BIODIVERSITY STRATEGY AND ACTION PLAN FOR THE REPUBLIC OF MACEDONIA

MINISTRY OF ENVIRONMENT AND PHYSICAL PLANNING
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FOREWORD

During the period since achieving its independence, the Republic of Macedonia has been striving to build a stable political and economic community, with a legal system able to facilitate rapid integration into the European Union and the wider international community. This primary strategic goal has given rise to sectoral targets, one of which is the establishment of efficient environmental protection measures in order to provide a basis for an improved quality of life.

One component of this strategic goal is the conservation of biodiversity and habitats. In the process toward achieving this goal, the Republic of Macedonia has ratified: the *Convention on Biological Diversity* (1997), *Convention on Wetlands of International Importance Particularly as Waterfowl Habitat* (1997), *Convention on the Conservation of European Wildlife and Natural Habitats* (1997) and *Convention on the Conservation of Migratory Species of Wild Animals* (1999). These conventions, together with the international agreements assumed from the former Socialist Federal Republic of Yugoslavia by means of succession, constitute part of the national legislation and represent a basis for biodiversity conservation.

In spite of the existence of legal bases for the regulation of biodiversity conservation (Law *on the Protection of Natural Rarities* [1973] as well as other sectoral laws), however, for a long period there has been a felt need to develop a national strategy for biodiversity conservation not only in order to establish a direction and identify priorities in this area, but also as an obligation arising from the *Convention on Biological Diversity*. The actions begun in 1998, before the involvement of the Global Environmental Facility (GEF), were initiated with the signing of the agreement for funding the project, "Activities Related to Biodiversity and Capacity Assessment." They have resulted in the preparation of the Country Study for Biodiversity and the Biodiversity Strategy and Action Plan for the Republic of Macedonia.

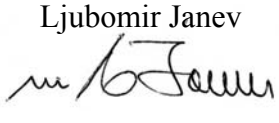
The Country Study was the first step in this procedure and represents an overview of the situation in Macedonia as it relates to species and ecosystem diversity, the level of knowledge of particular floristic and faunal groups and the levels and types of direct or indirect threats to their survival. In addition, it describes the uses of biodiversity for commercial purposes.

The Strategy, as a basic planning document, defines an integrated approach to the conservation and sustainable use of the components of biodiversity, while the Action Plan encompasses specific activities which must be accomplished in order to achieve the Overall Aim and Guiding Objectives enumerated within the Strategy.

Supported by the scientific community and with the close collaboration of non-governmental organisations and the wider public, we have succeeded in developing the basic strategic documents concerning biodiversity which will doubtlessly provide a meaningful contribution to the high quality conservation and sustainable use of biological resources.

Minister of Environment and Physical Planning,

Ljubomir Janev



1. Introduction

1.1. The value of biodiversity

Humans are an inherent part of the global ecosystem, whether it is acknowledged or not, and we have a unique role to play because of our ability to influence this very system and because the threat to biodiversity is also a threat to the basic life-support processes that maintain the living world of the planet Earth.

The role of micro-organisms, plants and animals in providing ecological services of value to humanity is the most important anthropocentric reason for conserving biodiversity. A myriad of organisms underpin the ecological life-support functions that enable human society to exist.

The value of biological diversity thus arises by virtue of the ecological services derived through the interactions between the organisms, populations and communities of the natural environment; the value of biodiversity loss corresponds to the sensitivity of these ecological services to both the depletion and the complete loss of species. There is a threshold of diversity below which most ecosystems cannot function. In other words, all self-organising living systems require a minimum diversity of species in order to capture the sun's energy and to develop the cyclic relation of fundamental compounds to producers, consumers and decomposers.

The major threat to biodiversity is not the direct exploitation of species by humans but, rather, the alteration and destruction of habitat which results from the growth of the human population and from damaging human activities. Habitat change by humans is caused directly through land-use changes, urbanisation, infrastructure development and industrialisation. Indirect habitat change is caused through environmental impacts resulting from the use and extraction of resources from the environment and from the discharge of various wastes into the air, soil and water. Included within this process are the global changes caused by the burning of fossil fuels and the emission of greenhouse and ozone-depleting gases.

The natural process of speciation (creation of new species) is constantly generating biological diversity. Differentiation of populations, however, normally operates on a time scale of from thousands to millions of years.

All estimates of present-day extinction rates show them to be drastically higher than the rate at which the natural processes that create biodiversity could expect to compensate for these losses. The extinction outputs far exceed the speciation inputs, and Earth is becoming impoverished as a result.

The Republic of Macedonia is not exempt from the global, regional and national processes which cause the loss of biodiversity. In spite of the fact that, on a national level, the components of biological diversity are in better condition than those of the more developed European countries, this should not be a mandate for complacency. On the contrary, it should be a challenge to be more deliberate in implementing activities focused on biodiversity conservation in its entirety.

1.2. Convention on Biological Diversity

The *Convention on Biological Diversity* (CBD) was adopted in Rio de Janeiro in 1992; more than 180 parties have since ratified it. This convention provides a comprehensive document outlining the principles of biodiversity conservation and sustainable use or, more precisely, it clearly defines the relationships among protection, sustainable use of natural resources and sustainable human development.

In ratifying the CBD, the "Parties to the Convention" undertake a commitment to implement the convention at a national level and to contribute to achieving its goals and objectives at a global level.

At the time the CBD was adopted (1992), the Republic of Macedonia was still not a regular member of the United Nations (UN). After acceptance into the UN and after many years' efforts by relevant government Ministries and scientific institutions, the Parliament ratified the CBD in 1997. Upon its agreement with the provisions of the convention, the UN General Secretary notified the Republic of Macedonia that it became an official party to the CBD on 2 March 1998.

1.3. Biodiversity Strategy and Action Plan

Due to global environmental changes, significant influences on biological resources and the functioning of ecosystems have been noticed. It is necessary for coordinated activities on a regional, national and local level to be undertaken in order to prevent, reduce and mitigate harmful effects to biodiversity, effects that are seen in the alarming data regarding the permanent loss of species richness. In order to accomplish this, the Biodiversity Strategy and Action Plan (BSAP) will define the national priorities for effective and integrated conservation, as well as essential actions, projects and programs for biodiversity conservation.

Implementation of the BSAP should involve all relevant institutions, such as the legislative authority and the government, as well as those members of society who are involved in the educational process of developing and increasing public awareness.

The BSAP presents a process by which a wide spectrum of participants may be united with one main goal in mind – the conservation and maintenance of biodiversity. Four main components are included within the BSAP:

- The basic document includes information about the current level of knowledge regarding biodiversity, as well as potential threats. In addition, this document provides a foundation upon which further planning, decision making and establishing of priorities for the conservation of the components of biodiversity can be based;
- The Strategy explains the goals, objectives and tasks for biodiversity conservation. It is a document which defines an integrated approach based upon the many strategic components within the realm of the conservation and sustainable use of biodiversity;
- The Action Plan for biodiversity conservation consists of specific tasks with a precisely defined timetable and budget and of detailed activities for achieving the strategic components. The Action Plan also gives detailed descriptions of the activities to be used in reaching predictable main objectives, as well as various alternatives that might be undertaken to realise the proposed goals.
- The final document will include the details of the implementation, evaluation and monitoring of the outcome of the BSAP and of associated activities regarding biodiversity conservation.

1.4. Country context

1.4.1. Geographic position

The Republic of Macedonia is situated in the central part of the Balkan Peninsula and extends between 40°50' and 42°20' North Latitude and between 20°27'30" and 23°05' East Longitude. Very important transportation routes pass through the country, serving to connect central and eastern Europe with the southern and south-eastern parts of the continent, and continuing toward the countries of the Near East and beyond. The neighbouring countries are:

- on the west, Albania
- on the south, Greece
- on the east, Bulgaria
- on the north, Serbia and Montenegro

Other statistical data:

Total length of the border: 849 km
Total area: 25,713 km^2
Population: 1,945,932 (according to the 1994 census)
Number of human settlements: 1632
Highest peak: Golem Korab – 2764 m msl

1.4.2. Physical geography

The landform of Macedonia, as a part of the Balkan Peninsula, is characterised by complex geotectonic features, which produce developed relief, complex geology and, hence, a diversity of soil types. This is an important factor in explaining the rich biodiversity of the country. The chief reason for the complex geotectonic evolution of the internal part of the Balkan Peninsula (Macedonia) is the large number of orogenic cycles, from the oldest yet known, to the youngest alpine orogenesis.

The Rhodope massif is the oldest tectonic unit on the Balkan Peninsula. It extends partly into Macedonia, not as a solid formation, but broken into several blocks of differing forms and dimensions. The Pelagonian and Serbian-Macedonian massifs are products of a Precambrian orogenesis event. The separation of the two masses (Pelagonian and Serbian-Macedonian) from the mother Rhodope massif and from each other, which was connected with the creation of the Vardar zone, occurred during the Palaeozoic Era. The so-called Hercynian orogenesis phase had an extreme influence in the western parts of Macedonia, where the sediment complex is folded and metamorphosed. The Republic of Macedonia possesses a complex mosaic of various metamorphic, sedimentary and igneous rocks in all tectonic units.

The relief structure of the country is very interesting and diverse, and is represented by mountains, valleys, ravines, narrow gorges, saddles and other forms. The present relief structure is morphogenically diverse as well, with both older and younger relief forms. The most important among the large relief forms are "mountains," which cover approximately two-thirds of the territory. They fall into two groups depending upon their time of formation, geologic composition and size of extension; these are the Rhodope and Dinaric groups. The Rhodope group is considered to be older and was formed during the Hercynian orogenesis. The

mountains Osogovski Planini, Plachkovitsa, Belasitsa and Ograzhden, situated primarily in the eastern part of the country, are characteristic representatives. The Dinaric group extends through the western, south-western, southern and central portions of the country. These mountains were formed during the alpine orogenesis. These include: the Shar Planina mountain group (Shar Planina Mountain, Korab – the highest peak in Macedonia, Bistra, Stogovo, Yablanitsa and Galichitsa), Vardar zone (Zheden, Vodno, Kitka, Mariovo, Nidze and Kozhuf on the right descending bank and Serta and Plavush on the left descending bank) and Pelagonian horst anticline (Baba, Yakupitsa, Karadzitsa, Babuna, Goleshnitsa, Selechka Planina and others).

