

European Environment Agency

Europe's biodiversity

– biogeographical regions and seas

Biogeographical regions in Europe

The Alpine region

– mountains of Europe

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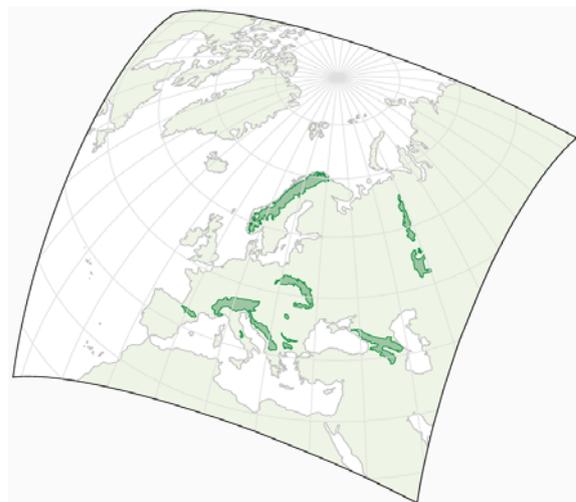
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Summary

- Mountains areas are vulnerable ecosystems, characterised by low productivity, slow response rates and isolation.
- The Alpine biogeographic region exhibits an extreme fauna and flora and a high level of endemism.
- Human impact such as tourism, transportation, traffic-caused fragmentation of biotopes, land-use change and also atmospheric pollution are strongly affecting many mountain areas with generally negative effects on biodiversity.
- Climate change continues to alter the distribution of species and will affect the species composition in most, if not all, mountain ecosystems. Lowland species are expected to move upwards in altitude. Highland species may become extinct, as no high grounds will be available for escape.
- The global importance and also the 'pleasure values' of mountainous ecosystems for people are being recognised in more and more international and European political fora. Also the number of regional initiatives formulated for the protection and the sustainable development of Europe's mountains is increasing.
- In certain European mountain ranges several large herbivores and carnivores are making a comeback as a result of habitat protection and re-introduction initiatives.

1. What are the main characteristics and trends of the Alpine biogeographical region?

1.1 General characteristics

Ranges of mountains from the Mediterranean to western Siberia constitute the alpine biogeographic region. It includes some of the oldest and most recent mountains of the world; the Alps, the Scandes, the Pyrenees, the Carpathians, the Rhodopes, the Urals, the Caucasia and the Dinaric Alps.

Table 1. Statistics for the Alpine biogeographical region.

Surface area (km ²)	Number of countries in region	National composition by area	Population (inhabitants/km ²)
780 000	22	Norway 17 % European Russian Federation 15 % Sweden 12 % Austria 6 % Italy 6 % Romania 6 % Bosnia-Herzegovina 5 % France 4 % Georgia 5 % Albania, Azerbaijan, Bulgaria, Croatia, Finland, FYR of Macedonia, Germany, Poland, Slovakia, Slovenia, Switzerland, Ukraine, and Yugoslavia <5 %	Sweden 19 Finland 15 Norway 11 Russian Federation 9

Sources: various sources by ETC/NPB and EEA. Note that information on population density in the area is incomplete.

The different mountainous areas in the Alpine biogeographic region share a number of common features to which species and life forms have adapted. Altitudinal gradients, climatic influence, soil types and geology all influence the distribution of species, the development of vegetation types and the diversity of species. Caucasia has similar vegetation belt patterns as the Alps as well as the arctic-alpine plant community in the Scandes has affinities with the western Urals and possible connections with the Alps.

Map 1. The Alpine biogeographical region.



Source: UNEP/Grid Warsaw.

In general, the Alpine biogeographic region exhibits a great variety of ecosystems and habitat types, of which 90 % are natural or semi-natural. Forests cover more than 40 % of the region's area and grasslands ca 25 %. More than 7 000 species of plants are registered (Ozenda, 1994) and most of the mountain areas have a high degree of endemism. The region is of great importance as refuges for plants and especially so for animals with large area requirements. It further constitutes an in situ gene bank for numerous species.



Gentiana lutea in the Alps.
Photo: Oswald Gabathuler.

The Alpine region is fragile with its species and populations being directly and indirectly influenced by changes in land-use practice, abandonment of small-scale agriculture, construction of transport networks and fragmentation of habitats. Mass tourism is both attracted to the region and its activity is damaging habitats and biotopes and may disturb wildlife species.

The concept for sustainability of the Alpine region has for generations been multi-functionality in terms of forestry and agriculture, human settlements and outdoor/leisure activities. Future conservation policies need to be spatially integrated and to reflect and support the long-term multi-functionality of the region. The high sensitivity of the region is stressed by IUCN special guidelines for managing mountain protected areas and the Convention on the Protection of the Alps.

The Habitats Directive in the Alpine biogeographic region

Annex I of the Habitats Directive (92/43/EEC) lists in total 198 habitat types of which 100 Annex I habitat types are found in the Alpine region. Two Annex I habitats are only present in the region: permanent glaciers (habitat 8340) and alpine *Larix decidua* and/or *Pinus cembra* forests (9420).

Source: ETC/NC. Please note that data are based on 15 EU Member States.

Table 2. Main habitat types in the Alpine biogeographical region, as defined by EUNIS (European Nature Information System) habitat classification.

Woodland and forest habitats and other wooded lands	Grassland habitats	Inland sparsely vegetated or unvegetated habitats	Regularly or recently cultivated habitats and gardens
41 %	26 %	13 %	8 %

Sources: ETC/NPB, estimation based on 80 % of the region.

Table 3. The number of vertebrate species (excluding fishes) found in the Alpine biogeographic region and the number of species threatened at the European level.

	Total	Mammals	Breeding birds	Amphibians	Reptiles
Number of species	593	129	359	40 ¹	65 ¹
Number of threatened species at European level	113	23 ²	84	3 ¹	65 ¹

Source: ETC/NPB. ¹ Only 94 % of the total area of the Alpine biogeographic region is covered by the European Atlas of Reptiles and Amphibians. ² Excluding cetaceans. Only 76 % of the Alpine biogeographic region is covered by the European Atlas of Mammals.

Table 4. Total number of FFH Annex II species and subspecies in the region.

Number of all Habitats Directive Annex II species and sub-species present in the EU-15 Member States in the Alpine biogeographical region	165
Mammals	21
Reptiles	4
Amphibians	11
Fishes	25
Invertebrates	40
Vascular plants	49
Mosses/liverworts	15

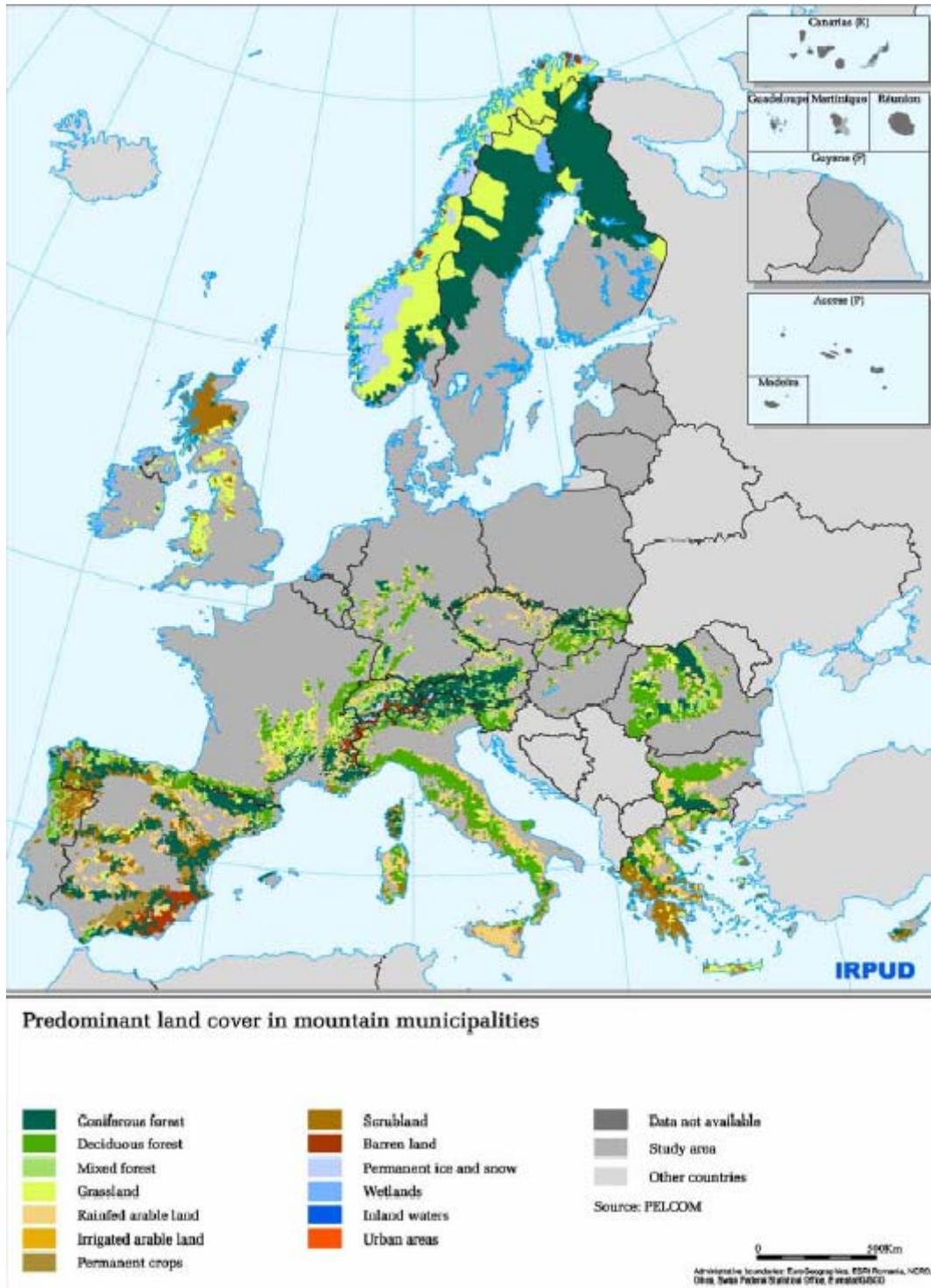
Source: ETC/NPB, March 2000. Note: data limited to 15 EU Member States.

1.2 States and trends in habitats and ecosystems in the Alpine biogeographic region

The Alpine region has a high coverage of 90 % natural and semi-natural habitats, of which more than 40 % is forested and more than 25 % grasslands (EEA, 2003). Also, montane regions have still a relatively high proportion of pastoral landscapes, with a mixture of trees, pastures and meadows (Map 2). Montane grasslands, which are located

above the tree line and south of the Boreal biogeographic region, used to be extensively managed by transhumance and removal of trees and scrubs. This process has been abandoned since the 70s of the 20th century. Where the physical conditions still allow so, levelling, re-seeding and heavily fertilising increase hay production in grasslands. The consequence of this is a change of structure and composition of the natural vegetation and soil erosion (Tucker and Evans, 1997).

Map 2. Predominant land cover in mountain municipalities



Source: Nordregio, 2004.

Even if there was less collectivisation, more traditional management, and more protected areas in the past few decades at higher elevations of eastern Europe (EEA, 2004), the main factors causing the decline of the land used for farming in mountains are the under-utilisation and abandonment of the agricultural land. Especially in the mountainous areas, cessation of farmlands will quickly cause the turn of higher flora rich areas to scrubs, affecting the invertebrate and vertebrate populations as well in the areas (CEC, 2001).

Particularly over the last thirty years species abound semi-natural grasslands have turned into agriculturally more productive, but species-poor grasslands, for instance silage has gathered ground on hay due to the technical advances allowing the transformation of agriculture from traditional farming to an intensified and mechanised manner of management (PASTORAL, 2003).

