activity, there is a need to clearly identify the relationships between land management and the effects on soil biota, and from a utilitarian perspective, it would be important to identify a sort of functional threshold, below which the soil system functioning can be corrupted.

Measures of soil biodiversity status

A limited number of data concerning the dynamics of soil biodiversity are available, and these are generally referred to a few groups of soil organisms. Mushrooms are, for instance, a group of soil

Table 13.1 Estimated global number of above ground and below ground organisms

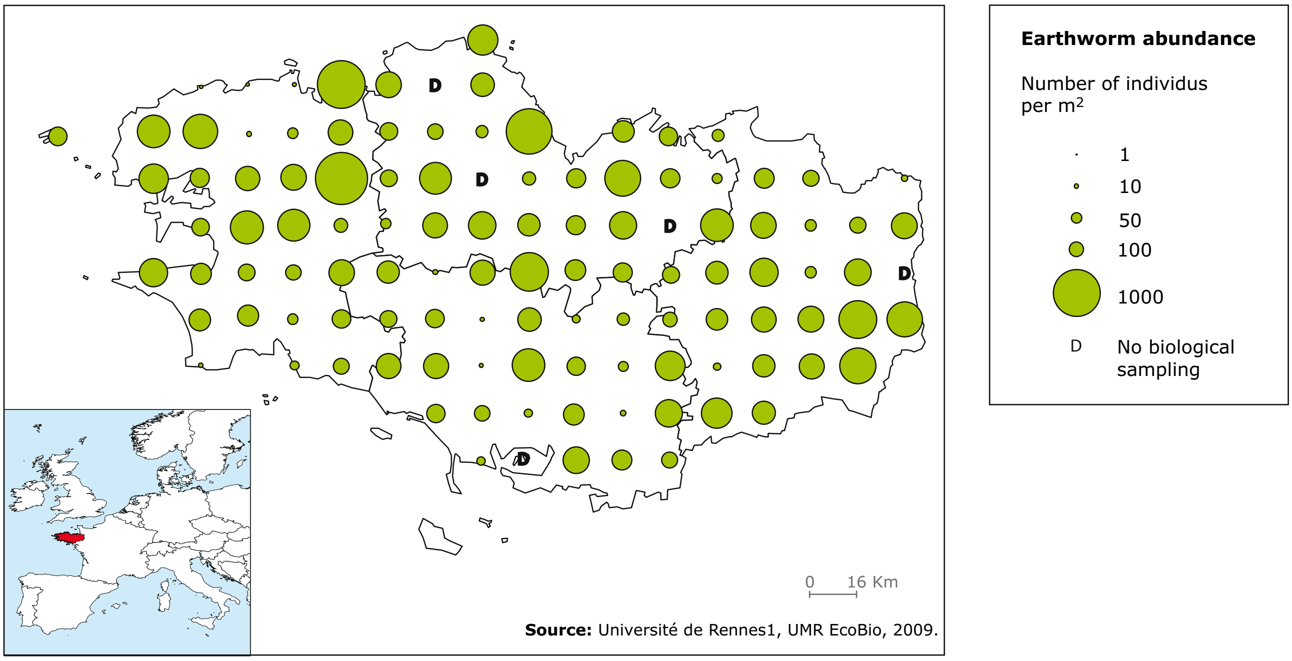
Group	Organism	Known	Known (%)
Plants	Vascular plants	270 000	84
	Earthworms	3 500	50
Micro-fauna	Mites	45 231	4
	Springtails	7 617	15
Meso-fauna	Protozoa	1 500	7.5
	Nematodes	25 000	1.3
Mico-organisms	Bacteria	10 000	1
	Fungi	72 000	1
Marine species	All marine organisms	230 000	30

Source: Adapted from De Deyn and Van der Putten, 2005, and Wall et al., 2001.

organisms for which a relative long history of records exists. From this type of data set, it has been possible to show mushrooms species decline in some European countries. For example, a 65 % decrease in mushroom species over a 20-year period has been reported in the Netherlands, and the Swiss Federal Environment Office has published the first-ever 'Red List' of mushrooms detailing 937 known species facing possible extinction in the country (Swissinfo, 2007).