"Valleys and larger plains" are the second distinct morphologic feature of the relief structure. They are distributed over approximately one-third of the country. Most distinct are the ones extending along the Vardar River. From the northwest to the southeast, they are situated as follows: Polog (373 km^2), Skopye (1,840 km^2), Tikvesh (604 km^2) and the Gevgeliya-Valandovo Valley (620 km^2). They are intersected by the respective gorges Zheden (Derven), Taor and Demir Kapiya. The largest valley in the Republic of Macedonia is the Pelagonia Valley, which is situated in the south-western part of the country and occupies an area of about 4,000 km^2. Other characteristic valleys and plains include: Ohrid-Struga Valley, Prespa Valley, Debarsko Pole Plain, Berovo Valley, Piyanets, Kochani Valley, Ovche Pole Plain, Strumitsa-Radovish Valley, Kumanovo Valley (628 km^2) and Slavishko Pole Plain.

Old, so-called "palaeo-relief" is characterised by saddles, which are remnants of former fluvial erosion. The best known saddles are: Pletvar, Prisad, Bukovo, Gyavato, Strazha and Preseka.

Traces of "glacial relief" can also be found in Macedonia. There are remnants of both glaciers and cirques on some of the mountains, and of only cirques on others due to the small size of the glaciers. Some of the cirques have filled with water and become glacial lakes. Such relief is characteristic mainly of the high mountains in western Macedonia.

"Karstic relief" is represented by all types of surface (depressions, crevices, fissures and karstic plains) and underground karstic forms. Underground forms include about 164 caves and 12 pits and sinkholes. Limestone is found mostly on the Suva Gora, Zheden, Yakupitsa, Galichitsa, Bistra, and higher parts of Shar Planina, mountains.

Other relief forms include "gypsum and younger fluvial relief."

In conjunction with the complex geotectonic features, developed and diverse relief, as well as climatic characteristics, the Republic of Macedonia also abounds in various soil types.

1.4.3. Climate

Due to specific natural and geographic characteristics, there are two main types of climates in the Republic of Macedonia: Mediterranean and continental. Thus, two prominent seasons occur: cold, wet winters and dry, hot summers. In addition to these, in the high, mountainous areas there is also a mountain climate characterised by short, cool summers and considerably cold and moderately wet winters, where precipitation is mainly in the form of snow.

In spite of the fact that Macedonia lies relatively close to the Aegean and Adriatic Seas, the influence of the Mediterranean climate does not reach very deeply into the country, except within a few valleys. This is a result of the high mountains which rise up in the west and south of the country. The influence of the Aegean Sea can be felt

along the valley of the Vardar River northward to Demir Kapiya, and slightly less so in the Skopye Valley. Some slight effect also reaches the valleys of the Strumitsa and Bregalnitsa Rivers, as well as the proximity of Doyran Lake. The influence of the Adriatic Sea on portions of western Macedonia extends primarily along the Crni Drim valley.

The continental influence enters from the north and continues toward the south. As a result, the characteristics of this climate are felt deeply within the country, especially in the northeast and eastern regions.

The average annual temperature is 11.3°C. The hottest towns are Valandovo and Gevgeliya, with temperatures of 14.5°C and 14.3°C, respectively. In the mountain climatic areas, the mean annual temperatures are: on Popova Shapka, 4.7°C, in Lazaropole, 6.8°C and in Krushevo, 8.2°C. The average precipitation within Macedonia (1951-1980) is 683.7 mm/year. The areas of highest precipitation occur in Mavrovi Anovi and Resen, with 1,197 mm and 757.9 mm, respectively, and the lowest in Ovche Pole Plain with only 490.3 mm. Hail falls most often in the period from April to October, with the highest incidences in April and May. It is most frequent in the Ovche Pole, Pelagonian and Tikvesh areas and in the valleys of Gevgeliya-Valandovo and Skopye.

Winds blow mainly from the northern quadrant but, in specific areas, the direction can change according to the relief structure. Although the best-known winds are the Vardarets and Yugo, local winds sometime occur in valleys or ravines. Annually, the quantity of sunlight present is about 2,100-2,450 hours, while the mean annual cloudiness rating is between 4.3 and 5.7 on a 10-point scale. The average number of clear days is 130 in the south and 73 days in the Skopye Valley. The average number of foggy days ranges from 4-72, mostly occurring in autumn and winter months. Fog is present mainly in the Skopye Valley (72 days) and in Polog (33 days), and occurs least often in the Strumitsa-Radovish Valley and in Malesheviya, where the average annual number of foggy days is 3-5.

1.4.4. Hydrography

The Republic of Macedonia contains an adequate number of water resources, both underground and surface, but they are not uniformly distributed. Underground waters include: phreatic, artesian, subartesian and well waters. They have great importance for the country, because it is estimated that nearly 60% of rural and 50% of urban drinking water supplies come from wells.

With respect to surface waters, 4,414 springs have been recorded, with a total capacity of approximately 31.4 m^3/s or 991.90 × 10^6 m^3/year. A great number have not yet been measured, but are included on hydrologic maps. The capacity of about 800 of the springs ranges from 1-5 l/s, but there are also 90 springs with capacities of more than 30 l/s, with 58 yielding 100 l/s. Of the springs occurring only in karstic areas, the most characteristic are: Rasche, in the foothills of Zheden Mountain (4 m^3/s capacity); Ostrovo, near the monastery of St. Naum by Ohrid Lake and Bilyana Springs, near the city of Ohrid. There are also numerous mineral springs, the most noteworthy of which is near the village of Bansko, with water a temperature of 72°C.

The rivers of Macedonia are divided into three primary watersheds: one flowing to the Adriatic Sea and two to the Aegean Sea. Another very small watershed flows to the Black Sea. The Vardar River (Aegean watershed) is the largest river, containing 80% of the water flow leaving the Republic of Macedonia. Of the remaining 20%, 13% flows through the Crni Drim River (Adriatic watershed), with only 7% through

the Strumitsa River, a tributary of the Bulgarian Struma River (Aegean watershed). The total length of the Vardar River is 388 km, of which 300 km are present in Macedonia. At the point where it exits Macedonia near Gevgeliya, its average flow is 174 m^3/s. Its major western tributaries are the Crna River (207 km in length with a 37 m^3/s average flow at its mouth) and the Treska River (138 km, 30 m^3/s). The longest eastern tributaries of the Vardar are the Bregalnitsa River (225 km, 28 m^3/s) and the Pchinya River (135 km, 16 m^3/s). The Crni Drim River flows only 48 km within the territory of Macedonia and, together with its tributary, the Radika River, one of Macedonia's most attractive rivers, encompasses 1,772 km^2 of watershed area. The Strumitsa River's watershed is 1,465 km^2.

Hydrologic and hydrographic features specific to the Republic of Macedonia are the natural tectonic lakes Ohrid, Prespa and Doyran. Ohrid Lake is the largest, occupying an area of 348.8 km^2, of which 229.9 are in the Republic of Macedonia. It is 30.5 km long and 15 km wide. The deepest point is 287 m and the average depth is 144.8 m. The lake is situated at 699 m msl. In addition to flow from the Crni Drim River, the lake receives water from 80 surface and underground springs and from Prespa Lake, which is located to the southeast at a higher altitude.

Prespa Lake, with an area of 274 km^2 (176.8 km^2 of which belong to Macedonia), is the second largest in the country. Its length is 28.6 km and its width, 16.9 km. Its greatest depth is 54 m, with an average depth of 18.8 m. The length of the shoreline is 100.1 km. Prespa Lake is situated at 853 m msl.

Doyran Lake, situated in the south-eastern corner of the country, occupies an area of 42.7 km^2. Of this amount, 27.1 km^2 is within the Republic of Macedonia. Prior to the recent hydrologic perturbations caused by both climatic and human factors, the lake's maximum depth was 10 m and the average depth, 6.7 m.

Among the other Macedonian water resources, there are 110 major and minor artificial lakes, but only 20 with volumes larger than 1,000,000 m^3. They are used for irrigation, water supply and the production of hydroelectric power.

1.4.5. Human population and settlements

Demographic characteristics. The territory of the Republic of Macedonia has been continuously inhabited since ancient times due to its favourable geographic location and climatic conditions. There are archaeological findings that indicate intensive human activity (settlements and other objects) dating from the Palaeolithic and Neolithic periods, Bronze Age, Iron Age, and from the Classical period (*Archaeological Map of the Republic of Macedonia* – Macedonian Academy of Science and Arts, 1994). These findings are most numerous in the areas of the Vardar River and Pelagonia, and in the valleys of some of the Vardar's tributaries. The current appearance and characteristics of many of the landscapes in Macedonia are the result of the distribution of settlements from prehistoric times to the present (e.g., degradation of the natural zonal vegetation in some regions, strong cultural characteristics within certain areas etc.).

Considering the long-term demographic trends and their influence on the quality of socio-economic development and the environment, it will be useful to mention the growth, structure and distribution of the population.

Data for the population of Macedonia over the past 50 years are presented in Table 1. From 1948 to 1994, a period of 46 years, the total population grew by 729,946 inhabitants, or 69%.

Table 1. Population of the Republic of Macedonia by year (according to census data).

Census Year	Population (Total Number)
1948	1,152,986
1953	1,304,514
1961	1,406,003
1971	1,647,308
1981	1,909,136
1994	1,945,932

Source: Calculations using data from the Statistic Yearbook of the Republic of Macedonia 2001, p.48, Skopje 2001

Table 2 shows a constant decreasing trend for natural population growth rate, however. Such trends unfavourably transform the age structure of the population (due to the continual aging process). The process of demographic aging (i.e., that the average age of the population is tending to increase), is subject to both the natural and mechanical components of population growth. The level of spatial mobility within the country conforms, to a great extent, to the size and distribution of ethnic and migrant populations. The number of migrants included within the total population figures increased from 12% to 36% during the period 1948-1994. According to the census of 1994, 46% of the migration was of local origin, 42% was between municipalities and 12% was from abroad. "Village to town" migration recorded the greatest growth during the period, 1961-1971. These migratory movements contributed greatly to the enlargement of regional differences in the age and educational structure of the population, primarily in the villages.