Climate change causes a general upwards movement of the tree line. This will have consequences for land-use, such as grazing and tourism. Arctic and alpine areas already witness a general increase in shrub or tree growth in high altitude sites. This will reduce areas of alpine heaths in mountains and change summit floras on high mountains, among others, by reducing the available land area for cold-adapted organisms (summit trap phenomenon). Most of the species that are new in these high-alpine sites are characteristic of ecosystems at lower altitudes on the mountains, such as from the alpine grassland zone.

Formerly untouched habitats of higher altitudes are seriously declining in some mountain ranges of Europe due to the increase in transportation and traffic infrastructures crossing Alpine habitats, and consequent fragmentation.

However, the lack of long-term datasets and knowledge makes the predictions of future development in mountain ecosystems rather difficult.

1.3 States and trends in selected species groups in the Alpine biogeographic region

1.3.1 Birds

European mountain ranges are not particularly diverse in avifauna and harbour few endemic species. Only in the Caucasus two endemic bird species are found (Caucasian black grouse *Tetrao mlokosiewiczi* and Caucasian snowcock *Tetraogallus caucasicus*) (Tucker and Evans, 1997). The bird communities in montane forests are a mix of lowland temperate and boreal forest with only a few specific species. Compared to most lowland habitats threats are not very outspoken in the mountain ranges. Highest pressures to birds in montane forests stem from overgrazing, inappropriate forest management and logging. In montane grasslands the highest threat is from high stocking density and overgrazing, in addition to abandonment and afforestation, recreation and atmospheric nutrient pollution.

Hunting, poisoning and change of habitats have resulted in serious decline in the abundance of the bearded vulture (*Gypaetus barbatus*) in Europe. Reintroduction projects have since 1986 been carried out on the French side of the Alps, releasing 2–3 captive-bred individuals each year. Nowadays, some one hundred pairs reside in the Pyrenees, Alps, Corsica and Crete (WWF, 2002; CEC, 2000).

1.3.2 Butterflies

In contrast to birds, European mountain ranges are centres of butterfly species richness. Especially the Alps and to a lesser extent the Pyrenees host several endemic butterflies (van Swaay and Warren, 2003). Extensively managed mountain grassland and pasture is very important for diurnal butterflies. Some 9 % of the 69 butterfly species with a higher degree of threat occur in alpine and sub-alpine grasslands. A key threat to highly

restricted endemic montane butterflies is climate change. Like birds, also butterflies are under pressure from habitat loss, land abandonment, and fragmentation of habitats.

1.3.3 Large herbivores

The populations of several large herbivores have increased in the Alps, partly as a result of reintroductions. This is perceived as a positive trend (Loison *et al.*, 2003). However, the long-term stability of the system is hard to predict since there is an increasing human pressure and changes in land-use. This can, for instance, be seen in the increase of lowland species, such as roe deer and red deer, in the mountain ecosystems.

Although the chamois (*Rupicapra rupicapra*) thrives with almost 7 500 individuals in the south-eastern Carpathians, the number of them in the western Carpathians has dramatically decreased in the last years, from 1 200 to only 450 individuals present (EEA).

The southern chamois (*Rupicapra pyrenaica*) nearly became extinct because of intensive hunting and poaching. Establishment of game reserves and the adoption of hunter-kill ratios led to an increase in the population size from a few thousand to 50 000 individuals in 40 years in the Pyrenees, the Cantabrian Mountains and the Apennines, and the southern chamois passed from the status of a relic population to a thriving one (EEA, under publ.).

However, there are negative examples as well. The Pyrenean ibex (*Capra pyrenaica pyrenaica*), for instance, that has taken refuge in a small area in the Mont Perdu massif of Aragon in the past, is now extinct. For centuries hunting was the main cause of its decline, but the small Spanish residual population has recently been faced to other threats as well such as the lack of habitat, competition with other ungulates, human disturbances, poaching, and insufficient genetic diversity. These led to a serious decline of the population. The last Pyrenean ibex was found dead under a fallen tree on 6 January 2000.

1.3.4 Carnivores

The wolverine (*Gulo gulo*) is the only large predator in Europe with its main habitat in the mountains. The main diet of wolverines is semi-domesticated reindeer. Long-term hunting and persecution has led to a reduction in population size and distribution. Hunting was allowed in Sweden until 1969 and in Finland until 1982, when the wolverine received total protection. The whole region in northern Europe today holds less than 1 000 wolverines (Fig. 1).

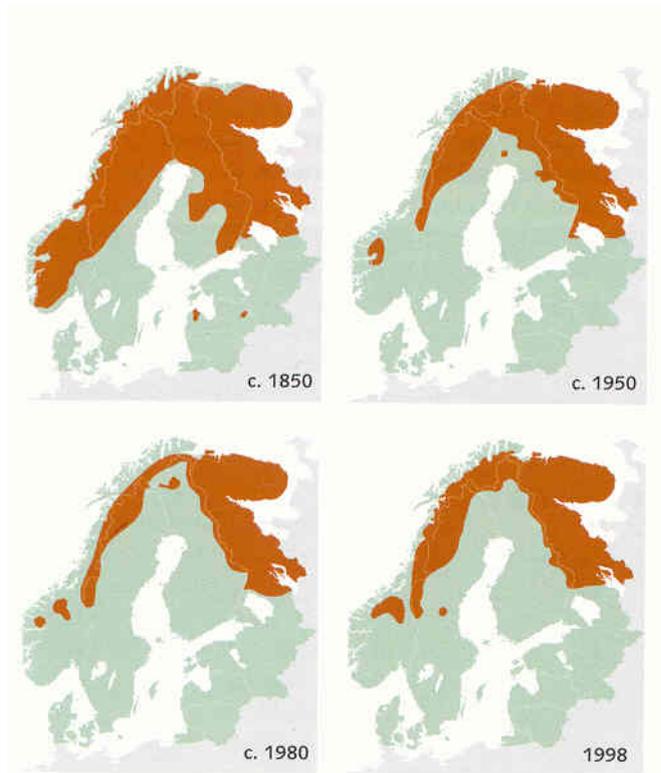


Figure 1. Changes in the main distribution areas of wolverines in Fennoscandia (source: Hallanaro and Pylvänäinen, 2002).

The brown bear (*Ursus arctos*) is one of the most rare large mammals in Europe due to expanded human population, its destroyed habitats by deforestation, agriculture, and to hunting. Western European populations (in the Pyrenees, Cantabrian Mountains, Trentino Alps, Apennines) are fragmented. In Austria, it was reintroduced and shows a positive trend in population size with a total number of 15–20 bears. Despite of the low density in Sweden and Norway, the re-colonisation of the brown bear receives negative campaign from humans and became a serious political issue. On the other hand, in France the shooting of the last wild female brown bear on 1 November 2004 in the Aspe valley shocked people – including President Chirac. This put the Pyrenean population of 14 remaining brown bears at even greater risk of extinction.

The lynx (*Lynx lynx*) occurred in nearly all parts of Europe in the first half of the last century; nevertheless the species was eradicated by 1950 from most parts of Europe, and only survived in the north and the east. Reintroduction initiatives started in the 1970s and led to successful rehabilitation in western Europe, for instance in Switzerland the population reached 100 specimens in the last four decades. There are about 7 000 lynx left in Europe (WWF, 2002).

The endemic Iberian lynx (*Lynx pardinus*) shows a serious decline in abundance due to habitat deterioration, loss of prey animals, and to accidents. There is only a surviving 150–200 individuals in Europe (WWF, 2002), making this species the most endangered cat worldwide.

2. The Alps

2.1 What are the general characteristics of the Alps

2.1.1 Profile

Originating as a result of a collision between the African and Eurasian continental plates, the Alps today runs 1 200 km long and 200 km wide from Nice to Vienna. This relatively young mountain range, with peaks extending over 4 000 m, has a central backbone of crystalline formation with external fringes of limestone and schist formations. The geological structure of the Alps has been remodelled due to erosions and repeated frost/thawing periods. The present geomorphology is a landscape with varying exposition to wind, sun, rain and other climatological variables. Taken together with the altitudinal gradient, the Alps offers a complex set of microclimates.

2.1.2 Climate

The high reaching Alps severely influences the climate of central Europe and connects the Mediterranean climate in the south and with the temperate climate in the north. The mountain peaks in the western part serve as a barrier for winds over long distances. The peaks also contribute to produce sufficient rainfall to allow the establishment of forests in valleys and on lower mountain slopes. Peaks however protect valleys from high levels of precipitation; valleys have only a fraction of the rainfall of the edges of the Alps. Steppe and conifer forest develop here, while rich grasslands and deciduous forests are found in areas with greater rainfall.

The annual and spatial distribution of rainfall is highly variable; it mostly rains in the summer in the north, while the south is very dry in summers except for thunderstorms. Heavy thunderstorms may cause serious erosion. Rainfall is increasing with altitude and at higher altitudes the amount of precipitation is more or less equal across the Alps.

2.1.3 Soils

The development of stratified soil characteristics is usually low in the alpine biogeographic region. This is caused by low temperatures and the continuous rejuvenation of soils by erosion. The low temperature also contributes to a slow degradation of litter-fall; humus is accumulating. Acid soils are predominant in the sub-alpine zones also on limestone.

2.1.4 Human presence

The Alpine region is the largest wild area in Europe, the most anciently occupied as well as the most visited mountains in the world. Humans have left imprints in the region for more than 7 000 years. Agricultural activities have traditionally been present and have given rise to numerous semi-natural habitats allowing living space for a number of species. At the end of the 19th century, the ancient rural civilisation went through a crisis which disrupted the way of living which had not been changed for hundred of years. Overpopulation led to deforestation and overgrazing which in turn has led to increased erosion.

An extended communication network has had important effects on the human presence in the area. The first trans-alpine railway crossed the Brenner in 1867. From this time on communication grew rapidly, hydro-electric power stations were built and industrial activities increased in the region.



*Hydro-electric power plants in regulated water systems may have severe negative effects on biodiversity in mountainous regions.
Photo: Chris Steensmans.*

Mass-tourism developed mainly after WW2 and has replaced farming as the pillar of alpine countries. Traditional farmland in mountain regions has decreased and been abandoned: of land exploited in 1850 only a quarter remains.

2.2 Present biodiversity status and trends: habitats, fauna and flora

2.2.1 Habitats

The Alps exhibit a complex geomorphology and an array of microclimates which contribute to a wide variety of habitats and high levels of biodiversity.

2.2.1.1 Mountain forests

Half of the Alps is covered by forests, being composed by a relatively low number of tree species. The main conifers are silver fir (*Abies alba*), Norway spruce (*Picea abies*), larch (*Larix decidua*), Scots pine (*Pinus sylvestris*), Alpine pine (*P. cembra*, *P. uncinata*, *P. mugo* and *P. nigra*). These conifer species are the main species forming the alpine forests.

In addition the region hosts ca 40 species of deciduous trees, among them beech (*Fagus sylvatica*), hazel (*Corylus avellana*), ash (*Fraxinus excelsior*), sycamore maple (*Acer pseudoplatanus*), alder (*Alnus incana* and *A. viridis*). Few of these species however play any major role at altitudes above 600 m.



Montane beech and mixed beech-fir-spruce forest.

Photo: Peter Friis Møller

Until the end of the 19th century, forest gradually decreased under the pressure of a growing human population. With a change in agricultural practice in the 20th century, forests are now increasing in area through natural re-growth and afforestation. The increasing forested areas in the Alps play an important role in preventing soil erosion, avalanches and landslides.

2.2.1.2 Alpine grasslands

A remarkable high biodiversity is found in the alpine grasslands, comparable to the biodiversity found in certain types of tropical rain forest. The habitat is characterised by the domination of two plant families, grasses and sedges. After hundreds of years of traditional grazing, only a limited part of the biomass has been exhausted and the flora is hardly altered at all.



Taraxacum dominated alpine landscape: agrobiodiversity at its lowest level.
Photo: Jürg Stöcklin.

Endangered grasslands

The essential danger facing alpine grasslands is erosion through:

- deliberate destruction of habitats due to construction of tourism infrastructures
- overgrazing, especially in the southern Alps
- climate change, in particular the shortening of the period with snow cover
- re-establishment of plant communities at this altitude and under the present climatic conditions is a very slow process and sometimes impossible.