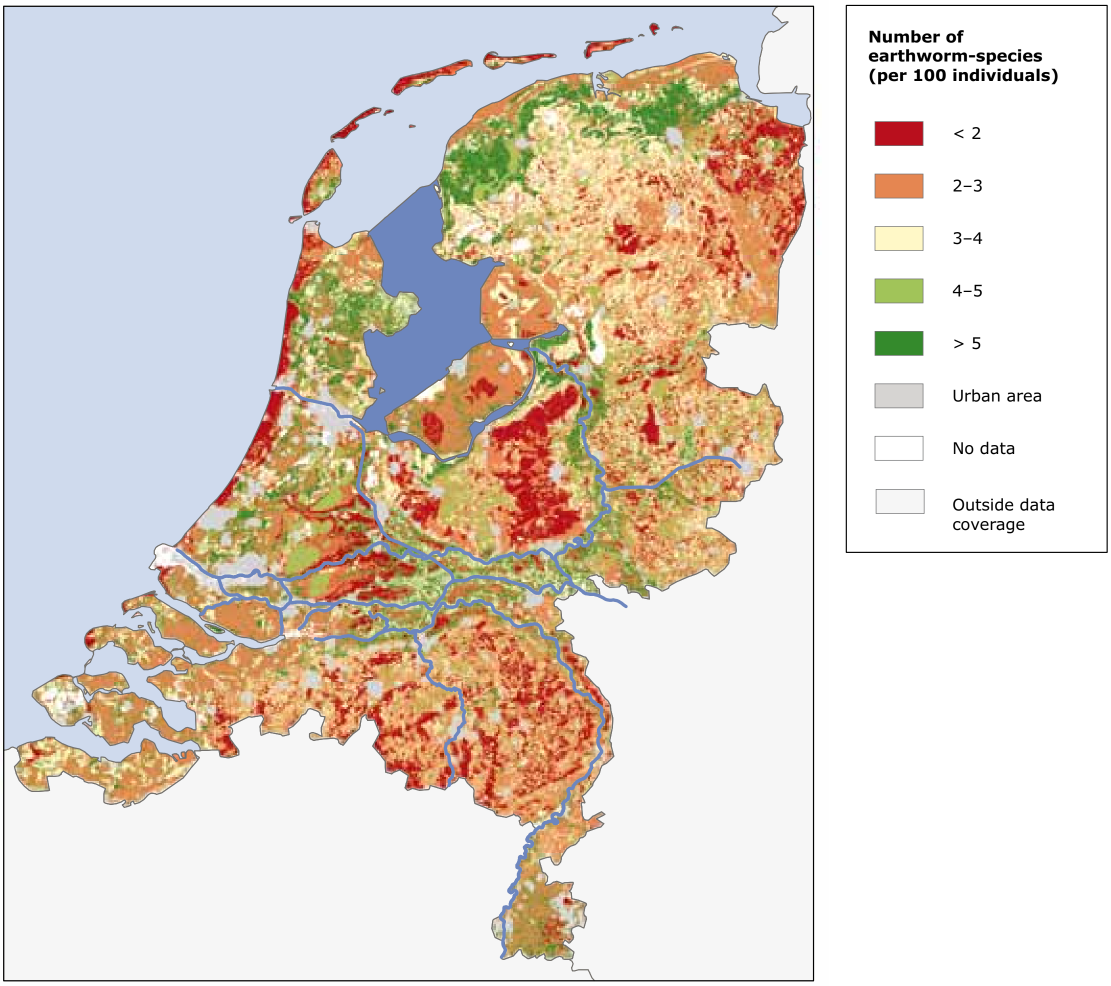
Figure 13.2 and Figure 13.3 show an estimate of earthworm diversity in Brittany and the Netherlands respectively. The disappearance of earthworm species has been reported by several research projects and studies. In a recent EU-wide sampling over half of the species identified were rare, and found only once or twice across the different sites (Watt et al., 2004). The disappearance of large endemic earthworm species has also been reported in the south of France (Abdul Rida and Bouché, 1995).

Figure 13.2 Earthworm abundance in Brittany



Source: Cluzeau et al., 2009.

Figure 13.3 Number of earthworm species (per 100 individuals)



Source: RIVM.

Additional information

- Soils are home to over one quarter of all living species on Earth, and one teaspoon of garden soil may contain thousands of species, millions of individuals, and 100 m of fungal networks. Bacterial biomass is particularly impressive and, in a temperate grassland, soil can amount to 1–2 tonnes per hectare, which is roughly equivalent to the weight of two or three cows.
- Soil is estimated to contain about 2 500 billion tonnes of carbon to a depth of 1 m. The soil organic carbon pool is the second largest carbon pool on the planet and is formed directly by soil biota or by the organic matter that accumulates due to the activity of soil biota.
- Every year, soil organisms process 2 500 kg of organic matter (the weight of 25 cars) in soil in a surface area equivalent to a football field.

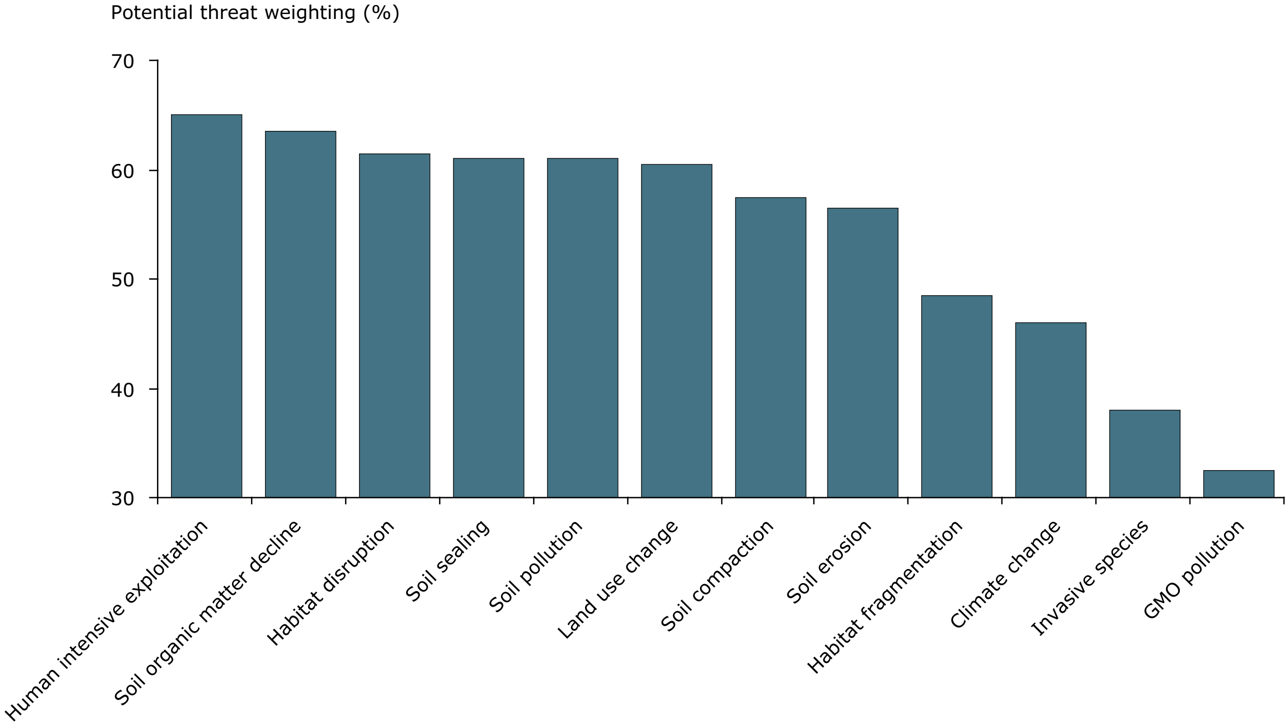
13.2 Pressures and threats

Contrary to the vast majority of living organisms, for which the processes affecting their extinction are relatively well known and understood, we have a very limited knowledge on the factors causing a decline in the diversity and abundance of soil organisms.