Table 2. Dynamics of the population growth, 1953-1994.

Census Year	Population Growth
1953	23.1
1961	20.6
1971	15.4
1981	13.6
1994	8.5

Source: Calculations using data from the Statistic Yearbook of the Republic of Macedonia 2001, p.48, Skopje 2001

Migration within the Republic of Macedonia, exemplified by the rapid growth of cities and an unbalanced regional population distribution, has resulted in numerous problems, including the unsustainable use of biological resources. Consequently, problems resulting from the observed demographic patterns should be considered when creating implementation and monitoring policies for the programmes connected with the sustainable use of biological resources. Considering the mean population age within the State, the most desirable age structure is seen within large cities, while the worst situation is present in rural settlements (Table 3).

Table 3. Structure and characteristics of the population by location (1994).

Age Structure	Macedonia	City of Skopye	Other Towns	Villages
0-19	33.2	30.2	32.2	36.0
20-30	30.8	30.5	30.3	30.5
40-59	22.8	26.7	34.5	18.9
60 and older	13.0	12.6	12.0	14.1
Unknown	0.2	0.0	0.0	0.3

Source: Calculations using data from the Census of 1994, Population, housing and agribusinesses, Book V, Skopje 1996

Settlements. Modern settlements within the Republic of Macedonia differ from each other in size, spatial organisation and social and cultural characteristics. Rural and urban social organisation varies mainly with demographic and economic indicators. The principal differences between villages and towns can be seen in the affinities of their communities. Villages are inclined toward agriculture, in contrast to towns' professional/industrial orientation in the secondary and tertiary sectors. There are also other rural-urban differences, such as the size of the community, level of dispersal of structures, social differentiation and stratification, mobility, ambient surroundings and systems of interaction.

High population concentrations in the larger cities (Skopye – 444,760 inhabitants, Bitola – 86,174, Kumanovo – 94,589, Prilep – 71,899 and Tetovo – 65,318), the inappropriate siting of industrial facilities and an inadequate communal infrastructure create serious problems in ensuring a quality environment. Demographic, economic, social and environmental characteristics within the population also demonstrate significant rural-urban differences.

While the processes of industrialisation and urbanisation have had a positive influence on the development of towns and their nearby villages, they have negatively impacted distant hill and mountain villages. The official territorial limits of Macedonian villages encompass 86.7% of the nation's land area and include 40.2% of the total population (records from 1994). Villages having less than 50 inhabitants represent a specific problem (360 villages – 20.6% of the total number of villages). It is expected that the villages within this subgroup, especially the ones having 10 or less inhabitants, will eventually be totally abandoned (104 villages). The situation is especially serious in the regions of Prilep, Kavadartsi, Shtip, Veles, Ohrid, Demir Hisar and Bitola.

Photo 1 and Photo 2. Rural settlements (Macedonian village).

2. Biodiversity within the Republic of Macedonia

The richness and heterogeneity of species and ecosystems are the most striking features of the biodiversity of the Republic of Macedonia. This situation is a result of Macedonia's specific geographic position, climate, geology, geomorphology, hydrography, pedology and other characteristics, such as the changes which occurred during past geologic periods (e.g., from the end of Tertiary through the Ice Age, with its glacial and interglacial phases). A huge number of relict species and ecosystems are the result of these changes, which continue to have an effect on the recent flora, fauna and fungi.

According to recent data, the imposing number of more than 18,000 taxa of flora, fauna and fungi – 900 of which are endemics – express Macedonia's rich biodiversity. The presence of more than 260 plant assemblages also shows the great diversity of ecosystems.

Based upon an analysis of biodiversity richness within the countries of the European continent, the Republic of Macedonia holds the top position on the "European Hotspot" list. Despite the fact that the biodiversity of the flora and fauna has not been fully studied, the findings to date indicate its great abundance. As an example, the diversity of invertebrate species on a relatively limited surface at some sites (Ohrid Lake, marsh ecosystems and others) can be directly compared to the diversity of coral reefs; in some cases, the biodiversity in Macedonia is higher.

2.1. Diversity of ecosystems

The richness and diversity of ecosystems is a result of the heterogeneity of natural conditions within the State, such as relief and geologic features, climate, soils etc. Even though Macedonia's land area is relatively small, it exhibits a great diversity of relief forms, with heterogeneous geologic substrata and a complex pedologic structure, combined with particular climatic influences.

During the country's long geologic history, influences from these factors helped to create a rich mosaic of relict and recent ecosystems (e.g., wetland, meadow, halophytic, steppe-like, hilly dryland/grassland, forest, mountain, sub-alpine and alpine), coupled with anthropogenically developed ruderal (i.e., growing on waste or in waste places), weed, and agricultural ecosystems.

In accordance with their importance, range, genetic and species diversity richness, ecological functionality, as well as economic value, the following key ecosystems may be distinguished: forest, dryland/grassland, mountain and aquatic/wetland.

2.1.1. Key ecosystems

Forest ecosystems. These ecosystems cover a large portion of the land area of the Republic of Macedonia at elevations of 150-2,200 m. Broadleaf forests dominate (Hornbeam [*Carpinus betulus*], Chestnut [*Castanea sativa*], Beech [*Fagus sylvatica*], Hop-hornbeam [*Ostrya carpinifolia*] and Oak [*Quercus* sp.]), while evergreen forests (Fir [*Abies* sp.], Spruce [*Picea* sp.] and Pine [*Pinus* sp.]) as well as mixed forests (Beech-Fir) are distributed in small areas. Due to over-harvesting, they have been degraded in the lowland areas and completely destroyed in some places. Nevertheless, they are represented by over 80 pure forest stands and include species from seven classes.

Forest ecosystems are present in the following qualitative regions:

- The "Oak region" is distributed within lowlands and highlands to 1,100 m msl. The average annual temperature in this region ranges from 9-14.2°C, and the average precipitation is 500-850 mm. The prevailing soil type is cinnamon-coloured forest soils, but other soil types are also locally present (e.g., red podzolic soils [terra rossa], chernozem, pseudogley-gley, luvic, brown podzolic etc.). Climate-zonal Oak forests dominate in these regions, mixed with orographically-edaphically and hydrologically conditioned Chestnut, Common ash (*Fraxinus excelsior*), Maple (*Acer* sp.), Poplar (*Populus* sp.), Willow (*Salix* sp.) etc. in places. With respect to vertebrate fauna, typical inhabitants of this region are eastern Mediterranean and Syrian boreal species such as: Balkan whip snake (*Coluber gemonensis*), Fallow deer (*Dama dama*), Eastern hedgehog (*Erinaceus concolor*), Weasel (*Mustela nivalis*), Balkan spadefoot toad (*Pelobates syriacus balcanicus*), Green woodpecker (*Picus viridis*), Cat snake (*Telescopus fallax*), Worm snake (*Typhlops vermicularis*) etc.
- The "Beech region" covers the mountainous areas between 1,100-1,700 m msl. The fact that it encompasses only 22% of Macedonia's total forested area notwithstanding, this region possesses the largest timber mass in the country. The average annual temperature in this region ranges from 6.4-8°C; the average precipitation is 900-1100 mm. Light brown podzolic soils (in the lower belt) and brown podzolic soils (in the higher belt) are the prevailing soil types. The sub-mountain Beech region is present between 1,100-1,300 m (chiefly consisting of the climate-zonal community, assn. *Festuco heterophyllae-Fagetum*). Refugial types of Beech forests, as well as Pine forest communities (Black pine [*Pinus nigra*]), may be found here. The mountain belt spreads between 1,300 and 1,700 m (the range of the climatogenic assn. *Calamintho grandiflorae-Fagetum*) and is formed by various types of Beech and Beech-Fir forests. In the successional habitats, forests of Aspen (*Populus* sp.), Birch (*Betula* sp.) and White pine (*Pinus sylvestris*) are also present. Typical faunal inhabitants in this region are: Slow worm (*Anguis fragilis*), Roe deer (*Capreolus capreolus*), Red deer (*Cervus elaphus*), Aesculapian snake (*Elaphe longissima*), Wildcat (*Felis silvestris*), Pine marten (*Martes martes*), Fire salamander (*Salamandra salamandra*) etc.

Photo 3. Upper range of the Beech belt on Dobra Voda Mountain (Photo V. Matevski).

The "pre-mountain (sub-alpine) region" is the highest forest belt, located between 1,700 m and approximately 2,100 m msl. The annual mean temperature is 3.5°C and the average precipitation is about 1,000 mm. The prevailing soil type is brown podzolic; other types are very infrequent. In this belt, forests are comprised of Norway spruce (*Picea abies*), Dwarf mountain pine (*Pinus mugo*) and Molika pine (*Pinus peuce*), as well as a heath of *Bruckenthalia spiculifolia, Vaccinium myrtillus* etc. In the "pre-mountain" forest complexes, characteristic animal species consist of Siberian boreal faunal elements, typical inhabitants of the forested areas of Siberia and northern Europe. Such species include: Waxwing (*Bombicilla garrulous*), Lynx (*Lynx lynx*), Three-toed woodpecker (*Picoides tridactylus*), Red squirrel (*Sciurus vulgaris*), Black grouse (*Tetrao tetrix*), Capercaillie (*Tetrao*

urogallus), Hazelhen (*Tetrastes bonasia*), Brown bear (*Ursus arctos*) and Adder (*Vipera berus*).

Dryland/grassland ecosystems. These occur in the lowland and highland belts from 60-1,200 m msl. The soils on which they develop are geologically diverse (silicate, limestone, dolomite etc.). The climatic characteristics are similar to those of the Oak forest region. Dryland/grassland ecosystems encompass a higher number of differing plant communities such as: meadow, halophytic and steppe-like, as well as the plant communities of highland pastures. They usually develop within successional habitats, primarily due to the permanent degradation of forest phytocoenoses (mainly Oak), but also on abandoned agricultural land areas.