2.2.1.3 Nival and rock vegetation

With an increasing altitude the vegetation in the nival zone becomes more and more scarce; ca 150 flowering plants can be found above 2 900 m, 50 species at 3 500 m and only ca 10 species above 4 000 m. Bryophytes and lichens however thrive under severe conditions, more than 200 species have been recorded.

Vegetation inhabiting rocky habitats exhibit a high proportion of endemism. In the Alps, 35–40 % of all endemic species are found on rocks and in screes; half of the 40 plant species endemic to the Maritime Alps are rock inhabiting (rupicolous).

2.2.1.4 Inland waters

The Alps dominate the plains of Europe, their springs and glaciers feeding the major water-courses of central Europe. Five major European rivers are originating from the Alps: Rhone, Rhine, Danube, Adige and Po. More than 2 % of the area of the Alps is covered by the ice of 1 300 glaciers. A majority of the waters have been dammed (79 %) for hydro-electric power production. In most of the waters, pollution have been detected. Changing the natural course of waters may have detrimental effects on biodiversity. Natural waterways encompass a high variety of biotopes which shelter an exceptional fauna and flora. The diversity is drastically changed when hydro-electric power plants are established. For instance has the number of alluvial forests decreased dramatically. Large lakes in the Alps have relatively low phosphorus concentrations (10–60 µg/l). During 1960s and 70s an increase in P concentration caused environmental deterioration.

2.2.1.5 Flora

The altitudinal succession and the size of the Alps creates the basis for a highly diverse flora. The region hosts some 5 000 native vascular plants, about 40 % of the European flora. It is one of the most diverse regions of Europe, despite the fact that the number of tree species is relatively low. The Mediterranean Alps contribute particularly to

biodiversity in harbouring up to 2 800 species.



*The Alps has a highly diverse flora, more than 5 000 vascular plant species can be found, among them Geum reptans.
Photo: Jürg Stöcklin.*

During the latest glaciation populations were isolated on nunataks (ice free areas) which led to the development of endemics. The area hosts ca 350 endemics, most of them found in the south. Strictly endemic species represent 7–8 % of the alpine flora.

2.2.1.6 Fauna

In addition to pure mountain species, the fauna of the Alps include species immigrated from the Arctic biogeographic region during glaciated periods and which can be found in the northern tundra, e.g. mountain hare (*Lepus timidus*), rock ptarmigan (*Lagopus mutus*) and butterflies like *Erebia pandrose*. The marmot (*Marmota marmota*) however immigrated to the Alps from the oriental steppes during inter-glacial periods. Some species are found in the region due to their adaptability: red fox (*Vulpes vulpes*), ermine (*Mustela erminea*) and vipers (*Vipera berus* and *V. aspis*). Others have found the high altitudes as a retreat from human presence: among them the golden eagle (*Aquila chrysaetos*) and the chamois (*Rupicapra rupicapra*). Among insects it is noteworthy that the Alps holds more species of Coleopters than Scandinavia and Great Britain, nearly one third of them are endemic.



The brown bear Ursus arctos is a key omnivorous species in the Alpine biogeographic region. The population of brown bear earlier decreased in sub-regions, but due to monitoring and reintroduction programmes as well as less poaching an increasing number of brown bears have been recorded.

Source: www.copyright-free-pictures.org.uk

2.3 Main pressures on biodiversity

The biodiversity of the Alps faces several main threats, related to the growing tourism industry. Increased traffic and communication networks, fragmentation of habitats and ecosystems, discontinued or changed agricultural practices. In addition, climate change is

acting as a global influence on the biodiversity of the region.

2.3.1 Human population

Today the Alps have a human population size of ca 11 million in eight countries. The human population density varies considerably with altitude, mountain areas are sparsely populated, to a level comparable with the Arctic region, while the densely populated valleys have similarities with urban lowlands as in the Netherlands or the Ruhr district. In 1990 the vertical distribution of the human population concentrated 93 % below an altitude of 1 000 m and only 7 % above 1 000 m. In general, the average human population density of the Alps is ca 60 inhabitants/km². Bavaria, Vorlberg, Tyrol and Salzburg are areas where the human population is increasing, while parts of Piemont, Liguria and Slovenia is severely affected by depopulation and sometimes have densities close to 0. There is also a significant temporal variation, with peaks in summer and during winter tourism periods.

2.3.2 Agriculture

About 70 % of the Alpine biogeographic region is influenced by human activities. In addition to human impact on natural or semi-natural landscapes (e.g. lowering the timberline in mountains), different land-use practices created a great variety of cultural landscapes adapted to existing physical conditions in mountains. Landscapes such as terrace, alpine pastures, hedge-dominated landscapes such as the 'Egartenlandschaft' in the Bavarian Alps or chestnut woods in the southern Alps have been established, giving a distinctive character to regions. Hence, farmers in the mountain have an important function in maintaining these landscapes. Because of being forced into competition with the growing tourist industry, mountain farming nowadays concentrates on the intensification and mechanisation of production. This has led to the abandonment of remote and less accessible alpine regions where a high degree of manual work is required. The result is a loss of ecological stability and of traditional habitats for especially adapted species. For example the biodiversity of sub-alpine grasslands is being decreased by reforestation. Land abandonment induces snow gliding, avalanches, changes in water storage capacity and water transport in soils, the onset of soil podzolisation and a potentially higher frequency of natural hazards.

A grazing plan to restore biodiversity in the Mercantour national park

Ecological and economic considerations need not necessarily be conflicting. The implementation of a grazing plan in the Mercantour national park on the Sanguinière Mountain, France, is an example of sustainable development with a dynamic restoration of biodiversity which has at the same time enhanced the economic potential of pastoralism.

Land degradation due to over exploitation in the 19th century had already been remedied to some degree by the replanting of indigenous larch forests. The upper ridges were still suffering from overgrazing and increasing erosion. On the other hand, lower pastures were being entirely wasted by the proliferation of *Nardus* grass and grasshoppers preventing the development of other species. When sheep were left free to wander, they left the *Nardus* grass untouched preferring more palatable grasses that were exhausted before the end of the grazing season. By this time, the *Nardus* was completely inedible and covered with grasshoppers. However, when the sheep were brought to the *Nardus* early in the season, they preferred it. Shepherding proved to be essential; bringing sheep to the appropriate pastureland at the appropriate time, preventing them from grazing on particularly fragile zones (for example on high ridges which were left to wildlife), limiting the area and the period of grazing in large forests to prevent them from disturbing birdlife in the breeding season. Relatively fragile zones were grazed on a rotational basis

After three years, despite of the reduced area used for grazing, productivity was maintained, and foraging potential was increased. Biodiversity was enhanced in the *Nardus* zone. Vegetation recolonised the ridges, leaving them less open to erosion. The population of chamois increased from zero to approximately 50 individuals. Rare and protected species of grouse (*Tetrao tetrix*) began to flourish.

2.3.3 Tourism

The Alps receives some 100 million tourists every year (40 % during holiday seasons and 60 % at weekends). Together the Alpine countries share a gross revenue of 52 billion dollars (25 % of the world production of tourism) and about 70 % of the 11 million people in the Alps live directly or indirectly from the revenues of the tourism industry. Tourism thus forms an important base of the Alpine economy. Tourism activities are related to a number of serious environmental effects on the recreational value being exploited. Overall, landscape damages caused by tourist activities derives from the construction of facilities, increased traffic and communication networks and by indirect effects as the change in or the abandonment of agriculture practices.



Traffic is a major cause of death for the European badger (Meles meles). 30 000 animals are killed along roads every year in Sweden only.

Photo: Linus Svensson.

2.3.4 Skiing and sporting activities

About 3 000 cable-lifts transport ca 1.3 million persons each year in the Alps. The development of mountain climbing and skiing into mass-tourism activities puts tremendous pressure on alpine resources. Heavy damage is caused to soils and vegetation. Construction works and scraping of extended areas, the morphological structure of soils is altered making them vulnerable to water erosion. This creates a mono-functional, artificial landscape that lacks natural vegetation. Hillsides with low vegetation cover have high water runoff levels causing an increased risk for flooding lower areas. Compensating winters with snow shortage by the use of snow cannons may result in extended snow periods, water shortage as well as problems with pollution of waters. Artificial snow is since 1995 combined with stabilising chemicals with unclear environmental effects.

2.3.5 Fragmentation of habitats

Between 1963 and 1993 the number of habitats with an area greater than 1 500 km² not intersected by major transport networks decrease from 31 to 14, indicating a loss of biotopes for species requiring large areas. A rapid increase (at a rate of 100 %) on long-distance traffic crossing the Alps is expected the next 20 years. Taken together with an increase in local traffic and tourist movements (of which 83 % is by car) both the communication network and the traffic itself pose threats to biodiversity in the region.

2.3.6 Climate change

Mountain areas represent within a relatively small area different climatic belts linked to altitude, and therefore highly sensitive to any climate change. They can be considered as 'early warning systems' for climate change. The extent of environmental and economic damage will depend on the resilience of mountain landscapes to buffer the expected extreme weather events. This can be achieved through good landscape maintenance in mountain forestry and pastoralism. Raising temperature and changes in precipitation patterns would cause changes in snow cover and water reserves, soil instability through reduction of permafrost soils, and also influence the frequency of natural phenomena such as mudflows, floods or drought. In the south-western Alps, a progressive decrease in precipitation is expected leading to steppe-like vegetation patterns. In general, the Mediterranean climate might spread further northward and upward endangering Alpine plant communities and causing extinction of some European tree species in the central Alps.

2.4 Biodiversity policy initiatives

2.4.1 The alpine convention

The Alpine Convention (8 countries: Germany (D), Austria (A), France (F), Italy (I), Liechtenstein (FL), Monaco (MC), Slovenia (SLO), Switzerland (CH) plus the European Community (EU)) was signed in 1991 and ratified in 1995. Eight protocols have been signed Only the Monaco Protocol has been ratified so far and came into force in March 1999.

Protocoles/States	A	CH	D	F	FL	I	MC	SLO	EU
Nature protection and landscape management		•	•	•	•	•	•	•	•
Mountain agriculture		•	•	•	•	•	•	•	•
Land management and sustainable development		•	•	•	•	•	•	•	•
Mountain forest		•	•	•	•	•	•	•	•
Tourism		•	•		•		•	•	
Energy			•					•	
Soil protection		•	•				•	•	
Monaco Protocol	•	•	•	•	•	•	•	•	•

Source: CIPRA web site, Sept 2000.

Note : Country codes, see text.

2.4.2 Protected and unprotected areas

Protected areas such as national parks, regional parks, biosphere reserves or natural reserves cover about 15 % of the Alps. Human intervention of any kind is forbidden on 1 % of the area. The 13 national parks cover 4.2 %. All the large protected areas are to be found at high or very high altitudes. Very little protection is given to forests below the sub-alpine zone, no protection at all in the valleys. Domestic alpine species are just beginning to be taken into consideration, in terms of the genetic resources they represent.

2.4.3 Information, research and monitoring programmes

CIPRA (International Commission for the Protection of Alps) an NGO, created in 1952, promotes a global approach for the conservation of natural and cultural diversity and resources in the Alps, through exchange of information and experiences, publications and conferences. It was instrumental in the setting up of the Alpine Convention for which it has an observatory status. As part of this Convention, the Alpine network of protected areas (RESALP) was set up by contracting parties in order to co-ordinate various initiatives among which inventories, monitoring activities (on large carnivores, on ungulates, on flora), and training.

3. The Scandes

3.1 What are the general characteristics of the Scandes

3.1.1 Profile

The Scandes of the Alpine biogeographic region runs along the Scandinavian peninsula for 1 400 km from 59° to 70°N. The ridge has an average elevation of 500 m with several peaks over 1 000 m, the highest at 2 469 m. Being defined as the area above the lower fringe of the birch forest, the area covers about 200 000 km², half of it in the upper alpine area, half of it in the mountain birch forest.