Overall, all the processes leading to soil degradation (decline of organic matter, salinisation, contamination, etc.) have negative impacts on soil biodiversity.

- Decline of soil organic matter: around 45 % of soils in Europe have a low or very low organic matter content (meaning 0–2 % organic carbon) and 45 % have a medium content (meaning 2–6 % organic carbon). The decline of soil organic matter influences the activity

Figure 13.4 The relative importance of soil biodiversity threats on the basis of expert judgement



Source: Jeffery et al., 2010.

and diversity of soil organisms which are also affected by the reduction in plant diversity and productivity. This has implications for carbon storage, nutrient cycling and fertility services.

- Salinisation: around 3.8 million ha in Europe is affected by salinisation. Salinisation of the soil due, for example, to inappropriate soil irrigation practices, causes organisms to either enter an inactive state or die.
- Compaction: estimates of areas at risk of soil compaction vary. Some researchers classify around 36 % of European subsoils as having high or very high susceptibility to compaction and 18 % as moderately affected. Compaction reduces the habitats available to soil organisms as well as their access to water and oxygen.
- Sealing: on average the sealed area is around 9 % of the total area in Member States. During 1990–2000, the sealed area in the EU 15 increased by 6 %, and the demand for both new construction sites due to increased urban sprawl and transport infrastructures continues to rise. Soil sealing caused leads to a slow death of soil communities, by cutting off all water and soil organic matter inputs to below ground communities, and by putting pressure on the remaining open soils for performing all the ecosystem services.
- Contamination: the number of sites in Europe where potentially polluting activities have taken place now stands at approximately 3 000 000. Of these, around 250 000 sites need urgent remediation. The main activities causing local contamination are industrial and commercial activities and disposal and treatment of waste, although these categories vary widely across Europe. Toxic pollutants can destabilise the population dynamics of soil organisms, by affecting their reproduction, growth and survival, especially when they are bio-accumulated.

In general, the richest soil biodiversity is present in grassland soils followed by forests, cropped lands and urban lands. Thus, it is evident that changes in land use have an impact on soil biodiversity. Intensification of farming practices (e.g. use of pesticides, fertilisers, heavy machinery) has also a negative impact.

To date, an evaluation of threats to soil biodiversity on the basis of quantified data is not possible. Nevertheless, Figure 4 represents an attempt to compare the relative importance of different soil biodiversity threats on the basis of expert judgement (Soil Biodiversity Expert Workgroup of the Joint Research Centre of the European Commission).

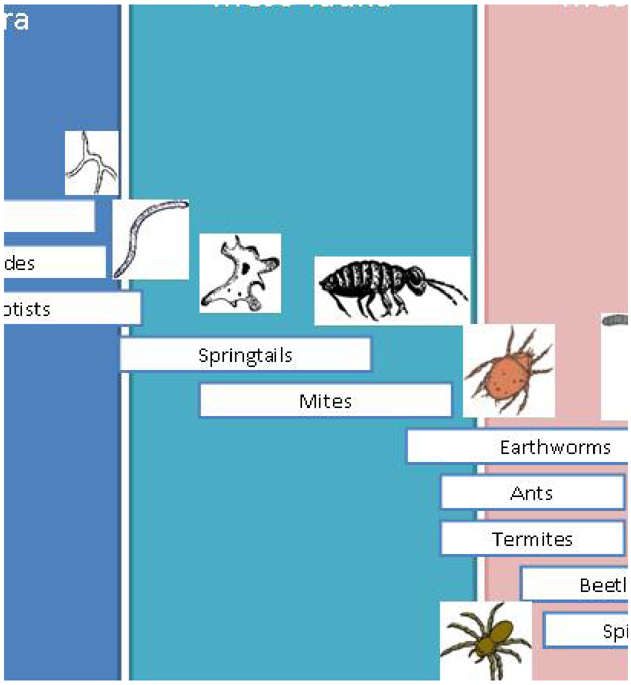
13.3 Services

Essentially, all the terrestrial ecosystems rely on soil: in turn, the correct functioning of the soil depends largely on the activities performed by the organisms living in it, which can be summarised as follows.

- Formation and decomposition of soil organic matter, making nutrient available in forms usable by plants and other organisms: the contribution of soil organisms to nutrient cycling in terrestrial ecosystems is well established and quantified for a number of ecosystems (Swift et al., 1998). Some of these processes, particularly within the N-cycle, are performed only by very specific organisms, while others, such as soil organic matter decomposition, are carried out by a diverse group of bacteria, fungi, protozoans and invertebrates. As a result, soil organisms support the quality and abundance of plant primary production crucial for, among others, food supply.
- Regulation of carbon flux and climate control: soil organisms increase the soil organic carbon pool through the decomposition of dead biomass, while their respiration releases carbon dioxide (CO_2) to the atmosphere. Peatlands and grasslands are among the best carbon storage systems in Europe, while land-use change, through the conversion of grasslands to agricultural lands, is responsible for the largest carbon losses from soils.
- Regulation of the water cycle: soil organisms create pore spaces and soil aggregates which affect the infiltration and distribution of water in the soil. For instance, it has been observed that the elimination of earthworm populations due to soil contamination can reduce the water infiltration rate significantly, in some cases even by more than 90 %. Moreover, the diversity of micro-organisms in the soil contributes to water purification, nutrient removal, and to the biodegradation of contaminants and of pathogenic microbes.
- Decontamination and bioremediation: certain soil organisms are able to accumulate pollutants in their bodies, to degrade pollutants into smaller, non-toxic molecules, or to modify those pollutants into useful metabolic molecules. This bioremediation capacity of soil micro-organisms is often used to clean up contaminated sites.