From a faunal standpoint, eremial (i.e., grassland or semi-desert) elements originating from the Aral-Caspian refugial centre and adapted to life in steppe-like or semi-desert conditions are dominant within the dryland/grassland ecosystems. Typical species include: Striped field mouse (*Apodemus agrarius*), Stone curlew (*Burhinus oedicnemus*), Common quail (*Coturnix coturnix*), Sand boa (*Eryx jaculus*), Lesser mole rat (*Nannospalax leucodon*), Great bustard (*Otis tarda*), Common partridge (*Perdix perdix*), Balkan wall lizard (*Podarcis taurica*), Little bustard (*Tetrax tetrax*) etc.

Mountain ecosystems. Mountain ecosystems are present within a large portion of the Republic of Macedonia; however, optimal conditions for their development are only present on mountains with elevations above 2,000 m. The average annual temperature in this belt is -4°C; the average precipitation is 800 mm. Within the areas having a limestone substratum, limestone-dolomitic black soils (mould-zonal soil type) are most often present, whereas the **ranker** soil type is typical in areas without limestone.

The communities of the mountain pastures, located on silicate (vegetative class *Caricetea curvulae*) and carbonate (vegetative class *Elyno-Seslerietea*) soils, are represented by approximately 15 associations. Communities that develop on limestone and silicate rocks, limestone screes, under snow banks etc. are also included within mountain ecosystems.

The fauna of mountain ecosystems is complex in content because it is a mixture of faunal elements of various origins. The most striking feature of this fauna is the presence of indigenous relict-endemic, palaeo-Mediterranean and oreal (high-mountain) faunal elements such as: Balkan snow vole (*Dinaromys bogdanovi*), Balkan alpine chamois (*Rupicapra rupicapra balcanica*), Mountain souslik (*Spermophilus citellus karamani*) and Balkan mole (*Talpa stankovici*), as well as a very large number of invertebrate fauna, of which the most dominant is butterflies. Tundral (arctic) faunal elements are present only in very restricted numbers within mountain ecosystems. Examples include the bird, Ring ouzel (*Turdus torquatus*), and more butterfly species of the genus *Erebia*.

Photo 4. Vegetation of a limestone scree (rocks) on Galichitsa Mountain (Photo V. Matevski).

Aquatic/wetland ecosystems. The group of key aquatic/wetland ecosystems includes the three natural lakes, the well-developed river network – especially the watershed of the Vardar River – and remnants of formerly widespread marshes and swamps.

- *Ohrid Lake.* This is the largest lake in the Republic of Macedonia and is situated in a tectonic valley in the far south-western portion of the country. Ohrid Lake is a typical oligotrophic lake with outstanding transparency, low nutrient content and low productivity. With its relict and endemic organisms, it represents the most significant lake ecosystem in Europe and is under the protection of the United Nations Educational, Scientific and Cultural Organization (UNESCO). The diversity of phytoplankton and zooplankton in Ohrid Lake is relatively poor. The phytoplankton is dominated by *Bacillariophyta*, *Chlorophyta* and *Cyanophyta* while the zooplankton by Water fleas (*Cladocera*), Copepods (*Copepoda*) and Rotifers (*Rotatoria*). The benthos at shallow depths is represented by abundant macrophytic vegetation (representatives of *Charophyta*), and at deeper depths by the dominant diatoms. Zoobenthos consists primarily of segmented worms (*Annelida*), snails (*Gastropoda*), Ostracods (*Ostracoda*), flatworms (*Plathelminthes*) and sponges (*Porifera*), with a high level of endemism. Among the nektonic organisms, the most important are the relict and endemic species of salmonid fishes.
- *Prespa Lake.* This lake is located in a tectonic valley between Galichitsa and Pelister Mountains. Rich encrusting layers of Green and Blue-green algae and diatoms can be found on the rocky submerged substrate. In addition, significant areas of macrophytic vegetation are present. Like Ohrid Lake, the zooplankton is represented primarily by species of Copepods, Rotifers and Water fleas, while the zoobenthos is dominated by flatworms, Ostracods, segmented worms, snails and sponges. The relict species of fishes which are distinguished by a high level of endemism are also dominant among the nektonic organisms of the lake.
- *Doyran Lake.* Characterised by high floristic and faunal diversity and a low level of endemism, this is a typical eutrophic lake. Diatoms are dominant among the phytoplankton and periphyton. Among the zooplankton, Copepods, Protozoans (*Protozoa*), Rotifers and Water fleas are dominant, while within the zoobenthos, flatworms, Molluscs (*Mollusca*), Ostracods, segmented worms and sponges predominate. Cyprinid species of fishes dominate the nektonic organisms.

The three natural lakes provide favourable conditions for the development of aquatic macrophytic (floating and submersed) vegetation, as well as the development of shoreline marsh species.

- *Riverine ecosystems.* The riverine ecosystems are characterised by well developed water mosses, as well as Algal flora, especially in the upper reaches of the Vardar River. Within these ecosystems, zooplankton is poorly represented, and the benthos which does occur has very reduced populations. Nekton is characterised by rich relict and endemic fauna, especially fishes.
- *Wetland ecosystems.* Wetland vegetation, which in the past used to cover large areas, today appears mainly as fragmentary patches along the shorelines of the three natural lakes (e.g., Ohrid Marsh, Prespa Marsh and Struga Marsh), as well as within remnants of other former lakes and marshes (e.g., Katlanovo Marsh, the marsh near Negortsi Spa, Monospitovo Marsh, the marsh near Gostivar etc.). The fauna of wetland ecosystems is characterised by a high level of diversity and endemism, expressed especially within the taxonomic

groups of invertebrate limnofauna (*Cyclopoida, Harpacticoida, Isopoda, Oligochaeta* and *Ostracoda*).

2.1.2 Threatened ecosystems

Within the Republic of Macedonia, many rare, relict and endemic communities occur in almost all vegetation types. Of special importance are those with restricted distribution among the aquatic, wetland, meadow, halophytic, steppe-like, forest, sub-alpine and alpine vegetative communities, as well as those present within the vegetation of highland pastures. Nevertheless, some of these are seriously endangered or threatened with extinction, while others are considerably reduced in their populations and biological viability.

The spectrum of factors which threatens ecosystem diversity is fairly broad and of complex nature. The character and intensity of their influences vary and are specific to each individual ecosystem.

Forest ecosystems. Threats to forest ecosystems are quite varied and include desiccation, die-back processes, forest fires and various diseases. For example, desiccation of the Fir-Spruce forest (assn. *Abieti-Piceetum scardicum*) along the Tetovska River, the Beech-Fir forest (assn. *Fago-Abietetum meridionale*) on Bistra (Senechka) Mountain, the Chestnut forest (assn. *Castanetum sativae macedonicum*) along the Brajchinska River on Pelister Mountain etc. have been observed.

The large number of forest fires is also threatening communities of Dwarf mountain pine (assn. *Pinetum mugo macedonicum*) on Yakupitsa Mountain, the Black pine forests (assn. *Pulsatillo macedonicae-Pinetum nigrae*) of Karadzitsa Mountain, as well as assemblages of assn. *Phillyreo-Juniperetum excelsae* and assn. *Querco-Carpinetum orientalis macedonicum* at Demir Kapiya Gorge etc.

Serious consequences are also appearing as a result of human activities. The viability of specific forest communities is being influenced by inappropriate reforestation activities (*Ephedro-Prunetum tenellae* in the vicinity of Lyubash near Kavadarci), water capture/extraction (*Tilio cordatae-Fagetum* on Drevenichka Mountain near Demir Hisar), drainage (*Periploco-Fraxinetum anguistifoliae-pallisae* near Negortsi Spa; *Carici elongatae-Alnetum glutinosae* in the Polog Valley and Debartsa regions) etc. Recently, forest ecosystems have also begun to be threatened as a result of the construction of roads, railroads, artificial lakes, tourist settlements, ski-lifts, rubbish tips (dumps) etc.

Due to the destruction of certain forest ecosystems, particular species of Fungi are also disappearing (e.g., *Antrodia juniperina, Boletus dupainii, Inonotus tamaricis, Pyriformes demidoffii* etc.). Many of these factors also affect the status of different related faunal groups. The reduction of the populations of individual species can be best seen in the Oak region. With respect to vertebrates, the following species are considered to be extinct in Macedonia: Golden jackal (*Canis aureus*), Red deer (*Cervus elaphus*) and Fallow deer (*Dama dama*), although the last two have been reintroduced. The species, Black vulture (*Aegypius monachus*), Bearded vulture (*Gypaetus barbatus*), Pine marten (*Martes martes*) and Marbled polecat (*Vormela peregusna*), exhibit the most reduced populations.

Dryland/grassland ecosystems. In general, the dryland/grassland ecosystems are not threatened. Exceptions are present within some specific communities (e.g., assns. *Crypsidetum aculeatae balcanicum* and *Pholiureto-Plantaginetum balcanicum*) which develop on saline soils in the Ovche Pole Plain, as well as the *Viola allschariensis* and

V. arsenica communities in the highland pasture belt which are found on soils containing antimony and arsenic (at Alshar near Kavadartsi). These communities, present only in small areas, are in potential danger of destruction due to agricultural activities (in the first instance) and mining (in the second). Some insufficiently studied communities found on limestone and dolomitic substrates are also being threatened by the quarrying of marble (Pletvar, Sivets and Tser).

Photo 5. Endemic Alshar viola (*Viola allschariensis*) (Photo V. Matevski).

Within these various ecosystems, reductions in the populations of the following faunal species have been recorded: Stone curlew (*Burhinus oedicnemus*), Common quail (*Coturnix coturnix*), Sand boa (*Eryx jaculus*), Geoffrey's bat (*Myotis emarginatus*), Whiskered bat (*M. mystacinus*), Lesser mole rat (*Nannospalax leucodon*), Great bustard (*Otis tarda*), Common partridge (*Perdix perdix*), European souslik (*Spermophilus citellus citellus*), Common mole (*Talpa europaea*) and Little bustard (*Tetrax tetrax*).