The Scandes were formed 300 million years ago and have been further shaped during successive periods of glaciation during the Quaternary. They are a mixture of partly transformed volcanic rocks and sand stone with layers of sedimentary limestone. Thin moraine soils and bare rock dominate, even if some richer soil layers are locally found. The topography changes from rolling forms of the southern mountain areas, including Hardangervidda the biggest mountain plateau in Europe (8 000 km²), to dramatic peaks carved out by glacial action in the west and north.



The sub-alpine region is in the Scandes characterised by a belt of Betula spp. Photo: Kjell Sjöberg.

3.1.2 Climate

The main climatic factors structuring biodiversity in the mountains are temperature and humidity, especially related to the length of the snow-free season. In the alpine zone the

mean temperature in summer tends to be 6–10 °C lower than at sea level. In addition, increasing latitude and the influence of the nearby ocean creates two main regional climatic clines, running south – north (mainly variation in temperature) and coast – inland (mainly variation in humidity). The growing season, expressed as number of days with mean temperature above 5 °C, is less than 140 days in the region. The westernmost part of the Scandes in south Norway has an annual mean precipitation of 2 000 mm, but most of the area is dryer, with less than 1 000 mm. The Scandinavian peninsula is favoured from south to north by a relatively mild, oceanic climate due to the influence of the Gulf Stream. This major climate impact makes the difference in timber line and vegetation less pronounced between south and north, than in more continental European alpine areas.



The alpine belt of the Scandes in winter. Photo: Kjell Sjöberg.

3.1.3 Human presence

The human impact on nature in Scandinavia was for a long period of time limited to the coastal areas, which were accessible by boat. Inland and mountain areas were used mainly for hunting and in more recent times for grazing by livestock. Even the 'traditional' reindeer herding by the Sami people started only a few hundreds years ago, before which the Sami were hunters and followed the natural migrations of the herds. Today the Scandes are visited by outdoor tourists.

3.2 Biodiversity, habitats, flora and fauna

3.2.1 Habitats

The Scandinavian Alpine subregion includes wide areas of mountain forest, as well as extensive alpine areas, traditionally divided into three subregions characterised by composition and extent of the vegetation.

The alpine level is characterised by a mountain tundra similar to corresponding areas in the Urals but quite different from the vegetation found in the Alps or the Pyrenees.

3.2.1.1 Mountain forests

The timber line, which varies between 1 200 m in the southern Norwegian mountains and the sea level on the coast of Finnmark, is almost exclusively composed of mountain birch

woods (*Betula pubescens czerepanovii*). Other deciduous trees such as grey alder (*Alnus incana*), bird cherry (*Prunus padus*), aspen (*Populus tremula*), rowan (*Sorbus aucuparia*), and various willows are also present. The birch forests on richer sites are characterised by tall herbs like alpine sow-thistle (*Cicerbita alpina*), northern wolfsbane (*Aconitum septentrionale*), large white buttercup (*Ranunculus platanifolius*) and globe flower (*Trollius europaeus*). The mountain forests were previously much used for pastures and collection of firewood. Alpine dairy farming resulted in a cultural landscape with patches of open land surrounding small farm buildings. Cessation of use and management has led to re-growth by scrub over the last few decades, and this has decreased much of the open, semi-natural areas which were important for a temporary artificial increase in local species diversity.



Capercaillie, Tetrao urogallus, a species of the Alpine lower forest. It prefers old-growth spruce stands. Photo: Kjell Sjöberg.

3.2.1.2 Streams, lakes and glaciers

Numerous small brooks are fed by melting snow during spring and quite a few of them drain mountain areas wet enough to have permanent watercourses. Most of the larger watercourses are more or less altered, but there are still a few unaltered larger rivers, like the Kalix river in Sweden and lakes like Torne träsk in Sweden and Femunden in Norway. The region is rich in rainfall and the moist climate maintains a multitude of lakes, streams and rivers, as well as bogs and moors. The water quality is mostly good to excellent, with the exception of acidification problems in the south-west. Some large glaciers are found in the western part of the region, the largest of which are Jostedalbreen, Svartisen, and Folgefonna.

3.2.1.3 The alpine belt

The low alpine level is characterised by a well-developed treeless vegetation cover, including mires and low shrubs (bluish willow *Salix glauca*, downy willow *S. lapponum*, woolly willow *S. lanata*, dwarf birch *Betula nana* and bilberry *Vaccinium myrtillus*). In the mid-alpine level, dominant plants are sedges (e.g. *Carex bigelowii*), grasses (e.g. *Festuca ovina*) and rushes (e.g. *Juncus trifidus*), with herbs like mouse-ear (*Cerastium*), buttercup (*Ranunculus*) and saxifrage (*Saxifraga*) species in more humid areas. The high alpine level lacks continuous vegetation formations of vascular plants, and bare rock and boulder fields characterise extensive areas. Only scattered plants occur, lichens and bryophytes are most frequent, about 30 species of herbs and grasses are found. The flora here is relatively poor, with 250 vascular plants present compared with the 650 found at the same level in the Alps.



Lichens (Cladonia spp.) and bryophytes are important in forming the vegetation of the alpine belt of the Scandes.

*Photo: Gil Wojciech, Polish Forest Research Institute,
www.forestryimages.org*

3.2.2 Species diversity

During its maximum extent about 18 000 years ago, the Weichsel continental glacier left little or nothing of Scandinavia uncovered. Species immigrated during the post-glacial period. The present species composition indicates that immigration mostly took place from the south. However, there are some indications of colonisation from the east, north of the ice-cap. Species with a circumpolar distribution are often found in the Scandes today. The occurrence of speciation within the Scandinavian alpine area is negligible and there are very few endemic species because of the last glaciations. Still, there is always the possibilities that species have evolved outside the area, have dispersed into it after the last glaciation, and then died out everywhere else.

Most of the plant and animal species can be assigned to one of three biogeographical groups. Many of the species, at least in the lower part of the alpine areas, are quite common species in most of north-western Europe. More than half of the nearly 100 birds species in the Scandes belong to this group. The majority of the species in the highlands are northern species such as polar fox (*Alopex lagopus*), snowy owl (*Nyctea scandiaca*), polar fritillary (*Clossiana polaris*) or arctic species such as Norway lemming (*Lemmus lemmus*), wolverine (*Gulo gulo*), rough-legged buzzard (*Buteo lagopus*). Species of this kind tend to attract little attention in European conservation policy as they are not 'endemic' to any European region. However, they are almost all endemic to the circumpolar region. About 30 mountains bird species have this type of distribution. An exclusive element from a Scandinavian perspective, is represented by the disjunct species such as: purple gentian (*Gentiana purpurea*), alpine forgetmenot (*Myostis decumbens*), false musk orchid (*Chamaeorchis alpina*), mountain hare (*Lepus timidus*), ptarmigan (*Lagopus mutus*), dotterel (*Eudromias morinellus*). These species are found in

the Scandes and other alpine areas in Europe, such as the Alps, whereas they are missing in the lowlands in between.

3.3 Human influence and the use of biodiversity

3.3.1 Economic use of species

3.3.1.1 Reindeer hunting

Annual reindeer (*Rangifer tarandus*) hunting in the south of Norway is an important activity. The number of wild reindeer in the area fluctuates at 30 000 individuals distributed over an area of 40 000 km² of alpine and sub-alpine landscapes. The herds can occasionally have a dramatic structuring effect on the plant cover by overgrazing. The hunting of the only alpine wild reindeer population in Europe has been debated. However, as long as the herds are not under natural control by carnivores, lack of hunting would result in uncontrolled growth, which would certainly end in mass starvation of the animals. Hunting of small game like grouse (*Lagopus lagopus* and *L. mutus*) and hares (*Lepus timidus*), as well as sport fishing for brown trout (*Salmo trutta*) and other freshwater fish species, are also wide-spread recreational activities of some economic importance for local communities.



Reindeer in the alpine belt of the Scandes. Photo: Kjell Sjöberg.

3.3.2 Human pressures on biodiversity

3.3.2.1 Grazing

Sheep grazing is extensive over most of the lower elevations of the Norwegian Alpine area. Added to the extensive grazing by domestic reindeer it creates a supplementary pressure on the vegetation, in the Swedish and northern Norwegian parts of the region. Cessation of grazing and harvesting of traditional alpine pastures may also affect the structure and diversity of species associated with these habitats.

3.3.2.2 Hydroelectric power plants

The large-scale development of hydroelectric power in Norway and Sweden has resulted in many large artificial reservoirs and changed water flow regimes in several rivers. The impact on nature is severe, but local. Attempts have been made to compensate the effects of dams on migratory salmonid fish populations by releasing stocked fish. Pylons

and other installations for electricity transfer interrupt the tracks of larger animals and kill birds colliding with the wires. The number of birds killed by high-voltage power lines are remarkably high. Bevanger and Brøseth (2004) reports an annual minimum ptarmigan collision rate at 5.3 birds km⁻¹ power line. They further report that the number of ptarmigans killed after collisions with power lines is more than 2 times the yearly hunting bag.

3.3.2.3 Tourism

Scandinavian natural areas, especially the mountains, traditionally provide free access to the public for recreation. An increase in the use of motorised vehicles, mainly during the winter, disturb both wild animals and humans. The vehicles also create tracks in the landscape, tracks not easily healed in biotopes with slow re-growth.

3.3.2.4 Infrastructure development

There is no permanent households in the upper alpine areas. With the exceptions of tourism, the development of infrastructures is limited to roads and railways to transport people through the areas. A few settlements like the old mining town Røros is found in the lower part of the mountain forest. Mining discharges have affected lakes and rivers at a local scale.

3.4 Biodiversity policy initiatives

3.4.1 Protected areas

There are several large nature parks and national parks in the Scandinavian alpine area. At least 25 areas larger than 1 000 km² are uninterrupted by roads in Scandinavia and Finland, and more than 60 % of them are situated in the alpine region. The largest is situated north of the Graddis road and is about 15 000 km². Some of the largest unfragmented and protected areas in Europe are located in the Scandes, where pressures from population, land-use and traffic are relatively low.

3.4.2 Internationally designated areas

Eight of the 20 alpine Ramsar Convention sites are situated in the Scandes. The region also comprises 14 Biogenetic Reserves, one Biosphere Reserve, the Torne Träsk, and one World Heritage Site, the Lapponian area, which is one of the largest in Europe.

4. The Pyrenees

4.1 What are the general characteristics of the Pyrenees

4.1.1 Profile

The Pyrenees, the mountain chain of southwestern Europe, stretches from the shores of the Mediterranean Sea in the east to the Atlantic Ocean in the west. The range is 430 km long with a width of 10 km at its eastern end, but reaches 150 km in the central zone. The highest point is Aneto Peak, at 3 404 m. In both the lower eastern and northwestern sectors, rivers dissect the landscape into numerous small basins. In the north, the slopes descend abruptly onto the broad plains of Aquitaine and Languedoc. On the Spanish side the descent is more gradual. The Pyrenees is recent elevations of an ancient mountain chain.

4.1.2 Climate

An intricate mosaic of climatic patterns can be found on both sides of the Pyrenees. Generally however, the northern slopes are exposed to the influences of the Atlantic ocean, with high precipitation while the south is dryer due to Mediterranean influences. The Atlantic influence penetrates southward across the low peaks of the western Pyrenees, tempering somewhat the differences of climate between the northern and southern slopes on the western extremity. Winds from the southeast and east carry moist air from the Mediterranean, some of which falls as precipitation over the south-eastern peaks, resulting in an increased humidity.