As shown in Figure 13.5, soil organisms are involved in the provision of all the main supporting and regulating services. The current rate of soil degradation due to the misuse of soil by humans, is threatening the sustainability of human life on Earth. Therefore, the responsible management of soil and its biodiversity is pivotal to sustaining human society.

Figure 13.5 Contribution of soil biodiversity to the provision of ecosystem services



Source: Adapted from MEA, 2005.

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14 Data and information gaps

Although a great deal of information has been gathered since the 2010 target was adopted, there are still significant gaps in Europe's knowledge and data on biodiversity at all levels — Member State, EU and global (EC, 2010).

Four main parameters — diversity, distribution, abundance and quality — have been identified as priorities for gap filling in order to enhance understanding of genetic diversity, species and ecosystems. Measures must be taken to improve the value and usability of data, including better data compatibility and harmonisation. Suitable data infrastructure and information systems should also be developed.

A strategic plan to fill gaps, in particular on the link between biodiversity, ecosystems and their services, must be adopted and supported with appropriate resources. At the global level, the EU is supporting efforts to establish an Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES), which should help build strong consensus by validating the existing scientific evidence. It would also contribute to mainstreaming and integrating biodiversity and ecosystem services into policymaking processes (Green Week, 2010).

Box 14.1 summarises the main data and knowledge gaps that are relevant to biodiversity policymaking, implementation and evaluation. It does not, at this stage, differentiate the scale of gaps: some areas, topics and issues may require much more effort than others. Nor does it prioritise how the gaps should be addressed, for example via research activities, indicator and reporting frameworks, monitoring initiatives and so on.

14.1 Status and trends of biodiversity — genes, species, habitats and ecosystems

European data on the status and trends of biodiversity is not comprehensive and there are fundamental gaps, even for the small number of species and habitat types targeted by the EU nature directives.

Knowledge gaps exist in individual elements of biodiversity. Little is known, for example, about many aquatic systems (e.g. floodplains and deltas), genetic diversity outside the agricultural sector, soil biodiversity and for many species groups (e.g. invertebrates). Generally, data for marine species and habitats are much scarcer than for terrestrial ecosystems and across some important ecosystem types (e.g. marine and coastal) (EEA, 2010).

Significant efforts have been made to improve the data on the status of certain species groups. For instance, the European Red List has comprehensively assessed the status of all mammals, amphibians, reptiles, butterflies, dragonflies and a selection of saproxylic beetles at the EU level. Early in 2011 all freshwater fish and a selection of plants and molluscs will be assessed, covering a total of about 6 000 species.

However the European Red List revealed that there was not enough scientific information to evaluate the risk of extinction of some species. These were classified as Data Deficient (DD) and a higher proportion of DD species were registered for marine mammals and saproxylic beetles (IUCN, 2010).

Analysis of Member State data on the conservation status of the 216 habitat types and ca. 1 180 species listed in the annexes to the EU Habitats Directive revealed significant data gaps. In particular the conservation status is 'unknown' for 18 % of habitat types assessed and 31 % of the species, indicating an important lack of quantitative and qualitative data from the Member States (ETC/BD, 2008).

Considerable further work is required to assess the status of plants, invertebrates, fungi and marine species, as this represents an important gap in European species assessments. In addition, particular efforts are needed to improve European data on:

- diversity (genetic, species, habitats)
- distribution (inventories, atlases, mapping)

Box 14.1 Key initiatives where knowledge and data gaps are identified or analysed

The initiatives below list and describe the main biodiversity knowledge and data gaps at the EU level. Although not exhaustive, these references cover the main issues and derive from specific reviews involving a large number of experts and organisations.

- In 2008, the European Topic Centre on Biological Diversity (ETC/BD) made a comprehensive analysis of data completeness, quality and coherence of the EU Member States reports under Article 17 of the Habitats Directive. These reports concerned 216 habitat types and ca. 1 180 species from the annexes of the Directive, for the period 2001–2006 in 25 EU Member States (Bulgaria and Romania joined the EU in 2007). More information is available at ETC/BD (2010).

- In 2009, the EEA published a first assessment of progress towards the European target of halting biodiversity loss by 2010, based on the Streamlining European 2010 Biodiversity Indicators (SEBI2010). The report confirmed that the SEBI 2010 process and indicator set currently provide the best means of evaluating progress in CBD focal areas in Europe. However, it also identified gaps in the indicators' biological, temporal and geographic coverage. More information is available at EEA (2009a, 2009b).

- In May 2010, the European Platform for Biodiversity Research Strategy (EPBRS) adopted its European Biodiversity Research Strategy 2010–2020, which includes the following topics:
  - objectives for European research on biodiversity and ecosystem services
  - integrated research
  - developing the research environment
  - the path for implementing the strategy

  More information is available online (www.epbrs.org/news/show/18).

- EPBRS conducts e-conferences and workshops dedicated to particular research topics in connection to the EU presidencies. The research priorities identified during the Swedish Presidency – 'Targets for biodiversity beyond 2010, research supporting policy' – are particularly relevant to identifying knowledge and data gaps on biodiversity and ecosystems. More information is available online (www.epbrs.org/event/show/25).

- The EUMon project (FP6 project) – EU-wide monitoring methods and systems of surveillance for species and habitats of Community interest – focused on four major aspects important for biodiversity monitoring: involving volunteers; coverage and characteristics of monitoring schemes; monitoring methods; and setting monitoring and conservation priorities. It further developed tools to support biodiversity monitoring. Its main deliverables include relevant papers on biodiversity monitoring gaps and harmonisation across the EU, which are available online (http://eumon.ckff.si/deliverables.php). It also produced policy briefs specially addressed to coordinators and administrators of monitoring schemes (http://eumon.ckff.si/policy_briefs.php).