Mountain ecosystems. Mountain and high mountain ecosystems are less threatened since anthropogenic influences are reduced (due to their limited accessibility and unfavourable climatic conditions). Typical activities which could negative affect the viability of these ecosystems include overgrazing and the uncontrolled collection of certain plant species (e.g., *Althaea officinalis, Anacamptis pyramidalis*, *Arctostaphylos uva-ursi, Centaurium erythraea*, *Dactylorhiza maculata*, *D. sambucina, Gentiana lutea* subsp. *symphiandra, Gentiana punctata, Hypericum perforatum, Juniperus communis*, *Origanum vulgare, Primula veris, Pulmonaria officinalis*, *Sideritis raeseri, S. scardica*, *Thymus tosevii* var. *degenii* etc.).

The construction of ski-lifts, mountaineers' towers, television transmitters and other aerial systems usually installed on mountain peaks often cause the degradation of plant communities which have restricted distributions on the summits of mountains.

With regard to the faunal component of mountain ecosystems, indirect anthropogenic impacts do not threaten the stability of these populations. The only direct human impact concerns the Balkan alpine chamois (*Rupicapra rupicapra balcanicus*), which never reaches its optimal population number due to uncontrolled hunting.

Aquatic/wetland ecosystems. Fresh water ecosystems within the Republic of Macedonia consist of flowing, lacustrine, temporary and underground waters. Of the species present within these ecosystems, the dominant groups (based upon place of origin) consist of both floristic and faunal elements originating from the Black Sea/Caspian refugial region (immigrants from the post-glacial age), as well as a complex of indigenous relict-endemic elements which are most numerous within the three natural lakes. Lakes are most sensitive to anthropogenic impacts, in comparison to the other types of freshwater ecosystems, and their restoration is very difficult. Therefore, they should be dedicated for complete conservation.

Box 1. Ohrid Lake

Ohrid Lake: The lacustrine ecosystem of Ohrid Lake, together with the old centre of the city of Ohrid, have been declared a UNESCO World Cultural and Natural Heritage Site. The main problems which have led, to a greater or lesser extent, to the disturbance of the ecological balance within this ecosystem are

excessive water releases – in order to provide a higher level of electricity production – and the temporary shutting down of the integrated collection/treatment system for communal and industrial wastewaters. As a result of water level fluctuations, only fragments of the formerly abundant floating macrophytic vegetation can be seen. From the standpoint of fauna, Ohrid Lake, with its 216 relict-endemic taxa, is the richest and most important freshwater centre of endemism in Europe. As is the case with the other relic lakes, the process of intra-lacustrine speciation is also highly expressed in Ohrid Lake, especially within the taxonomic groups of *Gastropoda, Oligochaeta, Ostracoda, Plathelminthes* and *Porifera*. Although the degree of threats to invertebrate fauna is still insufficiently studied, with regard to vertebrates, six of seven endemic Ohrid fish species (according to the International Union for Conservation of Nature [IUCN]) are included within the category, "V" (Vulnerable), while one species is considered to be "EX" (Extinct). The two species of trout (*Salmo balcanicus* and *S. letnica*) are particularly caught for food, so their populations are continuously being reduced.

Box 2. Prespa Lake

Prespa Lake: The constant reduction of the water level of Prespa Lake over the years has adversely affected the state of the floating vegetation and faunal communities in the littoral zone of the lake. The presence of large quantities of organic silt on the lake bottom is accelerating the process of eutrophication, which manifests itself with the appearance of phytoplankton blooms during the summer period. Of the floating macrophytic vegetation, the most significant is the assn. *Lemno-Spirodelletum polyrhizae* subassn. *aldrovandetosum*, which develops only within the inshore areas of Prespa Lake (near Dolno Perovo village) and is directly endangered by the lowering of the water level. Of the total number of endemic species (24), the most threatened are fishes. Among the six endemic species of fishes, the Prespa bleak (*Alburnus belvica*) is the most caught; nevertheless, its population is remaining stable. Due to uncontrolled fishing, the Carp (*Cyprinus carpio*) is the most endangered species in Prespa Lake and, according to IUCN, it is included on the list of species being at critical risk (CR).

The establishment of the strictly protected "Ezerani" reserve and the initiative currently underway for proclaiming Prespa Park a transboundary park will surely contribute to the improvement of the state of this lake ecosystem.

Box 3. Doyran Lake

Doyran Lake: The status of Doyran Lake is the most alarming. Since 1988, the level of the water surface has drastically fallen, contributing to a decrease in water depth and a recession of the shoreline, accompanied by a complete loss of the littoral zone and its related biological communities. Accelerated eutrophication has led to intensive sedimentation and a dramatic reduction in the epibenthic communities, as well as serious changes in the structure of the Algal microflora. These changes have particularly affected the Common reed (*Phragmites australis*) zone and other aquatic macrophytic vegetation (assn.

Myriophyllo-Nupharetum is completely extinct).

The zooplankton community, under the influence of these changes, has lost its limnetic character. Until 1988, 94 zooplankton taxa were present in the open waters of the littoral and pelagic zones, whereas the recent status of this community shows a reduction to only 28 taxa. Comparative population density analyses indicate that the abundance of the zooplankton community within the pelagic complex is one-seventh its former level, and that of the littoral complex one-tenth of its previous numbers. Although currently severely disturbed, the benthic community likely still has enough genetic potential to completely restore itself. The status of the benthos can be inferred from the amount of the annual fish catch, which in optimal conditions used to be as much as 500 tonnes. In the past few years it has been reduced to 70 tonnes, dropping to only 25 tonnes in 2002.

The accelerated succession of this lake ecosystem is evidenced by the appearance of the Calanoid copepod (*Eudiaptomus gracilis*), a typical representative of marsh ecosystems, which was recorded in Doyran Lake for the first time in 1995. In order to restore the disturbed environmental balance, efforts have been made to bring additional quantities of water to the lake, which is expected to improve the state of the biological communities within the lake ecosystem.

Photo 6. Photo of Doyran Lake, showing an "island" of dead bivalve shells (Photo P. Stoyanovski).

Riverine ecosystems. As the major recipients for all types of wastewater, these ecosystems are under great anthropogenic pressures. The situation with the rivers Bregalnitsa, Crna, Pchinya and Vardar are the most alarming. Some of the artificial lakes (reservoirs), such as Kalimanci and Tikvesh Lakes, function as sinks for persistent substances. Others, which provide drinking or industrial water (e.g., Mavrovo, Strezhevo and Turiya), have experienced a deterioration in water quality due to excessive water extraction. Benthic communities in the riverine ecosystems are showing reduced abundance, which will ultimately lead to a decline in fish populations. Six of the 20 endemic fish species within the Republic of Macedonia are found in riverine ecosystems. Three of these are considered to be globally threatened species (*Gobio banarescui , Salmo pelagonicus* and *S. peristericus*).

Wetland ecosystems. Marsh communities are the most reduced, despite the fact that, in the past, they covered very large areas. As a result of drainage activities within the last 50-60 years, most wetland habitats have been either totally converted to agricultural production or remain in only a fragmented state. Such communities include: *Cypero-Caricetum acutiformis* (Gostivar), *Glycerietum maximae* (Pelagonia), *Scirpo-Alopecuretum cretici* (Monospitovo Marsh) etc.

Mountain marshes and peat bogs are also under anthropogenic pressures as a result of the capture/extraction of water from mountain springs and streams for use in drinking water systems. Therefore, the marsh communities of the vegetative classes *Montio-Cardaminetea* and *Scheuchzerio-Caricetea fuscae*, as well as the diversity of Algae, have been degraded.

From a faunal standpoint, impacts to most of the swamps and marshes have caused a reduction in the populations of all Amphibians, as well as individual species of other invertebrate and vertebrate groups. The most affected are: Water vole

(*Arvicola terrestris*), Eurasian bittern (*Botaurus stellaris*), European pond terrapin (*Emys orbicularis*), Otter (*Lutra lutra*), Balkan terrapin (*Mauremys rivulata*), Dice snake (*Natrix tessellata*), Miller's water shrew (*Neomys anomalus*), Water shrew (*N. fodiens*), Balkan spadefoot toad (*Pelobates syriacus balcanicus*), Eurasian Spoonbill (*Platalea leucorodia*) and Greek marsh frog (*Rana balcanica*). Only Belchishta Marsh still exists in its original state, where the population of Otters, a globally threatened species, is the largest.

Photo 7. Photo of Tikvesh Lake Strict Nature Reserve (Photo V. Matevski).

2.2. Diversity of species

2.2.1. Micro-organisms

From a taxonomic aspect, micro-organisms are poorly studied. The main body of research deals with the quantitative structure of individual physiologic groups of bacteria. Data on both the qualitative and quantitative structure of the bacterial community of Ohrid Lake do exist, however. By contrast, there are only data on the structure of some physiologic groups of bacteria within riverine ecosystems and reservoirs.

2.2.2. Algae

With regard to the lower plant groups, the Green, Silicate (diatoms) and Blue-green algae are dominant, with other groups found in smaller numbers. To date, 1,580 species of Algae have been identified, of which diatoms - *Bacillariophyta* (40.1%) and Green algae - *Chlorophyta* (35.3%) form a majority. The other groups (*Chrysophyta, Euglenophyta, Pyrrophyta* and *Xanthophyta*) are rarely studied and, consequently, it will be necessary to initiate basic research on their structure, distribution and ecology. The most important centres of Algal diversity are Ohrid and Doyran Lakes. There are no current systematic studies for Prespa Lake. In addition to the relic lakes, mountain aquatic ecosystems (especially post-glacial lakes) appear to be equally important centres of Algal diversity.

Photo 8. Photo of the diatom, *Navicula oblonga*, a rare species of Algal flora from the Republic of Macedonia (Photo Z. Levkov).

Table 4. Number of Algal taxonomic groups within the Republic of Macedonia (all types).