4.1.3 History of human presence

Mankind was already established in the Pyrenees, at least on a seasonal basis, 4 000 years ago. Fire was almost certainly used in this period to clear forests for pasture land near the summits. The development of pastoralism from this time onwards was one of the main determining factors for the present day landscapes at high altitudes. All the different aspects of the mountain ecosystems were fully exploited in the tradition of agro-silvo-pastoralism, a state of relative equilibrium between the natural habitats and human activities being maintained for centuries. A typical feature was the summer migration of livestock from the meadows in the plains and valleys to the pastures of the higher altitudes. This practice has almost completely died out. Formerly, the whole of the Pyrenees was a pastoral mountain and has been durably marked by the presence of flocks and herds. The slopes exposed to sunlight in the valleys were used for growing crops. The forest has been exploited for timber for hundreds of years. However, deforestation accelerated in the 18th century with the development of mining; beech wood was widely used for making charcoal.

4.2 Present biodiversity status and trends

4.2.1 Habitats richness and trends

4.2.1.1 *The montane belt*

The montane belt is characterised by mixed forests of beech and fir. In the north there is a predominance of acidophile beech (*Fagus sylvatica*) with Scots pine (*Pinus sylvestris*) playing a relatively minor role. The south on the other hand is dominated by Scots pine. Evergreen oak (*Quercus rotundifolia*) climb to relatively high altitudes, also juniper (*Juniperus thurifera*) are present. The Iraty forest in the west is one of largest beechwoods in Europe with particularly favourable climatic conditions. Many giant specimens of beech can be found. There are a few small portions of only several acres of Pyrenean primal forest still existing. Birds living in the beech and fir forests make up at least half of the bird biomass of the Pyrenees. These forests also serve as habitats for western capercaillie (*Tetrao urogallus*), red deer (*Cervus elaphus*), pine marten (*Martes martes*) or beech marten (*Martes foina*).



Martes spp. are found in the beech-fir forest of the Pyrenees.
Photo: Michael Mengak, The University of Georgia,
www.forestryimages.org

4.2.1.2 The sub-alpine belt

The sub-alpine zone is made up of a sparse forest dominated by mountain pine (*Pinus uncinata*) – some specimens 700 years old – on grassland and shrubby moorland interspersed with rocks and screes. Shrub species are characterised by dwarf juniper and particularly in the north by rhododendrons (*Rhododendron ferrugineum*) and bilberry (*Vaccinium myrtillus*) whereas bearberry (*Arctostaphylos uva-ursi*) dominates on the southern slopes. The sub-alpine belt is somewhat simpler than in the Alps with fewer types of scrubland and moorland: 61 % of its flora species are the same as those found in the corresponding zone in the Alps. Examples of characteristic birds are: citril finch (*Serinus citrinella*) and crossbill (*Loxia curvirostra*).



Common crossbill, *Loxia curvirostra*, is one of the species of the sub-alpine belt in the Pyrenees.
Photo: Terry Spivey, USDA Forest Service,
www.forestryimages.org

4.2.1.3 Alpine and nival belts

Pyrenean alpine grasslands with sedge (*Carex* spp.) and fescues (*Festuca scoparia*, *F. eskia*, *F. supina*) are very similar to those found in the Alps: out of 101 plant species, 79 also exist in the Alps and 21 are endemic (Blandin, 1992). The alpine belt exists only in

the eastern Pyrenees as far as the Anie mountain, the highest peaks only reach a maximum of 2 000 m. It is the domain of ungulates such as isard (*Rupicapra pyrenaica*). The cliffs and the rocky slopes also serve as nesting places for large birds of prey such as: golden eagle (*Aquila chrysaetos*), griffon vulture (*Gyps fulvus*), Egyptian vulture (*Neophron prenopterus*) and bearded vulture (*Gypaetus barbatus*).

4.2.1.4 Caves and karst fissures: many subterranean habitats

Numerous caves can be found at all altitudes. The cave dwelling fauna in the Pyrenees is amongst the richest in the world. The beetles belonging to the genus *Aphaenops* are endemic species in the Pyrenees and live exclusively in caves and crevices in calcareous rocks or microhabitats in screes, with low numbers estimated at a few thousand individuals. Some species are very rare and their existence is known only from discoveries of a few specimens. They all show the morphological and biological adaptations that are characteristic of an underground life. Excessive hunting, pollutants in particular by pot-holers (fuel) or when rain water infiltrates the habitat after leaching the top soil (pesticides) or by accident (oil leaks) have serious consequences for their survival.

4.2.1.5 Rivers and lakes

Torrents, cascades and lakes are plentiful in the Pyrenees. However, there are very few glaciers in comparison to the Alps. Lakes at high altitude have a much more prolific biological production than Alpine ones. There are more than 1 500 lakes between 1 000 and 2 500 m of altitude. Species that can live there are very specialised and their number and density always limited. Several fish have been introduced: the rainbow trout (*Oncorhynchus mykiss*), brook trout (*Salvelinus fontinalis*) or the lake trout (*Salvelinus namaycush*) and charr (*Salvelinus alpinus*). The brown trout (*Salmo trutta*) is the only indigenous trout. The introduction of rainbow trout has caused problems because it eats the larvae of the Pyrenean newt (*Euproctus asper*). This endemic species has declined considerably as a result.

4.2.2 Flora richness and trends

Pyrenean flora is very closely related to flora of the Alps. Flora richness increases from west to east. The total number of vascular plants is estimated at about 3 000. There are even fewer tree species than in the Alps. Spontaneous gymnosperms are reduced to only three species: Scots pine, juniper and fir. There are quite a number of shrubs. The genus *Salix* has about twenty different species, and Ericaceae are well represented. Despite of the relatively modest altitude of the Pyrenees, glaciation during the ice age was severe. Arctic-alpine species are numerous and even have some representatives that are missing in central European mountains downy willow (*Salix lapponum*) and *Phyllodoce caerulea*. Vast areas of the Iberian peninsula served as refuges for species during periods of glaciation; later recolonisation therefore took place under highly favourable conditions. The level of endemism is high: 120 species strictly endemic or endemic to the Pyrenees and the Iberian peninsula, with species such as Pyrenean saxifrage (*Saxifraga longifolia*), Pyrenean water saxifrage (*S. aquatica*), and *Androsace cylindrica*. As in the Alps many of the endemics are found at relatively low altitudes.

4.2.3 Fauna richness and trends

The Pyrenean fauna is today rich in larger herbivores as well as in a variety of predators. In all there are 42 species of mammals present. Some species, such as the wolf, lynx, and brown bear, have disappeared or had their numbers severely reduced, especially in the northern Pyrenees. The brown bear is today a relic species. The southern Pyrenees, however, represents one of the last important refuges for wild European fauna driven out of areas with denser human populations. The marmot, which disappeared from the chain 10 000 years ago, has been successfully reintroduced. Several amphibian species have managed to adapt to living at high altitudes: the endemic Pyrenean newt, the common

frog (*Rana temporaria*), Pyrenean frog (*Rana pyrenaica*, newly discovered in 1993), fire salamander (*Salamandra salamandra*), palmate newt (*Triturus helveticus*), midwife toad (*Alytes obstetricans*), common toad (*Bufo bufo*). The Pyrenean desman (*Galemys pyrenaicus*), a semi-aquatic mole, is an interesting example of endemic fauna.



Wolf, Canis lupus, had decreased to a level of 400–500 individuals in the Pyrenees during the 70s. Due to less hunting and less adverse view on the wolf from the public, the population has recovered and is now estimated to more than 2 000 animals, about 30 % of the European population (excl. Russia).

Photo: Terry Spivey, USDA Forest Service, www.forestryimages.org

4.3 Human influences and biodiversity

4.3.1 Economic use of species biodiversity

4.3.1.1 Domestic breeds

A certain number of domestic breeds adapted to specific areas have developed over the centuries. Some sheep breeds have survived particularly in the western part. Manechs and béarnaises can be counted by the thousand in Pyrenean pastures. However a large number of local breeds of donkey and goat have disappeared.

4.3.2 Main pressure on biodiversity

4.3.2.1 Hunting

The isard (*Rupicapra pyrenaica*), is a mountain antelope that nearly became extinct due to intense hunting and poaching. Measures were taken such as the establishment of game reserves and the adoption of hunter-kill ratios. In 40 years, the isard passed from the status of a relict population of few thousands to around 50 000 individuals. The Pyrenean ibex (*Capra pyrenaica pyrenaica*) has been present in the Pyrenees since prehistoric times. It took refuge in a small area in the Mont Perdu massif of Aragon. Through the centuries the main cause of its decline was hunting. The causes of the recent decline of the small Spanish residual population have been attributed to various factors: lack of habitat, competition with other ungulates, human disturbances, poaching, and insufficient genetic diversity. The last Pyrenean ibex died in the year 2000.

4.3.2.2 Deforestation

Present day distribution of beech and fir has been largely determined by human exploitation. Beech was used as fire wood and charcoal in furnaces for metal extraction. Traces of exploitation over the past centuries can be seen in almost every valley in the west just as far as Canigou, forest degradation was quite considerable. Recently tree growth has reclaimed wide areas. The sub-Mediterranean climate of much of the southern flank has prevented regeneration of beech and fir forests which have been replaced by dryer forests, sometimes oak (*Quercus rotundifolia*) but more often Scots pine (*Pinus sylvestris*). Large areas of the forest on the upper limits were transformed into pastures for summer grazing. Over-exploitation in the past led to soil degradation and despite of the fact that much of the land has been abandoned, it is unfit for rapid recolonisation by forest species.

4.3.2.3 Agro-pastoralism in decline

Pyrenean pastoral landscapes constitute singular ecosystems, maintained by shepherding, bringing appropriate domestic animals to appropriate pastures at the right time, and burning scrubland when necessary. Generally sheep are now left to wander at random over wide areas, which results in over-grazing in some patches and the invasion of scrubland in others. Pastoral activity has diminished considerably; cattle raising for beef is the main branch to continue. A few immense flocks of sheep do still exist following their traditional trail between summer pastures at high altitudes and wintering in the Ebro plains. Gradually, the less fertile plots have been deserted, and the landscape has become dotted with patches of brooms and brackens and plantings of coniferous trees. Except for such areas as the Basque Country of Spain and the Roussillon region of France, the agriculture of the Pyrenees is in decline.

4.3.2.4 Tourism and road networks

In the past the occupation of the mountains by the rural population was spread over wide areas. This strongly contrasts with the high seasonal concentrations of the tourist population of today. Spas like Gavarnie, Cauterets, Luchon, and Panticosa, set up in the 19th century are still popular. Gavarnie, for example has a million visitors a year. Ski resorts, although not as highly developed as in the Alps, are particularly damaging to landscapes and biodiversity. Tourism has also contributed to the abandonment of traditional ways of life.

Most of the rail and road traffic between France and Spain goes by coastal routes at either end of the Pyrenees. Nevertheless indications of increasing pressure of traffic in the Pyrenees can be seen in the successive building of road tunnels: Aran valley (1948), Aure valley (1976), and Puymorens (1994). Freight road traffic is on the increase. A motorway has been built between Toulouse and Barcelona. There are many propositions and projects to multiply the transport network in the Pyrenees, potentially very damaging to biodiversity.

4.4 Biodiversity policy initiatives

4.4.1 National parks

The two Pyrenean national parks cover 61 315 ha. The 'Parque nacional de Ordesa' was set up in 1918 with the particular object of protecting the range of the Pyrenean ibex already threatened by hunting. The French national park of the Pyrenees was set up in 1967 amidst a storm of controversy. There was considerable local opposition to the creation of the park. It has an extremely indented configuration because it follows the border between France and Spain, and in some parts it is only a few hundred metres wide. The limits of the park do not correspond to natural boundaries. Ninety percents of the territory necessary for the survival of the brown bear is outside the park. Nevertheless the park serves as a refuge for numerous other animals and plants.

The two parks cooperate for various activities, notably for the monitoring of species and habitats, such as the follow up and counting of bearded vulture (*Gypaetus barbatus*), the making of an inventory of endemic flora and the realisation of vegetation maps. The Charter of Cooperation between the two parks has been renewed for the period 1998–2008.

The Charter for the protection of the Pyrenees set up by the Conseil International Associatif pour la protection des pyrénées (CIAPP,) was re-launched in 1996 at the European NGO Consultation on Sustainable Mountains in the framework of the implementation of Agenda 21 chapter 13.