- The EBONE project (FP7 project) – European component of the GEO-BON global programme – aims to address the lack of data as a major constraint on developing and using indicators for large-scale biodiversity assessment at the national, European and global levels (Parr et al., 2010).

Concerning ecosystem services, the RUBICODE project (FP6 project) identified fields of research that are relevant for EU biodiversity conservation policy. These are detailed in Anton et al. (2010).

- abundance (monitoring population sizes and habitats surface area, trends)
- quality (structure and function of habitats/ecosystems)

Across Europe there are significant geographic, geopolitical and taxonomic biases in the quality of data available on the distribution and status of species. For some species groups, like beetles, it would appear that few European countries have an organised and systematic monitoring programme. Moreover, in most countries of the EU even basic data on species distribution and population status are limited (Nieto and Alexander, 2010). However for other groups, such as mammals, national mammal population monitoring schemes have been initiated in some EU Member States. For example in the UK the Tracking Mammals Partnership has set up a surveillance and monitoring network that delivers distribution and population trend information (Temple and Terry, 2007).

A future challenge is to improve monitoring and data quality so that the information can be updated and improved, and conservation action can be given as solid a scientific basis as possible. The use of remote sensing and Earth observation technology for biodiversity monitoring needs to be further developed and requires European-level coordinated actions. Also better synergies and complementarities among different monitoring programmes are needed (e.g. as addressed by EBONE at European level and GEO BON at global level).

Several ongoing and proposed research projects aim at filling these knowledge gaps and addressing some of the issues mentioned above, such as LIFEWATCH, BioSOS and MS-MONINA. However, such short-term research projects cannot provide long-term data series, which can only be obtained through stable monitoring schemes integrated into policy design and implementation at EU and country levels.

14.2 Pressures and threats

Despite being the region with the longest and broadest biodiversity knowledge base, key knowledge gaps remain across Europe. Data are often lacking at relevant scales for key environmental drivers or habitat changes (EEA,2010).

Specific actions could be investigated around the five main categories of threats to biodiversity: habitat loss, pollution, overexploitation, alien species (invasive, in particular) and climate change.

Remote sensing (e.g. GMES, CLC) could be of greater benefit to understanding habitat loss, degradation and fragmentation if the classification system were refined and if data were made available on a more regular basis. Additionally continued research into sensor selection and methods, and into algorithms of habitat/land cover classification and translation of spectral data, will all aid monitoring and mitigation of **habitat loss** and degradation.

There is limited knowledge of the impact of **pollution** on biodiversity and further research is required to better understand how the different types of pollution influence the different biodiversity components.

Better and more comprehensive statistics and data on commercial and amateur fishing, hunting and collection, and other uses of wildlife are needed to avoid **overexploitation** of natural resources.

Increasing knowledge on the distribution of **invasive alien species** in Europe, the ways and means of their expansion, and invasion mechanisms would support mitigation.

Improved knowledge on the impacts of **climate change** on biodiversity is also needed, in particular assessing the vulnerability of species, habitats and ecosystems. Scenario building and modelling are fundamental tools for biodiversity conservation and sustainable use and need to be developed.

Further research on issues like 'tipping points' and 'planetary boundaries' for biodiversity will provide information on the resilience and relative health of a species or habitat, allowing prioritisation of conservation measures.

14.3 Effects of conservation measures and management (responses)

There are indications that adopting key measures in the framework of European biodiversity policy can deliver positive results for biodiversity. These include designating sites as part of the Natura 2000 network, adopting and implementing international Species Action Plans (SAPs), empowering conservation NGOs, and additional measures by Member States (EEA, 2010).

In addition, many other European policies actually have an important impact and may contribute to conserving, managing and restoring biodiversity. For instance, the Common Agricultural Policy and the Water Framework Directive are both directly relevant to the management of biodiversity.

However, there is also a need to improve understanding of how agri-environmental measures, organic farming and other measures such as fishing quotas can benefit biodiversity. Furthermore, it would also be beneficial to revise available data such as the Farm Accountancy Data Network and other CAP statistics, including data from IACS/LPIS (Integrated Administration and Control System, Land Parcel Information System).

The EU also supports biodiversity through direct funding. For example the Life+ funding programme has a window for nature and biodiversity. However, LIFE expenditure, measures and biodiversity outcomes should be further analysed in terms of their effectiveness and impact on biodiversity and should be made publicly available.

Recent efforts to link biodiversity science with economics have been particularly promising but further interdisciplinary research and assessment would support strengthened decision-making and policymaking processes on European biodiversity in the 21st century.

14.4 Ecosystem services

The ecosystem service approach has had a limited influence on policy formulation and decision-making (Haines-Young and Potschin, 2008). Possible reasons for this are limited understanding of the ecological underpinnings of ecosystem services (Balmford et al., 2003; Luck et al., 2003; Palmer et al., 2004; Kremen, 2005) and the role of biodiversity as one part of the biophysical system responsible for providing ecosystem services.

In addition, information is lacking on how various drivers are affecting ecosystem services (Haines-Young and Potschin, 2009) and there is a need to develop tools to predict how these changes might affect the provision of ecosystem services in the future (e.g. Schröter et al., 2005; Metzger et al., 2006).

A partial understanding of ecosystem services makes it hard, if not impossible, to value them accurately. Efforts are needed to harmonise and streamline the data on ecosystem services as well as to make data available at appropriate scales of analysis (de Groot et al., 2002). Ecosystem services are undoubtedly valuable but that value needs to be reflected in conventional, market-based economic activity. A fundamental requirement for monitoring ecosystems and their services and for measuring the success of conservation actions is the identification of indicators.