Taxonomic Group	Families	Genera	Species	Varieties	Forms	Total Taxa
Bacillariophyta	13	69	512	109	12	633
Charophyta	2	2	18	-	3	21
Chlorophyta	29	90	398	124	35	557
Chrysophyta	4	7	10	4	-	14
Cyanophyta	16	48	204	10	58	273
Euglenophyta	3	5	23	3	1	27
Eustigmatophyta	1	1	1	-	-	1
Glaucophyta	1	1	1	-	-	1
Phaeophyta	-	-	-	-	-	-
Pyrrophyta	5	8	12	3	1	16
Rhodophyta	6	7	7	-	-	7

Xanthophyta	2	2	9	-	-	9
Total	**82**	**240**	**1,195**	**256**	**128**	**1,580**

2.2.3. Fungi and Lichens

Fungi represent a very heterogeneous group of organisms; however, studies to date have dealt mainly with *Ascomycota* and *Basidiomycota*. The other orders are poorly studied. There are approximately 1,250 recorded species of Fungi. Most belong to the orders *Ascomycota* (130), *Basidiomycota* (1050), *Myxomycota* (10), *Oomycota* (20) and *Zygomycota* (35).

Lichens (lichenoid Fungi) (*Lichenes*) number approximately 340 species.

Photo 9. Photo of the Fungus, *Clathrus ruber*, in the Pchinya River gorge (Photo M. Karadelev).

Table 5. Number of Fungal and Lichen families, genera and species within the Republic of Macedonia.

Types of Fungi	Families	Genera	Species
Ascomycota (without Lichens)	35	60	130
Basidiomycota	49	284	1,050
Chytridiomycota	5	6	10
Dictiosteliomycota	-	-	-
Hyphochytridiomycota	-	-	-
Labyrinthulomycota	-	-	-
Myxomycota	7	7	10
Oomycota	5	9	20
Plasmodiophoromycota	-	-	-
Zygomycota	9	12	35
Total Fungi	**110**	**378**	**1,250**
Lichenes	11	73	340
Total with Lichens	**121**	**451**	**1,590**

2.2.4. Higher plant groups

The flora of the higher plant groups is quite rich, possessing diverse floral elements (arctic-alpine, Caucasian, Eurasian, Greek-Anatolian, Illyric, Mediterranean, Middle-European, Tertiary relict and cosmopolitan) and a large number of endemic species (Balkan, Macedonian, south Balkan etc.). It is represented by 210 families, 920 genera and approximately 3,700 species. The most numerous group is flowering (Angiosperm) plants, with about 3,200 species, followed by mosses (350) and ferns (42).

Mosses. Mosses are represented by 67 families, 167 genera and 349 species. The class *Anthocerotae* includes one species and the class *Hepaticae*, 52 species, while the class *Musci* possesses 296 species. It seems likely that future studies of mosses in the Republic of Macedonia will increase these numbers.

Peat mosses. This group is represented by six species which mainly inhabit moist areas and bogs in mountain and high mountain areas. They are only rarely found in lowlands (most often on silicate soils). The species *Diphasium alpinum, Huperzia sellago, Isoetes phrygia* and *Lycopodium clavatum* have very restricted distributions.

Photo 10. Photo of the relict plant, *Isoetes phrygia*, on Selechka Planina mountain (Photo V. Matevski).

Horsetails. Horsetails are represented by seven species which may be found in very moist places, from lowlands to high mountain areas (by gorges, marshes, moist meadows, mountain streams, rivers and valleys). The most frequent species are *Equisetum arvense* and *E. palustre*, with the rarest being *E. fluviatile* and *E. sylvaticum*.

Ferns. In the Republic of Macedonia, 42 species of ferns in 15 families can be observed. The most polymorphic genera are *Asplenium* (11 species) and *Dryopteris* (6). The following species are characterised by a restricted distribution: *Adiantum capillus-veneris, Blechnum spicant, Crytogramma crispa*, *Ophioglossum vulgatum, Osmunda regalis, Phyllitis scolopendrium* and *Thelipteris palustris,* as well as the endemic species *Asplenium macedonicum* (in the vicinity of Prilep). This group also includes the two species of aquatic ferns (*Marsilea quadrifolia* and *Salvinia natans*).

Photo 11. Photo of the Macedonian fern, *Asplenium macedonicum*, within its type location (Markovi Kuli near Prilep) (Photo V. Matevski).

Gymnosperms. These are represented by four families and six genera, including 15 indigenous species (the most polymorphic are the genera *Juniperus* and *Pinus*, each with five species).

Angiosperms. Angiosperms are represented by 120 families, 720 genera and approximately 3,200 species (5,000 taxa). The most polymorphic families of the class *Dicotyledonae* are the families *Caryophyllaceae* (345 species), *Compositae* (c. 470), *Cruciferae* (264), *Labiatae* (c. 260), and *Leguminosae* (457), whereas of the class *Monocotyledonae*, the families *Gramineae* (c. 280) and *Liliaceae* (c. 130) are most polymorphic.

Table 6. Number of families, genera, species and lower taxa of higher plants in the Republic of Macedonia.

Group	Families	Genera	Species	Subspecies, Varieties, Forms	Total Taxa
Total mosses (*Bryopsida*) - *Anthocerotae* - *Hepaticae* - *Musci*	67 1 25 41	167 1 36 130	349 1 52 296	-	-
Peat mosses (*Lycopsida*)	3	5	6	-	6
Horsetails (*Sphenopsida*)	1	1	7	13	20
Ferns (*Filicinae*)	15	21	42	18	60
Gymnosperms (*Gymnospermae*)	4	6	15	7	22
Total Angiosperms (*Angiospermae*) - *Dicotyledonae* - *Monocotyledonae*	c. 120 c. 102 c. 18	c. 720 c. 565 c. 155	c. 3,200 c. 2,600 c. 600	c. 1,700 c. 1,500 c. 200	c. 4,900 c. 4,100 c. 800
Total higher plants	**c. 210**	**c. 920**	**c. 3,700**	**c. 1,740**	**c. 5,350**

With regard to higher plant groups, complete studies exist on peat mosses, horsetails, gymnosperms and 78 families of angiosperms (*Dicotyledonae:*

Choripetalae). There are 24 families of the group *Dicotyledonae: Sympetalae*, as well as 16 families of the class *Monocotyledonae* that still need to be studied.

2.2.5. Fauna

With regard to the status of selected faunal groups, the situation is as follows:

Protozoa (Protozoans) – The diversity of this group of organisms is mainly concentrated in the waters of the three natural lakes (Ohrid, Prespa and Doyran). A total of 113 species has been recorded, of which 79 belong to the group of free-living Protozoans**.** Of the parasitic Protozoans, there are five subphyla; however, only the subphylum *Ciliophora* has been studied (34 species).

Porifera (sponges) – To date, nine species and one subspecies have been recorded, all inhabiting the three natural lakes.

Plathelminthes (flatworms) – Within this group, 85 species have been recorded. From the class of Turbellarian worms (*Turbellaria*), 65 species have been recorded, with the dominant representatives coming from the order *Tricladida* (a total of 40 species). The other two orders include 25 species (*Rhabdocoela* – 24; *Allocoela* – one). Two classes of this phylum, *Trematoda* and *Cestoda,* are represented by 10 species each. The largest centre of biodiversity for this group of organisms is Ohrid Lake, with 48 recorded species.

Cnidaria (Cnidarians) – These are represented by the class of Hydroid zoophytes (*Hydrozoa)* in freshwater ecosystems, of which two species have been recorded.

Nemertea (Nemertine worms) – Found in the sublittoral zone of Ohrid Lake, *Stichostemma graecense* is the only recorded species.

Nemathelminthes (roundworms) – Of the roundworms, studies have found only two classes, *Rotifera* (Rotifers) and *Nematoda* (Nematodes), represented by 613 species. The data on *Rotifera* originate from the analyses of the plankton communities of the three lakes and recognise 60 species. As planktonic organisms, they are characterised by a wide area of distribution and possess no endemic species. Research to date has identified a total of 553 species of Nematodes in Macedonia, which is likely to be much less than the actual number of species. In the first study of roundworms in Ohrid Lake, 23 aquatic, free-living Nematodes were found. Later, greater stress was given to the study of terrestrial Nematodes, mainly in forest ecosystems (450 species), as well as Nematodes which parasitise early vegetables, animals and humans (80 species).

Mollusca (Molluscs) – Molluscs are well studied, with a total of 282 known taxa (276 species and six subspecies). The class of snails (*Gastropoda)* is represented by 267 taxa (262 species and five subspecies), with 102 (97 species and 5 subspecies) belonging to the aquatic Gastropods. The terrestrial Gastropods, although incompletely studied, show a great diversity of species, with 165 recorded to date. From the class of Bivalves (*Bivalvia*), 15 species have been recorded. The most important centre of diversity for this group is Ohrid Lake.

Annelida (segmented worms) – This is a relatively well studied group, with a total of 182 recorded taxa (160 species and 22 subspecies). With regard to the class *Oligochaeta* (Oligochaetes), 139 taxa have been recorded (123 species and 16 subspecies), while the class *Hirudinea* (leeches) is represented by 35 taxa (29 species and six subspecies). Centres of their diversity are natural lakes and other aquatic biotopes.

Arthropoda (Arthropods) – This group has numerous representatives in the animal world and is also well represented within the Republic of Macedonia, with a large number of taxa (7,743), including 7,574 species and 169 subspecies.

With regard to the subphylum *Chelicerata* (Chelicerates), representatives of the class *Arachnida* (Arachnids) total 825 taxa (819 species and six subspecies). Among the six orders in this class, the order *Aranea* (spiders) is dominant with 558 species. The order *Pseudoscorpiones* (Pseudo-scorpions) is represented by 37 taxa (36 species and one subspecies) and the order *Opiliones* (Daddy longlegs) by 40 taxa (38 species and two subspecies). The order *Scorpiones* (Scorpions) is represented by three species and the order *Solpugida* (Sun spiders) by one species only. The order *Acarina* (ticks and mites) is represented by 196 taxa (193 species and three subspecies), most of which belong to the group of terrestrial mites (123 species), with the remainder being aquatic mites (70 species and three subspecies). The western portion of Macedonia is an important centre of biodiversity for this group, which is present in various types of habitats.