5. The Carpathians

5.1 What are the general characteristics of the Carpathians

5.1.1 Profile

The Carpathians are recent mountains forming the eastward continuation of the Alps. They stretch out in a great arc some 1 450 km long from the Danube Gap near Bratislava to the Iron Gate near Orsova. The chain is half as wide as the Alps and the peaks are half as high. Although a counterpart of the Alps, the Carpathians differ considerably from them in their structural elements. The sand-stone-shale band known as flysch, which flanks the northern margin of the Alps in a narrow strip, widens considerably in the Carpathians, forming the main component of their outer zone. Crystalline and metamorphic rocks, which represent powerfully developed chains in the central part of the Alps, appear in the Carpathians as isolated blocks of smaller size surrounded by lowlands. On the interior of the arc, the Carpathians contain a chain of volcanic mountains.

5.1.2 Climate

The Carpathians possess certain features of a continental climate but with higher average precipitation than the surrounding plains. Precipitation vary from 1 000 to 1 500 mm and reach a maximum of 2 360 mm in the High Tatra. The inland type of the climate is clearly seen in the valleys, as well as on the lower parts of the southern mountain slopes. Further, summers are hot and winters cold. In winter, temperature inversions are common: the low depressions retain very cold air while the mountaintops show relatively high temperatures. Compared with the Alpine subregion, the Carpathian climate at equal altitude and latitude is a little colder and in the south there is nothing comparable to the climate of the sub-Mediterranean Alps.

5.1.3 Soils

Upper Cretaceous and Paleogenic deposits appear in dislocated layers of flysch – interbedded sandstones, marls, and schists. Quarternary formations such as glacial deposits, alluvial deposits, and loess in the depressions are widespread.

5.1.4 Human influences

Human influence in the Carpathians started in the neolithic period. There is evidence of the burning of forests to obtain agricultural land from 4 500 BC onwards. Migration of tribes on a large-scale led to immigration of plant species from Asia, especially from the Middle East. Settlements continued to expand and the natural conditions of large areas were modified. In pre-Roman times ancient chronicles mention the cultivation of vines (*Vitis vinifera*) and the use of medicinal plants in the south-eastern Carpathians. The

Romans extended cultivated areas and exploited natural resources (especially wood). However, mass deforestation only began at the end of the 14th century with the development of mining and metallurgy which required large amount of timber. Nevertheless vast areas of forest have remained untouched particularly at high altitudes. Severe impact due to industrialisation did not really begin until the middle of the 20th century.

5.2 Present biodiversity status and trends

5.2.1 Habitats

The Carpathians can be divided into different vegetation belts similar to those found in the Alps. However owing to the fact that they do not reach such high altitudes, the nival and upper alpine zones are missing. The montane zone has an estimated area of 70 000 km², the sub-alpine 15 000 km² and the alpine zone only 1 000 km².

5.2.1.1 Forests

Forests cover more than 90 % of the Carpathians with some of Europe's largest stands of virgin forest. They are characterised by a great variety of tree species with distribution patterns corresponding to the various altitudinal belts. The foothills are dominated by oak *Quercus robur* in the valleys, *Quercus petraea* on hills. Mixed ravine and slope forests (*Acer pseudoplatanus*, *Fraxinus excelsior*, *Ulmus glabra*, *Tilia cordata*) are situated mainly on calcareous substrates.

Beech forests dominate the montane belt, mainly *Fagus sylvatica* and locally by *Fagus orientalis*, *F. moesiaca*, *F. taurica* in south and east. Mixed forests of beech-fir or beech-fir-spruce occur at upper levels. In most of the Carpathian Norwegian spruce (*Picea abies*) forests, usually unmixed, form the lower sub-alpine belt and the mugo pine (*Pinus mugo*), the upper sub-alpine zone. Larch- and arolla (*Pinus cembra*) forests are located near to upper forest line in a narrow, non-continuous belt. There are alluvial forests along streams and rivers with dominance of trees such as willow (*Salix fragilis*) and alders, (*Alnus glutinosa/A. incana*). Other, more rare forest types are important for biodiversity, such as alder swamp woods, relict pine forests and birch mire woods.

Virgin forests and the protection of biodiversity

Virgin forests are forests that have formed spontaneously, without human interference and continue to develop in the same way. The heterogeneous structure of the virgin forests is determined by a mosaic-like succession and overlap of different stages of growth in a closed and perpetual dynamic cycle. The area covered by virgin forests in Slovakia is estimated at 18–20 000 hectares, which besides primary forests also include forests in near-original condition considered as secondary virgin forests. Virgin forest are important at all levels of biodiversity assessment including diversity of ecosystems, species, and genetic information. They are inhabited by species having survived long periods of natural selection and represent a unique gene pool which is of great importance for conservation purposes.

5.2.1.2 Vegetation above the timberline

The sub-alpine and alpine belts of the Carpathians are constituted by grass communities on shallow soils, small shrub communities, tall-herb alluvial communities, rock and scree communities, and snow-bottom communities. Mosaics of small patches with sharp boundaries are very common. Alpine vegetation although covering only 2 % of the region is of considerable significance for biodiversity, with specialised species, adapted to extreme life conditions. Large areas of the alpine belt are occupied by a society of three-leaved rush (*Juncus trifidus*) and crowberry *Empetrum hermaphroditum*, *Festuca versicolor* and mountain avens (*Dryas octopetala*). Communities on mylonites, in the Tatra

Mountains are of particular interest and are represented by an endemic set of species including such as moss campion (*Silene acaulis*). The pioneer communities of scree habitats are represented by *Leontopodium alpinum*, *Artemisia eriantha*, *Papaver tatricum* and others. Snow-bottom communities are characterised by specific mosses from the genera *Anthelia*, *Pohlia*, *Kiaeria*, and vascular plants like dwarf willow (*Salix herbacea*), dwarf cudweed (*Omalotheca supina*).



Silene acaulis, one of the species found in the Carpathian alps. Photo: Oswald Gabathuler.

5.2.1.3 Peat bogs

Peat bogs provide specific habitat conditions, which enable the existence of rare plant and animal populations. Remnants of the ice ages may also be found in peat bogs – glacial relics, pushed here by a glacier moving from the north. Thus, these habitats can be considered as living chronicles of the evolution of natural environment. Bogs play a unique role in the biological diversity of the Carpathians. Typical plant species for these habitats are: *Sphagnum* spp., labrador tea (*Ledum palustre*), round-leaved sundew (*Drosera rotundifolia*), *Eriophorum* spp., white beak-sedge (*Rhynchospora alba*), bog-sedges, (*Carex limosa*, *C. canescens*). Peat bogs also support a unique fauna adapted to specific microclimatic conditions and vegetation environments. Rare butterflies for instance occur in the Orava region (west Carpathians): *Arichanna melenaria* and *Anarta myrtilii*.

5.2.1.4 Rivers and lakes

Although the Danube breaks through Carpathians on either end, and other important rivers like the Dniester, the Wisla, the Tisza spring in Carpathians, the genuine Carpathian rivers: the Váh, the Hron, the Muresand and the Olt are smaller. Carpathian rivers are characterised by a rain-snow regime; high-water periods occur in early spring and early summer, with the latter usually more powerful. Floods often assume catastrophic dimensions. There are some 450 small mountain lakes, mainly of glacial origin, most of them located between 1 350 and 1 970 m. The largest is Velké Hincovo pleso (0.18 km², 53 m deep). Dwoisty Gasienicowy Staw is noteworthy as the habitat of the relic crustacean species *Branchinecta paludosa*. There are about 50 reservoirs in the Carpathians the largest being in the extreme south, the Iron Gate Reservoir on the Danube.

5.2.2. Flora and fauna, richness and trends

The position of the Carpathians played in the past a significant role in migration and distribution of plants and animals. There are hundreds of endemic species and relics, most of them are plants and invertebrates. They are also an important area for migrating birds. Only the upper parts of the Carpathians were covered by ice during the last glaciation. The periglacial (tundra-like) landscape conditions of their lower parts caused migration of the biota to south-carpathic refugia and back. The glacial relic species now occupy the area above the timber-line or on steep rocks (e.g. the snail genus *Pupilla*), where they have not come into competition with returning forest species.

5.2.2.1 Flora

Carpathian flora is evaluated to hold around 3 500 species. They have retained vestiges of a rich autochthonous floristic base from the tertiary, which was however soon subjected to immigration from different geographic origins. Thermophilous species penetrated from the Pannonian and Continental regions, and elements from the Alps as well as the Balkans are present in the southern Carpathians. There are many endemic species although three times fewer than in the Alps. More than 250 endemic vascular plants are known. The share of endemic flora is 13 %, which is comparable to eastern Alps or the Pyrenees. There are endemic Carpathian species, many from genera *Alchemilla* (Lady's mantle) and *Sorbus*, and also for example *Aconitum firmum* and *Erigeron hungaricus*. In addition both western and south-eastern Carpathians have their own endemics such as *Campanula xylocarpa* and *Anthemis carpatica*.

5.2.2.2 Fauna

Carnivores are symbols of Carpathian natural habitats. Three species represent an important percentage of European populations. Lynx (*Lynx lynx*) populations of more than 2000 individuals could play an important role in preservation of the species in Europe. The wolf (*Canis lupus*) populations exist in four distinct areas of Europe, one of them being in the Carpathians (3 000 individuals). The brown bear (*Ursus arctos*), with about 6 000 individuals, represent about 60 % of the European population.

The chamois, while thriving in south-eastern Carpathians with almost 7 500 individuals, in western Carpathians has dramatically decreased in the last years, the present number being only 450 individuals compared to previous ideal number of 1 200. Some of the important migration routes for birds cross the Carpathians, either for Russian and West-Siberian bird populations wintering in the Balkans, or for birds from northern Europe wintering further south.

There are hundreds of endemic species and relics. Most of them are invertebrates such as endemic worms (*Tubifex montanus*, *Tatriella slovenica*, *Allolobophora carpathica*), molluscs (tens of species) or arthropods (*Ischyropsalis manicata*, *Paranemastoma kochi*). Two terrestrial vertebrates are among the endemic Carpathian species, the Tatra vole (*Microtus tatricus*) and montandon's newt (*Triturus montandoni*). The Tatra vole inhabits old climax spruce forests, mountain meadows, along streams and in humid rocky habitats. This rare rodent has a restricted range and is potentially endangered by habitat destruction and the introduction of predatory fishes.

5.3 Main pressures on biodiversity

5.3.1 Economic use of species

Many autochthonous trees and shrubs species have an economic importance producing wood, resin, fruits, flowers, leaves and bark with a medicinal character. One of the oldest cereals existing in the Carpathian region since Neolithic period, the Carpathian emmer (*Triticum dicoccon*) ceased to be cultivated in the 20th century. Some of the cultivated and useful wild plant varieties are endangered. These include perennial vegetables and

cereals as perennial rye and wheat (*Triticum dicoccum*, *T. monococcum*), fruits as apples, pears (*Malus* spp. and *Pyrus* spp.), small fruits (*Sorbus domestica*, *S. torminalis*) and vines (*Vitis* spp.).

5.3.1.1 Domestic animals at the edge of extinction

The hucul is the only European horse breed adapted to mountaineous environments. It has existed for centuries in the Carpathians and is considered to be the domesticated form of the tarpan (*Equus ferus*), a steppic horse species that became extinct in wild at the beginning of the 20th century in Ukraine. It was used in forestry and is capable of surviving during the winter without being stabled. After WW2 the hucul population declined dramatically because of lack of interest, and became critically endangered.

Two typical, now almost extinct breeds of cattle are known: Carpathian red cattle and Carpathian greyish brown cattle. Their restitution could be achieved using the last surviving herds in the Ukraine. The traditional west-Carpathian breed sheep, the Valashka, which has been the best adapted breed to the Carpathian climate, is at the edge of extinction. The Transylvanian tall hound used mainly for hunting wolves, bears, lynx and stags, is now facing extinction.