Overall more needs to be known about the interdependence of ecological and social systems for human well-being, including the way ecosystems function, their response to human pressure, and their relationship to biodiversity. Enhanced information on the environmental, economic and social benefits of the ecosystem services supplied by biodiversity would inform sustainable management of ecosystems and raise public awareness of biodiversity's value and its link to livelihoods. The value of non-marketed goods and services are an important element in this.

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15 Explanatory notes

15.1 General definitions in the Habitats Directive

The Habitats Directive (Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora) gives the following definitions:

Natural habitats (in many cases referred as 'habitats' in the document) are terrestrial or aquatic areas distinguished by geographic, abiotic and biotic features, whether entirely natural or semi-natural.

Natural habitat types of Community Interest are those habitats which, within the European territory of the Member States:

- are in danger of disappearance in their natural range; or
- have a small natural range following their regression or by reason of their intrinsically restricted area; or
- present outstanding examples of typical characteristics of one or more of the biogeographical regions.

Such habitat types are, or may be, listed in Annex I to the Habitats Directive.

Priority natural habitat types are those natural habitat types in danger of disappearance which are present on the European territory of the Member States and, for the conservation of which, the Community has particular responsibility in view of the proportion of their natural range which falls within the European territory of the Member States.

Habitat of a species is an environment defined by specific abiotic and biotic factors, in which the species lives at any stage of its biological cycle.

Species of Community interest are those species which, within the European territory of the Member States are:

- endangered, except those species whose natural range is marginal in that territory and which are not endangered or vulnerable in the Western Palaearctic region; or
- vulnerable, i.e. believed likely to move into the endangered category in the near future if the causal factors continue operating; or
- rare, i.e. with small populations that are not at present endangered or vulnerable, but are at risk (the species are located within restricted geographical areas or are thinly scattered over a more extensive range); or
- endemic and requiring particular attention by reason of the specific nature of their habitat and/or the potential impact of their exploitation on their habitat and/or the potential impact of their exploitation on their conservation status.

Such species are, or may be listed, in Annex II and/or Annex IV or V to the Habitats Directive.

Priority species are species for which the Community has particular responsibility for conservation in view of the proportion of their natural range which falls within the European territory of the Member States.

Annex I to the Habitats Directive lists natural habitat types of Community interest whose conservation requires the designation of Special Areas of Conservation.

Annex II to the Habitats Directive lists animal and plant species of Community interest whose conservation requires the designation of special areas of conservation. Most species listed in this Annex are also listed in Annex IV.

Annex III to the Habitats Directive lists criteria for selecting sites eligible for identification as Sites of Community Importance and designation as Special Areas of Conservation.

Annex IV to the Habitats Directive lists animal and plant species of community interest in need of strict protection.

Annex V to the Habitats Directive lists animal and plant species of community interest of which taking in the wild and exploitation may be subject to management measures.

15.2 Conservation status

The Habitats Directive defines in its Article 1 the term conservation status as applied to habitats and species. These definitions take into account parameters that affect their long-term distribution such as the extent of the area in which the habitat/species is found, the surface of the habitat area, its structure and functions (in case of habitat), the size of the population, its age structure, mortality and reproduction (of species). This forms the basis for developing a common assessment method and reporting format for the Member States (EC, 2009).

The concept of 'favourable conservation status' constitutes the overall objective to be reached for all habitat types and species of community interest. In simple words, it can be described as a situation where a habitat type or species is prospering (in both quality and extent/population) and with good prospects to do so in future as well. The fact that a habitat or species is not threatened (i.e. not faced by any direct extinction risk) does not mean that it is in favourable conservation status (EC, 2006).

Conservation status is assessed as being either 'favourable', 'unfavourable-inadequate' and 'unfavourable-bad', based on four parameters as defined in Article 1 of the Habitats Directive. The parameters for habitats are range, area, structure and functions and future prospects and for species they are range, population, habitat of species and future prospects.

Member States were encouraged to use expert opinions where there was insufficient data to make informed judgements. However, where there was great uncertainty, it was also possible to report the conservation status as 'unknown'. The assessments of the four parameters were combined following an agreed method to give an overall assessment of conservation status.

Thus, the conservation status of a habitat or species is presented in one of four categories:

Favourable (green) (FV): the habitat or species can be expected to prosper without any change to existing management or policies.

Unfavourable-inadequate (amber) (U1): a change in management or policy is required but the danger of extinction is not so high.

Unfavourable-bad (red) (U2): the habitat or species is in serious danger of becoming extinct (at least locally).

Unknown (grey) (XX): no, or insufficient, information is available. This category includes the following categories from Article 17 reporting: 'unknown but not favourable' (brown) (XU); unknown (grey) (XX) and not possible to assess (blue) (NA). (Source: EC, 2006 and ETC/BD, 2008.)

15.3 Biogeographical regions

Habitats and species which are typically found together are associated with regions displaying similarities in climate, altitude and geology. From an ecological perspective, Europe can be divided into nine land and four marine biogeographical regions. Therefore, when an assessment of the conservation status of a species or habitat was carried out by a Member State, the reference area for the assessments was not the territory of that Member State but the respective parts of biogeographical regions within that Member State (EC, 2009).

Alpine (ALP): mountain chains with high altitudes and cold, harsh climates, forests and rock peaks, including the Alps, Pyrenees, Apennine, Scandinavian and Carpathian mountains.

Atlantic (ATL): Europe's western coastal areas, with flat lands and cliffs, plus major river estuaries.

Black Sea (BLA): the western and southern shores of the Black Sea, extending through Bulgaria and Romania.

Boreal (BOR): Europe's far north, extending into the Arctic Circle.

Continental (CON): the heartland of Europe — much of it agricultural — spanning 11 countries from France to Poland. Hot summers contrast with cold winters.

Macaronesian (MAC): 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 (MED): Europe's hot, dry, southern countries, with mountains, grasslands, islands and extensive coastlines.