The subphylum *Branchiata* (Branchiate arthropods), with its unique class *Crustacea* (Crustaceans), represents one of the most thoroughly studied groups of organisms, with a total of 513 taxa (486 species and 27 subspecies). The subclass *Copepoda* (Copepods) is represented by 140 taxa (136 species and four subspecies), separated into three orders. The order *Cyclopoida* is represented by 60 taxa (57 species and three subspecies), the order *Harpacticoida* by 50 taxa (49 species and one subspecies) and the order *Calanoida* by a small number of species (30). From the subclass *Branchiura* (Branchiurans), only one species has been recorded to date – the Carp louse (*Argulus foliaceus*) in Doyran Lake. The subclass *Ostracoda* (Ostracods) possesses 172 known species. Within the subclass *Branchiopoda* (105 species), the order *Anostraca* is represented by seven species, the order *Notostraca* by two species, the order *Conchostraca* by three species and the order *Cladocera* by 93 species. The subclass of Malacostracans (*Malacostraca*) is represented by 95 taxa (72 species and 23 subspecies), separated into three orders. The order *Isopoda* is represented by 47 taxa (34 species and 13 subspecies), the order *Amphipoda* by 43 taxa (33 species and 10 subspecies) and the order *Decapoda* by five species. Since the Branchiate arthropods in Macedonia are linked with freshwater ecosystems, the largest centres of biodiversity occur in the three natural lakes, especially Ohrid Lake.

The subphylum *Tracheata* (Tracheates) is represented by a total of 6,405 taxa (6,269 species and 136 subspecies). The class *Myriapoda* (Myriapods) includes 72 taxa (71 species and one subspecies), separated into two orders: the order *Diplopoda* (millipedes) with 59 taxa (58 species and one subspecies) and the order *Chilopoda* (centipedes) with 13 species. The class *Insecta* (Insects) has a total of 6,333 taxa (6,198 species and 135 subspecies), separated into two subclasses. The subclass *Apterygota* (true wingless insects) has a small number of recorded species (18) belonging to three orders: *Collembola* (6), *Protura* (2) and *Diplura* (10). The subclass *Pterygota* (winged insects) has 6,315 taxa recorded within Macedonia (6,180 species and 135 subspecies). One of the best studied groups of the class *Insecta* is the order *Lepidoptera* (butterflies), with a total of 2,295 taxa recorded (2,261 species and 34 subspecies). The other orders have the following number of recorded taxa: *Ephemeroptera* (mayflies) – 63 taxa, *Odonata* (dragonflies) – 52 taxa, *Plecoptera* (stoneflies) – 93 taxa, *Orthoptera* (grasshoppers) – 178 taxa, *Isoptera* (termites) – two taxa, *Psocoptera* (book-lice) – 48 taxa, *Thysanoptera* (thrips) – 4 taxa, *Heteroptera* (true bugs) – 778 taxa, *Homoptera* (Homopterans) – 332 taxa, *Trichoptera* (Caddisflies) – 73 taxa, *Diptera* (flies and mosquitoes) – 606 taxa, *Hymenoptera* (ants

and bees) – 264 taxa and *Coleoptera* (beetles) – 1,527 taxa. The most important biodiversity centres for Tracheates (*Tracheata*) are the mountain massifs of Shar Planina, Galichitsa, Yakupitsa, and the refugial centres in the gorges of the Treska, Babuna, Topolka and Vardar Rivers.

Phylum *Chordata* (Chordates) – The fauna of Macedonia is represented by the subphylum *Vertebrata* (Vertebrates), separated into four classes and one superclass.

The superclass *Pisces* (fishes) is represented by 58 indigenous species, with centres of biodiversity in the three natural lakes, as well as in the Vardar River and its watershed.

The class *Amphibia* (Amphibians) is represented by 15 species and two subspecies, while the class *Reptilia* (Reptiles) by 32 species and eight subspecies. The most important centres of biodiversity for Amphibians are the marsh ecosystems and the temporal aquatic biotopes. With regard to Reptiles, the most important biodiversity centres for the Mediterranean and Aral-Caspian faunal elements are the lowland areas of the lower course of the Vardar River and Doyran region. For the central European, boreal and oreo-tundral herpetofauna – the mountain massifs of Galichitsa, Pelister, Shar Planina and Yakupitsa are important centres.

The class *Aves* (birds) is also well studied, with 338 recorded taxa (319 species and 19 subspecies). Of the total number of recorded taxa, 213 species breed locally, while the others appear during the winter or in periods of migration. The most important centres of biodiversity for ornithofauna are the three natural lakes (for waterbirds) and the gorges of the Babuna, Topolka, Treska and Vardar Rivers (for birds of prey). The mountain massifs in western Macedonia are the most important centres of biodiversity for the boreal and arctic-alpine complex of ornithofaunal elements.

The class *Mammalia* (Mammals) is represented by 82 species and one subspecies, belonging to six orders, 18 families and 51 genera. Eight species have been introduced by humans, either deliberately or accidentally. Three species are extinct in Macedonia, of which two have been reintroduced into the wild. The largest centres of biodiversity for the Mediterranean elements of this class are the lowland areas in south-eastern Macedonia and, for the central European faunal and boreal elements, the mountain massifs of western Macedonia.

Table 7. Diversity of animals by group.

Taxonomic Category	Taxonomic Group	Number of Species	Number of Subspecies	Total Number of Taxa
Phylum	*Protozoa* (Protozoans)	113	-	113
Phylum	*Porifera* (sponges)	9	1	10
Phylum	*Plathelminthes* (flatworms)	85	-	85
Phylum	*Cnidaria* (Cnidarians)	2	-	2
Phylum	*Nemertea* (Nemertine worms)	1	-	1
Phylum	*Nemathelminthes* (roundworms)	613	-	613
Phylum	*Mollusca* (Molluscs)	276	6	282
Phylum	*Annelida* (segmented worms)	160	22	182
Phylum	*Arthropoda* (Arthropods)	7,574	169	7,743
Phylum	*Chordata* (Chordates)	506	30	536

Total	9,339	228	9,567

2.3. Endemic and relict species

2.3.1. Micro-organisms

According to the studies to date, endemic species of bacteria have not been discovered.

2.3.2. Algae

Among the lower plant groups, Algae are represented by the greatest endemism, with 135 endemic taxa, or 8.5% of the total Algal flora. Most have been recorded in Ohrid and Prespa Lakes, but these data are old and should be revised.

Table 8. Number of endemic Algal taxa in the Republic of Macedonia by Algal types.

Taxonomic Group	Species	Varieties	Forms	Total
Bacillariophyta	62	16	7	85
Charophyta	1	1	5	7
Chlorophyta	10	5	1	16
Chrysophyta	2	-	-	2
Cyanophyta	10	2	11	23
Euglenophyta	1	-	-	1
Eustigmatophyta	-	-	-	-
Glaucophyta	-	-	-	-
Phaeophyta	-	-	-	-
Pyrrophyta	1	-	-	1
Rhodophyta	-	-	-	-
Xanthophyta	-	-	-	-
Total	**87**	**24**	**24**	**135**

2.3.3. Fungi and Lichens

There are no known endemic species of Fungi or Lichens in the Republic of Macedonia.

2.3.4. Higher plants

Among higher plants, in addition to the numerous Balkan and south-Balkan endemic species, a large number of Macedonian endemics are present. Most of them are representatives of the Angiosperms (114). Certain of the high mountains (Galichitsa and Shar Planina) and river gorges (Vardar, Treska and Babuna), as well as some portions of the lowland belt (Mariovo, vicinity of Prilep etc.), are considered to be centres of endemism.

Table 9. Number of endemic species among the higher plants within the Republic of Macedonia.

Group	Number of Endemic Species
Mosses (*Bryopsida*)	2
Peat mosses (*Lycopsida*)	-
Horsetails (*Sphenopsida*)	-

Ferns (*Filicinae*)	1
Gymnosperms (*Gymnospermae*)	-
Angiosperms (*Angiospermae*) - *Dicotyledonae* - *Monocotyledonae*	 109 5
Total number of endemic taxa	**117**

The relict species which are old from an evolutionary standpoint (i.e., taxa with very restrictive distributions) are of special interest within the flora of the Republic of Macedonia. They have been useful as biological indicators of past climate changes within the geographic area. Considering the geologic time scale, relicts can be classified as Tertiary, glacial, boreal and steppic.

- Tertiary relicts may be observed in almost all parts of the country, especially in the deep river gorges located mainly in the southern and western regions, where the influence of the Ice Age was much lesser. Such relicts include: *Aesculus hippocastanum, Buxus sempervirens, Ilex aquifolium, Isoetes phrygia, Osmunda regalis, Pinus peuce*, *Ramonda nathaliae, R. serbica, Taxus baccata, Thymus oehmianus, Viola kosaninii* etc.

Photo 12. Tertiary relict, *Ramonda nathaliae*, in the Pchinya River gorge near Katlanovo (Photo V. Matevski).

Photo 13. Molika pine (*Pinus peuce*) on Pelister Mountain.

- Glacial relicts are remnants of Ice Age flora and are distributed in high mountain regions in refugial and alpine habitats, such as névé (snow/ice formed by repeated freezing and thawing), eroded cliffs and mountain pastures (*Dryas octopetala, Loiseleuria procumbens, Salix herbacea, S. reticulata, Saxifraga opositifalia, Selaginella selaginoides* etc.).

Photo 14. *Crocus cvijicii* on Galichitsa Mountain (Photo V. Matevski).

- Boreal relicts are flora of the coniferous forests and peat bogs which developed during glacial and interglacial phases and which still remain on the Balkan Peninsula. These species had their maximum distributional extent within the southern portions of Europe. During the Tertiary Period, the boreal elements were widespread within the extreme northern zone of the Holarctic Region, while during the Ice Age, they descended into the Balkan Peninsula. Currently, in the Republic of Macedonia, boreal elements are represented by coniferous forests (mainly Spruce and Spruce-Fir), as well as by the plants of mountain peat bogs (*Coralorhiza trifida, Cypripedium calceolus, Goodyera repens, Listera cordata* etc.).
- Steppic relicts are remnants of the steppic flora that developed during particularly dry and hot periods of the interglacial phases. Currently, these relicts can be found within the steppic regions of Macedonia, as well as at certain locations in the western part of the country (*Adonis vernalis, Comandra elegans, Iris pumila, Morina persica, Onobrychis hypargyrea, Prunus tenella, Ranunculus illyricus, Stenbergia colchiciflora* etc.).