5.3.2 Land-use trends

The principal economic activities dependent on influencing are forestry and sheepherding. The majority of grasslands are used for production, but their biological quality depends on specific types of management. In Romania, the dramatic decrease of animal stocks has resulted in under-use of pastures or even large-scale abandonment of grasslands, and the overgrowth of wood vegetation and their eventual transformation into forests. Extensive meadow areas are used only sporadically or are even completely abandoned, and are consequently invaded by ferns or wood vegetation.

New, specific problems have arisen over the last 10 years in connection with the privatisation of lands. Most of the new owners, having got their property back from the state, practice inconsiderate, only profit-oriented activities. Sensitive areas in the upper parts of the mountains are threatened by different forms of tourism and skiing sports as well as the development of infrastructures related to them.

5.3.3 Climatic, physical and chemical pressures

The major threats to the regional biodiversity have been and continue to be air, water and soil pollution, even while industrial pollution decreased in the first years of the economic transition process due to significant reduction in industrial output. Carpathians, mainly their northern part, are affected by transmissions from northern and western parts of Europe. In the last years dry and hot summers caused heavy damages to fir and spruce stands.

5.3.4 Biological pressures

In the last decades many invasive plants have been competing with the native species. There are serious problems mainly with *Heracleum mantegazzianum* (in western Carpathians also *Telekia speciosa*), but also with *Impatiens parviflora*, *Impatiens glandulifera* and *Fallopia japonica*.



Heracleum mantegazzianum, is a highly invasive species throughout Europe.
Photo: Linus Svensson, ZooBoTech HB.

5.4 What policies are at work in the Carpathians

The Carpathians have been designated as one of the Global 2000 Ecoregions.

ACANAP – Association of Carpathian National Parks and Protected Areas is coordinating nature conservation activities in the area.

The WWF Danube-Carpathian Programme (based in Vienna) works with national governments and local NGOs to enhance the network of protected areas and to develop forest management programmes to demonstrate the economic sense of sustainable forestry practices. A key task for DPC Policy is to provide input to existing relevant forums and decision-making bodies.

Two of the western and three of the south-eastern Carpathian national parks have benefited from special funds of GEF (World Bank). In this area the first seven **Life projects in Central and Eastern European countries** were launched in 1999. They aim at conservation of threatened flora and fauna species (listed in FFH and Bern Convention), mainly the big carnivores and selected protected areas.

Reintroduction initiatives The LIFE project for saving and restoring the population of the endemic fish species *Romanichthys valsanicola* was launched in Romania in 1999. At present this species is limited to the Vilsan river. The restitution of the European mink (*Mustela lutreola*) is under preparation in the western Carpathians. There is project for restitution of the European bison (*Bison bonasus*) into the Slovak part of the eastern Carpathians Biosphere Reserve and in the protected area Vinatori-Neamt in Romania. In the Polish and Ukrainian part of the Biosphere Reserve its population is relatively abundant.



Bison bonasus, the European bison, is being restituted to the Carpatians. Photo: Gunilla Andersson.

6. The Rhodopes

6.1 What are the general characteristics of the Rhodopes

6.1.1 Profile

The Rhodopes, an extension of the Carpathians, runs southward and eastward along Bulgaria's border with Greece. They are part of the great mountainous uplift that covers much of the Balkan Peninsula. The Rila and Pirin ranges contain the Rhodope's most impressive high mountain landscapes.

6.1.2 Climate

The Balkan and Rhodopes subregion is located at the intersection of the moderate continental and the Mediterranean climatic zones, which is characterised by relatively large differences between the average summer and average winter temperatures as well as relatively high amount of precipitation during the year.

6.1.3 Altitude

The lowest elevation of the region is 640 m and highest points are in the Balkan Mountains: Botev Peak (2 376 m) and in the Rhodopes Mountains Vihren Peak (2 915 m).

6.1.4 Human influences

Most human activities specific to this region (industrial, transport, tourism and agriculture) have had detrimental effects on the natural ecosystems of this region. Sheepherding, forest exploitation and tourism have significantly influenced ecological diversity of the region.

6.2 Present biodiversity status and trends

6.2.1 Flora

The most typical species for the Rhodopes sub-region are species of mountainous, sub-alpine and alpine habitats.

The greatest amount of Bulgarian endemic is observed in the floristic complex of the Central Balkan Mountains – between the Trojan and Sipka Passes. Among the local endemics there are: *Alchemilla achtarovii*, *A. jumruckzalica*, *A. asteroantha*, *Betonica bulgarica*, *Centaurea karlovensis*, *Primula frondosa*, *Rosa balcanica*, *Satureja pilosa*, *Silene balcanica*, *Viola balcanica*, as well as some species which are of a limited distribution in other mountains, as: *Jasionella bulgarica*, *Luzula deflexa*, *Micromeria frivaldzkyana*.

6.2.2 Fauna

In the Balkan region, the mountain medium is prevalent, so that fauna will be especially rich in insects, mammals and birds. In this region, many species of invertebrates are considered endemic.

The diversity of birds is large, almost all European woodpeckers are nesting in this subregion.

The fauna is also representative for this region. The carnivore species are a symbol for wild and natural habitats. This region is an important habitat for the brown bear, wolf and the Balkan chamois, species that determine the preservation of the natural heritage.

6.3 Main pressures on biodiversity

6.3.1 Deforestation

The forested area are now about one-third of their previous extent as a result of human activity. Although the forests have been reduced in area, they have retained a high level of natural species composition and quality. On the other hand, the autochthonous trees and shrubs species have an economical importance producing wood, resin, fruits, flowers, leaves and bark for medical use.

Of special interest is the mountain's last few localities of dwarf pine (*Pinus peuce*), which has survived the burning of vegetation to open new pastures.

6.4 What policies are at work in the Rhodopes

The lack of knowledge and effective public policy is a less direct but no less critical threat to biological diversity. Insufficient scientific information on threats to biological diversity leads to inadequate management and administration of protected species and areas. Bulgaria gives attention to biodiversity protection.

The National Park Central Balkan (covering 730 km²), and eight of the nature reserves of the sub-region are on the UN List of National Parks and Protected Areas.

The science and practice of restoration ecology is still quite new in Bulgaria. Several reintroduction projects have recently been undertaken, for example reintroducing *Lynx lynx*, which was extirpated from Bulgaria.

7. The Urals

7.1 What are the general characteristics of the Urals

7.1.1 Profile

The Urals have developed from an ancient mountain system dating from mid to late Paleozoic period. It stretches from 51°N to 69°N over 2 500 km from south to north, and

are generally around 100 km wide. The highest point at 1 894 m is in the northern part, but most of the range is closer to 500–1 000 m above sea level. The relief is mostly hilly, without any sharp alpine features, a consequence of the age of the range and repeated glaciation events. The Urals form a natural boundary between the east European and the west Siberian plains. Approximately half of the range belongs to the European region. However, the whole mountain range will be described here, since the differences between east and west are relatively minor, and many studies have been conducted on the Siberian side.

7.1.2 Climate

The climate is continental. Sverdlovsk-Iekaterinburg, the main city of the Urals located on the south-eastern foothills, has an average temperature of 1.6 °C (January: -14.6 °C; July: +17.8 °C). Annual precipitation around 400–500 mm are relatively uniform over the whole range, with drier parts in south and north. Dominant wind directions are western and eastern, and these seem to alternate between years, resulting in complementary periodical sequence of dry and wet years on both sides of the Urals. Stable weather conditions observed in the winter can lead to pronounced temperature inversions. The relatively low altitudes and continental climate result in very little glaciation, with only a few cirque glaciers in the north. The S–N orientation of the range leads to a main climatic gradient: the timberline for example drops from 1 300 m in the southern Urals to 750 m in the northern Urals and even locally to 100 or 200 m close to the Arctic Ocean. Similarly, the length of the winter is 9 months in the north and 4–5 months in the south.

7.1.3 Human presence

Close to 20 million people inhabit the different regions and republics which are included in the Urals, but most of the population is restricted to the central/southern part, and to the foothills of the range. The highest population density (42 inhabitants/km²) is found in the Cheliabinsk region. There are indigenous peoples (Khanty and Mansi in the north, Bashkirs in the south), with a traditional nomadic way of living. Most of the sub-region is affected by a decline in the number of inhabitants.

7.2 Present biodiversity status: habitats, fauna and flora

7.2.1 Habitats

The Urals do not constitute a barrier for most species, because of their low altitude and the presence of wide passages at all latitudes. The flora and fauna exhibit very little specificity compared to the surrounding areas. The main reason for the somewhat higher diversity in the Urals is the higher diversity of habitats compared to the adjacent lowlands, since altitudinal zonation leads to a mosaic of various types of coniferous forest, deciduous birch forest and alpine-tundra. As for all mountain ranges, altitude is an important determinant of vegetation types. However, because of temperature inversions, typical taiga forests may be found below the deciduous, nemoral forests, at least in the middle Urals. The alpine level, above the treeline, is dominated by screes and stony terrain – soil is usually extremely poorly developed. Alpine habitats of the Urals are very restricted due to the low elevation of the range, and are most likely to disappear if the climate gets significantly warmer. The southernmost part of the Urals (Urals-Mugojary area) is a semi-desert, showing similarities to the near Kazakhstan desert. The northern part is mostly arctic, dominated by tundra.

7.2.2 Flora

The flora is characterised by a mixture of influence: arctic and taiga species in the northern part, European and Siberian forest and steppe species in the central/southern part. Dominant coniferous trees species are the Siberian spruce (*Picea abies obovata*), the Scots pine (*Pinus sylvestris*), the Siberian fir (*Abies sibirica*) and the Siberian pine

(*Pinus sibirica*). Larch (*Larix sibirica*) occurs in the northern part. Birch trees (*Betula pendula* and *B. pubescens*) are very common in the whole Urals, and have often replaced coniferous forests in parts of the range, partly as a consequence of over-intensive forestry practices. The frequency and intensity of forest fires is highly variable depending on the dominant tree species and climatic regimes (pine forests on dry sites burning more often than spruce forests on moist sites).

7.2.3 Fauna

Mammalian species richness is not influenced by the presence of the mountain range. The decrease in the number of mammal species from south to north is similar to the ones observed in the adjacent lowlands: from about 50 species in the south to 15 in the north (Shvarts *et al.*, 1996). All species of large mammals found in adjacent forests of Siberia or Europe are found in the Urals (e.g. moose (*Alces alces*), Siberian roe deer (*Capreolus capreolus pygargus*), lynx (*Lynx lynx*) and wolf (*Canis lupus*)). Among small mammals, dominant species at all altitudes is the red vole (*Clethrionomys rutilus*). The grey-sided vole (*C. rufocanus*) is common at high altitude and the bank vole (*C. glareolus*) at low altitude. Field vole (*Microtus agrestis*), root vole (*M. oeconomus*), common/sibling voles (*M. arvalis/rossiaemerdionalis*) and wood lemming (*Myopus schisticolor*) occur also, together with the harvest mouse (*Micromys minutus*) and the northern birch mouse (*Sicista betulina*), resulting in small rodent communities very similar to what can be found, for example, in Finland. Most bird species have distribution limits that do not coincide with the Urals.

7.3 Main pressures on biodiversity

7.3.1 Forestry

In the subpolar Urals, reindeer herding and hunting are the main pastoral activities. Forestry has resulted in large changes in forest structure, for example a large reduction in the area dominated by the economically most interesting species such as spruce. Agricultural activities in the southern Urals are dominated by horse breeding and bee-keeping.

7.3.2 Radioactive pollution

The northern parts of the Urals are relatively little affected by human activities due to the lack of transport infrastructure. The situation is very different in the Mid-Urals, which is one of the major industrial regions of eastern Europe with numerous large mining, metallurgical, and forestry industrial complexes. Large military complexes, linked to the development of nuclear weapons (production and underground testing), have been built in the area. This has resulted in extensive and severe pollution, which continues to be the main problem in the area today, both with respect to biodiversity and for the human population. There are billions of tonnes of industrial waste in this part of the Urals, a third of which is highly toxic (Badenkov, 1998).