Pannonian (PAN): the steppes of Hungary and southern Slovakia, the dry grasslands of the Carpathian basin.

Steppic (STE): 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.

A more comprehensive description and characterisation of the biogeographical regions is available online (http://ec.europa.eu/environment/nature/natura2000/sites_hab/biogeog_regions/index_en.htm).

For the purpose of Article 17 assessments of conservation status, the following marine regions were considered:

Atlantic (MATL): Northern and Western Atlantic, from the Straits of Gibraltar to the Kattegat, including the North Sea.

Baltic (MBAL): east of the Kattegat, including the Gulf of Finland and the Gulf of Bothnia.

Macaronesian (MMAC): Economic Exclusive Zones of the Azores, Madeira and Canary Archipelagos.

Mediterranean (MMED): east of the Straits of Gibraltar.

These marine regions are based on reported Economic Exclusive Zones or other territorial claims and were prepared purely for reporting under Article 17 of the Habitats Directive; they have no legal status.

15.4 Natura 2000

Natura 2000 is the centrepiece of the European Union's nature and biodiversity policy. It is an EU-wide network of nature protection areas established under the 1992 Habitats Directive and the 1979 Birds Directive. The aim of the network is to assure the long-term survival of Europe's most valuable and threatened species and habitats.

Under the Habitats Directive, Natura 2000 sites are selected on the basis of national lists proposed by the Member States. For each biogeographical region, the Commission adopts a list of *Sites of Community Importance* (SCI) which then become part of the network. Finally, the SCI are designated at the national level as Special Areas of Conservation (SAC).

Under the Birds Directive, Member States select the most suitable sites and designate them directly as *Special Protection Areas* (SPAs). These sites then automatically become part of the Natura 2000 network. (Source: EC, 2010).

15.5 European Red Lists

The European Red Lists provide taxonomic, conservation status, and distribution information on taxa that have been evaluated using the IUCN Red List Categories and Criteria: Version 3.1 (IUCN 2001); the European assessments have followed the *Guidelines for Application of IUCN Red List Criteria at Regional Levels* (IUCN 2003). The IUCN Red List Categories and Criteria are intended to be an easily and widely understood system for classifying species at risk of extinction.

This system is designed to determine the relative risk of extinction, with the main purpose of cataloguing and highlighting those taxa that are facing a higher risk of extinction (i.e. those listed as Critically Endangered, Endangered and Vulnerable) (IUCN, 2009).

The IUCN Red List Categories are based on a set of quantitative criteria linked to population trends, population size and structure and geographic range. The IUCN Red List Categories at regional scale are:

Extinct (EX): a taxon is 'Extinct' when there is no reasonable doubt that the last individual has died. A taxon is presumed 'Extinct' when exhaustive surveys in known and/or expected habitat, at appropriate times, throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

Extinct in the Wild (EW): a taxon is 'Extinct in the Wild' when it is known only to survive in cultivation, in captivity or as a naturalised population (or populations) well outside the past range. A taxon is presumed 'Extinct in the Wild' when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

Regionally Extinct (RE): a taxon is 'Regionally Extinct' when there is no reasonable doubt that the last individual potentially capable of reproduction within the region has died or disappeared from the region or, in the case of a former visiting taxon, individuals no longer visit the region.

Critically Endangered (CR): a taxon is 'Critically Endangered' when the best available evidence indicates that it is facing an extremely high risk of extinction in the wild (severe population decline, very small population, very small geographic area occupied, or if the calculated probability of extinction during the next 10 years of > 50 %).

Endangered (EN): a taxon is 'Endangered' when the best available evidence (large population decline, small population, small geographic area occupied, or if the calculated probability of extinction during the next 20 years is > 20 %) indicates that it is considered to be facing a very high risk of extinction in the wild.

Vulnerable (VU): a taxon is 'Vulnerable' when the best available evidence (large population decline, small population, small geographic area occupied, or if the calculated probability of extinction during the next 20 years is at least 10 %) indicates that it is considered to be facing a very high risk of extinction in the wild.

Near Threatened (NT): a taxon is 'Near Threatened' when it has been evaluated against the criteria but does not qualify for 'Critically Endangered', 'Endangered' or 'Vulnerable' now, but is close to qualifying for, or is likely to qualify for, a threatened category in the near future.

Least Concern (LC): a taxon is 'Least Concern' when it has been evaluated against the criteria and does not qualify for 'Critically Endangered', 'Endangered', 'Vulnerable' or 'Near Threatened'.

Data Deficient (DD): a taxon is 'Data Deficient' when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. 'Data Deficient' is, therefore, not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate.

Not Applicable (NA): a taxon is 'Not Applicable' when it is deemed to be ineligible for assessment at a regional level. A taxon may be 'Not Applicable' because it is not a wild population or not within its natural range in the region, or because it is a vagrant to the region. It may also be 'Not Applicable' because it occurs at very low numbers in the region or the taxon may be classified at a lower taxonomic level.

Not evaluated (NT): a taxon is 'Not Evaluated' when it has not yet been evaluated against the criteria.

All taxa listed as 'Critically Endangered' qualify for 'Vulnerable' and 'Endangered', and all listed as 'Endangered' qualify for 'Vulnerable'. Together, these categories are described as 'Threatened'.

15.6 Endemism

An endemic species is only found in a given region or location and nowhere else in the world. This definition requires that the region that the species is endemic to, be defined.

Regional endemics — species endemic to a region: the species is distributed in a larger area; its range covers parts of Europe that could be considered as a region. Typical examples would be species endemic to the Alps, the Iberian Peninsula, the Atlantic region, Scandinavia, the Dinaric Mountains, Central Europe, etc.

Endemic to Europe: species distributed in different parts of Europe, but which range does not exceed the boundary of Europe.

Endemic to EU: species distributed in different parts of the EU, but which range does not exceed the boundary of the 27 Member States of the EU.

15.7 Ecosystems

In this report, data and information on species and habitats are organised into main 'ecosystem' types, which provides a better link to the different policy areas. The following ecosystems were considered:

- Agro-ecosystems
- Grasslands
- Heath and Scrub
- Forests
- Wetlands
- Lakes and Rivers
- Coastal
- Marine

Each section presents information on a specific ecosystem. Existing data and information on ecosystems rely on definitions which may vary according to the source. Each section begins with the description of the specific ecosystem concerned. In formulating this description the following will be taken into account:

- information on range and conversion of each ecosystem is based on Corine land cover datasets with a specific cluster of CLC categories presented in the following table;
- information on habitats linked to each ecosystem is based on Article 17 reporting with a specific cluster of Annex I habitats (set out in Annex 1 to the present report);
- information on species linked to each ecosystem is mainly based on Article 17 reporting and IUCN datasets; a specific piece of work was completed by the ETC/BD to make the links between species and ecosystems (set out in Annex 2 to the present report);
- below each 'What is included here under the term', a summary of each CLC category and each Annex I Habitat used for the description is provided;
- overlaps can exist between the different ecosystems.

When using Corine land cover data, the allocation of CLC classes to each ecosystem was as listed in the following table.

Ecosystem		Corine land cover category
Agro-ecosystems	**Regularly cultivated land**	211 Non-irrigated arable land
		212 Permanently irrigated land
		213 Rice fields
		221 Vineyards
		222 Fruit trees and berry plantations
		223 Olive groves
		231 Pastures
		241 Annual crops associated with permanent crops
	Mixed cultivated land	242 Complex cultivations
		243 Land principally occupied by agriculture, with significant areas of natural vegetation
		244 Agro-forestry area
	Semi-natural areas	321 Natural grasslands
		322 Moors and heathlands
		323 Sclerophyllous vegetation
Grasslands		231 Pastures
		321 Natural grasslands
Heaths and Scrubs		322 Moors and heathlands
		323 Sclerophyllous vegetation
		324 Transitional woodland shrub
Forests		311 Broadleaf forests
		312 Coniferous forests
		313 Mixed forests
		324 Transitional woodland-shrub
Wetlands	**Coastal wetlands**	421 Salt marshes
		422 Salines
		423 Intertidal flats
		521 Coastal lagoons
		522 Estuaries
	Marshes/bogs	411 Inland marshes
		412 Peat bogs
	Watercourses/water bodies	511 Watercourses
		512 Water bodies
Lakes and rivers		511 Watercourses
		512 Water bodies
Coastal ecosystems		331 Beaches, dunes and sands
		421 Salt marshes
		422 Salines
		423 Intertidal flats
		521 Coastal lagoons
		522 Estuaries
Marine ecosystems		523 Sea and ocean

15.8 Changes in land cover

Two types of information are provided in each ecosystem section:

- surface area and net change in surface area, based on the three Corine land cover inventories — 1990, 2000 and 2006;
- information on conversion between land uses based on Land and Ecosystems Accounting methodology ([52]); additional important element of information is about the actual processes that have resulted in the flows between the different stocks of land cover; how land is being transferred or exchanges between the different cover categories; in each Ecosystem section, one graph is proposed based on a classification of land cover flows (the table listing the types of land cover flow is given in Annex 1 to the present report).

It is to be noted that:

- CLC 1990—2000 is based on 24 EU Member States excluding Finland and Sweden;
- CLC 2000—06 is based on 25 EU Member States excluding Greece and the United Kingdom (which had not finalised their CLC inventories by Spring 2010).

Therefore, comparisons between the 1990 CLC inventory and 2006 inventory do not include the four countries mentioned above.

The use of CLC categories to obtain quantitative statistics on ecosystems coverage and change should be understood as a proxy given the resolution and difficulty in linking data to certain land-use types; however, CLC is the best available data set with a European coverage.

15.9 Linking species and habitat types to ecosystems

The Article 17 data from the 2001—06 report has been grouped by ecosystem for the purpose of this baseline work.

In the framework of the ETC/BD work programme, the Institute of Landscape Ecology, Slovak Academy of Sciences (ILE/SAS), carried out an analysis of the habitat requirements of species listed in Annex II and Annex IV to the Habitats Directive. For amphibians, reptiles and mammals, these links were also prepared for all species naturally occurring in Europe. The analysis was carried out by ILE/SAS in February and March 2010. The geographic scope of this assessment study is Europe, defined as mainland of Europe (with the east boundary being in the Ural Mountains), islands geographically belonging to Europe (including Svalbard, Island, Azores, Canary Islands, Madeira and the respective islands in the Mediterranean Sea, including Cyprus) and the sea in boundaries of the Marine biogeographical regions. The list of broad ecosystem is available page 6.

The nature of the link between a species and its habitat is expressed in one of three categories:

- **preferred habitat**: main habitat of the species, species uses usually this habitat for its life or the main part of the population is linked to this habitat type;
- **suitable habitat**: habitat in which species regularly occurs, but it is not the preferred habitat or the preferred habitat is not possible to determine (for species living regularly in several habitat types);
- **occasional habitat**: species lives sometimes in this habitat type, but only marginally or small part of the species population uses this habitat.

Main sources of data:

- distribution maps and reports delivered by the EU 25 countries with Article 17 reports in 2007 published literature about species habitats and distribution
- for the production of the baseline report, only information on ecosystems preferentially used by species was used.

A similar work was carried out for Annex I habitat types of the Habitats Directive.

The allocation of individual Annex I habitat types and of Annex II, IV and V species to each ecosystem is given in the Annexes 2 and 3 to the present report.

For birds, work for ETC/BD carried out in 2002 by Wetlands International and SOVON (NL) was used. This work provided the links between Annex I bird species and EUNIS habitat types (level 1 and 2).

([52]) www.eea.europa.eu/themes/landuse/interactive/land-and-ecosystem-accounting-leac

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