The Ural radioactive trace in Chelyabinsk

A well-known example of pollution due to nuclear waste is the 'Ural radioactive trace' in the Chelyabinsk region which is in the eastern foothills of the Mid-Urals; (Sokolov and Krivolutsky, 1998). On September 29, 1957, a thermal explosion in a nuclear waste storage facility led to the contamination of 25 000 km² and the evacuation of 10 000 inhabitants. About 900 people may have developed diseases directly due to radiation. The overall radioactive emission was apparently of the same order of magnitude as Chernobyl explosion in 1986.

Extensive studies have been conducted after the disaster on various components of the flora and fauna. The original landscape belongs to the forest-steppe zone of the west Siberian lowland. Russian scientists documented the immediate and longer term effects on fungi, plants, mammals, birds, and insects (Sokolov and Krivolutsky, 1998). These effects are diverse. Effects at the individual level are not necessarily the same as effects at the population level due to various regulatory factors. The contaminated area acts as a sink and the differences in population densities are relatively small because of constant recolonisation from adjacent areas. Gileva *et al.*, (1996) reported higher frequencies of chromosomal aberrations in the common vole (*Microtus arvalis*), but abundance of small mammals were about the same in contaminated and adjacent areas. In 1992, pied flycatcher (*Ficedula hypoleuca*) had still a lower reproductive success in the contaminated area compared to adjacent areas, but the great tit (*Parus major*) had similar breeding success. Soil communities, and particularly collembollas and mites, were severely affected by radioactivity.

Following the accident the contaminated area was established as a reserve, and has been left fairly undisturbed since 1957 (Sokolov and Krivolutsky, 1998).

7.4 What policies are at work in the Urals

7.4.1 Protected areas

It is only in the north that the level of protection is relatively high. There are altogether 9 nature reserves in the Urals covering 1 430 162 ha, two national nature parks covering 1 974 000 ha, and 20 nature sanctuaries covering 497 380 ha (i.e. in total 39 000 km²; Badenkov, 1998). A national park covering 25 million hectares is planned, to partly remedy the insufficient level of protection in the area, especially the uneven representation of the different habitats in the mountain range. The southern part is the least protected, with less than 1 % in reserves (most of them being located in the mountains), one of the lowest proportions in Russia.

8. The Caucasian alps

8.1 What are the general characteristics of the Caucasian alps

8.1.1 Profile

The region covers the territory of eight Russian Federation members: the Krasnodar kray (south), the Stavropol kray, the Republic of Adygey, the Republic of Karachaevo-Cherkessia, the Republic of Kabardino-Balkaria, the Republic of North Osetia, the Chechen Republic and the Republic of Dagestan.

The region's topography changes from mountainous to plains and lowlands, with the highest altitudinal peak being the Elbrus (5 633 m).

Greater Caucasia experiences current glaciation with glaciers covering a total area of about 2 000 km² (1 400 glaciers). Major rivers of the region include: Terek, Sulak and Kuban.

8.1.2 Climate

The moderately continental dry climate of the foothills is subject to variable rainfall. The mountain climate is influenced by height zones and by Mediterranean air masses. The region's western areas are in the subtropical humidity zone (up to 2 000 mm of annual precipitation), while the eastern areas (Dagestan) are more arid.

8.1.3 Human presence

Prior to the economic crisis the following industries were developed in the plains and foothill areas: agriculture (grain production, vegetables growing, wine, melon-growing, cattle breeding), oil production, natural gas, mining for minerals and mineral water bottling. In mountain regions: wood logging, pasture cattle breeding, mining industry and non-ferrous metallurgy. Sporting and recreational tourism played a special role in the region's economy. The density of the human population in the region is 20–70 inhabitants km². The majority of population was concentrated in the Pre-Caucasia and Greater Caucasia areas. Currently the region's economy (except for territories in the Stavropol and Krasnodar krais) is suffering a severe decline. Together with recent social problems this has contributed to the dramatic poverty of the population, extremely high level of unemployment, criminalisation of economic relations, and emigration.

8.2 Present biodiversity status: habitats, species and genes, fauna and flora

8.2.1 Habitats

Before the period of antropogenic transformation the Stavropol elevation vegetation cover was represented by arid steppes (*Festuca valesiaca-Stipa* spp., *Artemisia* spp.) that have been currently ploughed. The forest-steppe used to dominate the foothills. The Tersk-Kumsk lowlands vegetation is of steppe or semi-desert type. Vegetation belts are apparent in Greater Caucasia. Relict mountain broad-leaved chestnut (*Castanea sativa*), oak (*Quercus iberica*) and beech (*Fagus* spp.) forests with evergreen shrub underbrush dominate the region's western area lower slopes. Central areas are dominated by beech forests mixed with conifers (Caucasian fir (*Abies nordmanniana*), Caucasian spruce (*Picea orientalis*)). Pine forests (*Pinus hamata*) dominate the more arid areas of the central and eastern Caucasia. Coniferous forests dominate areas higher than 1 200–1 500 m, successively followed by sub-alpine, alpine and subnival belts. Eastern areas are devoid of coniferous forests and are dominated by mountain steppes.

The region comprises several wildlife areas. Steppe and forest-steppe landscapes dominate the pre-Caucasia western and middle areas. This area has a high degree of agricultural development (major crops are cereals). Semi desert landscapes dominate the Tersk-Kumsk lowlands where cattle breeding and irrigated agriculture are developed. Land cultivation is developed in the greater Caucasia foothill areas, wood-logging – in the forest belt, while the sub-alpine and alpine areas are used as summer pastures.

8.2.2 Species and genes

This sub-region is the area of maximum biological diversity in Russia. It is the home of 536 species of vertebrates and 1 055 genera of vascular plants. The proportion of endemic species and subspecies is high (mammals – 21 %, birds – 5 %, reptiles – 33 %, amphibians – 45 %, fish – 7 %). Rare and endangered species account for about 20 %

(99 species) of vertebrate fauna. Of special interest are the relict mountain broad-leaved deciduous chestnut (*Castanea sativa*), oak (*Quercus iberica*), beech (*Fagus* spp.) forests with evergreen underbrush along the Black Sea coast. The region's fauna is of a mixed type. The endemic mountain Caucasian fauna includes: *Sorex raddei*, *Prometheomys schaposchnikovi*, Dagestan Caucasian goat (*Capra cylindricornis*), Caucasian black-cock (*Lyrurus tetrix*), and *Pelodytes caucasicus*. Species shared with western Europe include: chamois (*Rupicapra rupicapra*), royl stag, forest cat (*Felis silvestris*). Leopard (*Panthera pardus*, apparently extinct) is a species shared with Central Asia. There is a major node of landscape diversity in the sub-region's eastern area, while the foothill area serves as an environmental corridor between the Caspian and Black Sea regions used in particular for mass bird migrations.

8.2.3 Mammals

The region's terrestrial fauna is represented by slightly less than 130 species, including 98 species in the Greater Caucasia area. Endemic species (authentic and regional within Russian territory) proportion is high. This is the only region of Russia where the following species can be met: *Talpa levantis*, *Sorex raddei*, *Rhinolophus euryale*, *R. ferrumequinum*, *Barbastella leucomelas*, *Eptesicus bobrinskoi*, *E. bottae*, *Tadarida teneotis*, *Sicista caucasica*, *S. kazbegica*, *S. kluchorica*, *Prometheomys schaposchnikovi*, *Microtus daghestanicus*, *Chionomys nivalis*, *C. gud*, *C. roberti*, Caucasian ground squirrel (*Spermophilus musicus*), *Spalax giganteus*, jackal (*Canis auratus*), *Felis chaus*, chamois (*Rupicapra rupicapra*), *Capra aegagrus*, and Caucasian goat (*Capra caucasica*). Chiropter and hoofed mammals diversity is especially high. In general insectivores account for 12.4 % of the region's fauna, chiropters – 25 %, rodents and lagomorphs – 38 %, predators – 19 %, hoofed – 8.6 %.



Rhinolophus euryale is endemic to the Caucasian region.
Photo and copyright: ???

In the Greater Caucasia there is the following ratio of various orders: insectivores – 14 %, chiropters – 25 %, rodents and lagomorphs – 32 %, predators – 21 %, hoofed – 8 %. Rare and endangered species account for about 13 % of the terrestrial fauna, including 2 hoofed species (aurochs (*Bison bonasus*), *Capra aegagrus*), 6 predator species (leopard (*Panthera pardus*), forest cat (*Felis silvestris*), *Felis haus*, Caucasian otter (*Lutra lutra meridionalis*), European mink (*Mustela lutreola*), *Vormela peregusna*), 7 species of chiropters (*Tadarida teniotis*, *Rhinolophus ferrumequinum*, *Rhinolophus hipposideros*, *Rhinolophus mehelyi*, *Miniopterus schreibersi*, *Myotis blythi*, *Myotis emarginatus*) and one rodent species (*Spalax giganteus*).

8.2.4 Birds

The region's bird fauna is represented by about 253 species (including 212 in the Greater Caucasasia area). Regional endemics include 13 species, among them: *Bubulcus ibis*, *Milvus milvus*, *Lyrurus mlokosiewiczzi*, *Glareola pratincola*, *Merops superciliosus*, *Sylvia althaea*, *S. mystacea*, *Turdus torquatus*, *Certhia brachydactyla* and *Serinus pusillus*. Especially large is the sparrow family that accounts for about 68 % of the region's total species number. Waterfowl account for about 17 %, while predators account for 15 %. In the mountain areas of Greater Caucasasia the sparrow family's share increases to 72 %, while the waterfowl's share drops to 13 % with predators maintaining their share in the overall ratio. Almost 21 % of bird species (including migrating ones) are rare or endangered.

8.2.5 Reptiles and amphibians

The region's reptiles are represented by 73 species (42 in the Greater Caucasasia sub-region), of which 24 are endemic (authentic or Russian). Rare or endangered species (all regional endemics) account for about 10 % of reptile fauna.



Eumeces schneideri is an endemic reptile in the Caucasian region.
Photo and copyright: ???

The amphibians of the region are represented by 11 species, including 9 in Greater Caucasasia area. The endemic ratio for this group of vertebrates is extremely high. This include several species of caudate and ecaudate amphibians: *Triturus karelini*, *Triturus vittatus*, *Pelodytes caucasicus*, *Bufo verrucosissimus*, *Rana macroknemis*. The ratio of rare or endangered species is also high and includes: three triton species *Triturus karelinii*, *T. vulgaris lantzi* and *Pelobates syriacus*.

8.2.6 Plants

The flora of higher plants is extremely diverse and includes representatives of 1 055 genera, of which three are regional endemics. Tree and shrubs are represented by 189 species, with five endemics.

The region's lichen flora is diverse and includes representatives of 218 genera (214 in the Greater Caucasasia area). The Greater Caucasasia endemics include genera *Byssoloma*, *Chiodecton*, *Gyalectidium* and *Letharia*.

8.3 Main pressures on biodiversity

The region's territory is highly developed. As a result in the 18th – beginning of 20th centuries the number of game species – large animals (aurochs, elk, deer, Caucasian goat, leopard) populations were drastically reduced or totally exterminated. Foothill and mountain forests have been significantly damaged or totally destroyed. As a result the steppe meadows have advanced far into the mountains. The overall anthropogenic impact has resulted in a species diversity decrease (up to 20 % in certain areas) and

changes in the composition of communities (especially in the foothill areas) related to the simplification and changes in dominant species, increase in the number of human dispersed taxa (Yemelianova *et al.*, 1997). The economic and social crisis has had dual implications. On one hand, it has resulted in the decrease of anthropogenic loads on the plain areas, while on the other hand it has led to its increase with regard to the mountain-forest and alpine areas (forest cutting, poaching). Currently the following factors have major impact on the region's biodiversity:

- cereal crops growing, use of pesticides and insecticides
- cattle breeding
- wood logging
- industrial pollution
- poaching

Major areas of the Chechen Republic have been polluted with oil and petrochemicals.

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