2.3.5. Fauna

With a total of 674 endemic taxa (602 species and 72 subspecies), the Republic of Macedonia represents one of the most important centres of endemism in Europe, in spite of its small land area. The endemic taxa are distributed in the following different faunal groups:

Two endemic species of free living Protozoans are found in Ohrid Lake. Of the parasitic Protozoans (subphylum *Ciliophora*), there are 30 endemic species which, together with their hosts (*Oligochaeta*), represent relict species. The degree of endemism in *Ciliophora* is as high as 88%. Comparative analyses between parasitic Ciliates from Ohrid Lake and from Baikal Lake point to great similarity.

Out of 10 taxa (nine species and one subspecies) of sponges (*Porifera*), five species and one subspecies are endemic; the degree of endemism is 60%. The species *Ochridospongia rotunda* is the best known of the four endemic sponges found in Ohrid Lake, and it represents a relict genus and species, with its spherical shape closely resembling the endemic sponges of the Sea of Galilee and Baikal Lake.

With regard to the phylum *Plathelminthes* (flatworms), the highest degree of endemism is found in the class *Turbelaria* (order *Tricladida* – 25 taxa and order *Rhabdocoela* – 10). There are only three endemic *Nemathelminthes* (roundworms) species; all are Nematodes restricted to Ohrid Lake.

The phylum *Mollusca* (Molluscs) shows the greatest degree of endemism in the aquatic Gastropods, with a total of 76 endemic taxa consisting of 71 species and five subspecies (degree of endemism, 74.5%). In contrast, terrestrial snails, which are still insufficiently studied, have a limited number of endemic forms – 21. Of the 15 recorded bivalve taxa, four are endemic (three species and one subspecies), all of the genus *Pisidium*.

Segmented worms, the phylum *Annelida,* include 54 recorded endemic taxa, the dominant among them being the class *Oligochaeta* (Oligochaetes), with 39 endemics. It is followed by the class *Hirudinea* (leeches), with 11 endemics, and the taxonomically non-differentiated group of *Branchiobdellidae,* with four endemic taxa.

The largest animal phylum, *Arthropoda,* has 419 recorded endemic taxa (367 species and 52 subspecies). The subphylum *Chelicerata* (Chelicerates) has 71 endemic forms (65 species and six subspecies), subphylum *Branchiata* (Branchiate arthropods) – 137 endemics (113 species and 24 subspecies) and subphylum *Tracheata* (Tracheates) – the most endemic forms – 211 (189 species and 22 subspecies). The highest degree of endemism among the *Chelicerates* is seen in the orders *Pseudoscorpiones* (73%) and *Opiliones* (47.5%). Among *Branchiata,* the highest degree of endemism is shown by the subclass *Malacostraca* (orders *Isopoda* [85%] and *Amphipoda* [81.4%]), but is also seen in the subclass *Ostracoda* (26%). Within Tracheates (*Tracheata*), class *Myriapoda* (order *Diplopoda*) shows the highest degree of endemism (37%) and within class *Insecta*, the order *Lepidoptera* has the largest number of endemics (90).

With regard to *Vertebrata*, the superclass *Pisces* (Fishes) has the highest degree of endemism (34.5%). Among the other classes, only four endemic mammals are known (*Mammalia*).

Of the major centres of faunal endemism, the three relict lakes are especially noteworthy. The largest, Ohrid Lake, with 216 endemic taxa, has been described as the most important centre for endemism in Macedonia and nearby areas. No less important are Prespa and Doyran lakes which, due to their shallower depths, have fewer numbers of endemic and relict species. Of particular interest is the presence of

six endemic taxa (four species and two subspecies) common to both Ohrid and Prespa lakes, which confirms the common origin of these lakes from the former Pliocene Desaret Lake.

The groundwater, springs and caves of Macedonia are second in importance as centres of endemism. They are characterised by the presence of thalassophreatic (i.e., from saline waters), limnophreatic (i.e., from fresh waters) and terrestrial relict fauna which date from the Upper Tertiary.

Table 10. Number of endemic taxa of various faunal groups in the Republic of Macedonia.

Taxonomic Category	Taxonomic Group	Restricted to:				
		Ohrid Lake.	Prespa Lake	Doyran Lake	Other Locations in Macedonia	Total Number
Phylum	*Protozoa* (Protozoans)	32	-	-	-	32
Phylum	*Porifera* (sponges)	4	1	1		6
Phylum	*Plathelminthes* (flatworms)	32	2	-	1	35
Phylum	*Nemathelminthes* (roundworms)	3	-	-	-	3
Phylum	*Mollusca* (Molluscs)	61	8	1	31	101
Phylum	*Annelida* (segmented worms)	26	3	5	20	54
Phylum	*Arthropoda* (Arthropods)	51	4	4	360	419
Phylum	*Chordata* (Chordates)	7	6	1	10	24
Total number of endemic taxa		**216**	**24**	**12**	**422**	**674**

2.4. Rare, threatened and extinct species and assemblages

2.4.1. Micro-organisms

Due to insufficient taxonomic studies, it is not possible to make an assessment regarding the degree of threats to species or taxa of bacteria.

2.4.2. Algae

There are many endemic, rare and threatened Algal taxa within the Republic of Macedonia, but so far none has been placed under any sort of protection regime. The risks threatening Algal species (especially periphyton) arise from habitat loss due to declining water levels (in natural lakes), as well as from the accumulation of organic sediments which cover macrophytes and rock-encrusting communities (this situation is particularly serious in Doyran Lake). The numbers of the populations of oligotrophic and oligosaprobic indicator species within the aquatic ecosystems are constantly decreasing as a result of intensive anthropogenic impacts.

Data concerning the degree of threats to Algal taxa exist only for diatoms. According to the research to date, many imperilled species are found in Ohrid and Prespa Lakes (*Achnanthes inflata, A. minuscula, Diploneis domblitensis, Eucocconeis quadratarea* and *Hippodonta rostrata*), Doyran Lake (*Navicula oblonga, Nitzschia elegantula* and *N. reversa*) and the glacial lakes on Shar Planina and Pelister Mountains (*Decussata hexagona, Navicula amphibola, N. concentrica, N. tridentula, Pinnularia alpina, P. infirma, Planothidium peragallii, Stauroneis obtusa* etc).

Table 11. Number of diatom species according to their degree of threat in the Republic of Macedonia.

Category	Number of Species
Extinct or probably extinct species	9
Threatened species	107
Rare species	107
Endemic species	85

2.4.3. Fungi and Lichens

The Preliminary Red Data List of Fungi within the Republic of Macedonia has been prepared and includes 67 species of the order *Basidiomycota.* The following species of Fungi were determined to be rare: *Amanitha vitadinii, Basidiodendron caesiocinereum, Battarea phalloides, Creolophus cirrhatus, Dichomitus albidofuscus, Dichostereum durum, Mycoacia nothofagi* and *Myriostoma coliforme.*

Of the 67 species of *Basidiomycota* potentially threatened, of particular concern are *Amanita caesarea, Antrodia juniperina, Apoxona nitida, Battarea phalloides, Boletus regius, Chroogomphus helveticus, Hygrophorus marzuolus, Inonotus tamaricis, Pleurocybella porigens, Peniophora tamaricicola, Poronia punctat, Pyrofomes demidoffi* and *Suillus sibiricus.*

Within the Lichens, the following species are considered to be threatened: *Evernia divaricata, Hypogimnia physodes, H. tubulosa, Lobaria pulmonaria, Nephroma resupinatum, Parmelina exasperatula, P. omphaloides, P. pastillifera, P. sorediata, Parmelia sulcata, Peltigera canina, P. venosa, Pertusaria coccodes, Pseudevernia furfuracea, Ramalina carpatica, R. polymorpha, R. farinacea, Staurothele clopimoides, Stereocaulon paschale, Usnea carpatica, U. hirta, U. florida, U. glabrescens* and *U. causasica*.

Photo 15. *Pyrofomes demidoffi*, a threatened species of Fungus in the Republic of Macedonia (Photo M. Karadelev).

2.4.4. Higher plants

The Red Data List of threatened plant species within the Republic of Macedonia has not yet been prepared, although there is sufficient data to do so. Great numbers of higher plant species exist within Macedonia, representing a portion of the globally threatened species included in many international documents – international Red Data Lists, conventions and directives (IUCN Global Red Data List, Bern Convention, European Union [EU] CORINE [CO-oRdination of INformation on the Environment] Biotopes Programme species), lists of species of national importance (local endemic and relict species), lists of endangered species and, unfortunately, a certain number within the list of extinct species.

The IUCN Global Red Data List 1997 (Walter and Gillet, 1998) contains 70 taxa from the Republic of Macedonia (of which 19 are local endemics). Of these, one species has the world status "EX" (Extinct) – *Thymus oehmianus* Ronninger & Soska (it is our belief that this information is incorrect since vital populations of this species still exist within the Republic of Macedonia; a more suitable category would be "EN" [Endangered]); two species have world status "EX/EN" (Extinct/Endangered) – *Astragalus physocalyx* Fisch. and *Ranunculus degenii* Kummerle & Jav.; while one species has world status "V" (Vulnerable) – *Ranunculus cacuminis* Strid & Papan. Of

the remaining 66 taxa, 61 have world status "R" (Rare) and five have status "I" (Indeterminate).

Photo 16. Photo of the threatened species, *Thymus oehmianus*, in the Treska River gorge near the village of Zdunye (Photo V. Matevski).

Appendix 1 of the Bern Convention* includes 12 species (11 vascular species and one species of moss) with portions of their ranges located within Macedonia – *Aldrovanda vesiculosa, Astragalus physocalyx, Buxbaumia viridis, Campanula abietina, Fritillaria graeca, F. gussichiae, Galium rhodopeum, Lindernia procumbens, Marsilea quadrifolia, Ramonda serbica, Salvinia natans* and *Trapa natans*.

Of the species listed in the EU Habitat Directive† Annex II, two species of vascular plants and one species of moss are present within Macedonia. Three species (*F. gussichiae, L. procumbens* and *R. serbica*) are also present from Annex IV.

From the European CORINE list, nine species are present in Macedonia: *Coeloglossum viride, Jurinea taygetea, Narthecium scardicum, Orchis coriophora, Ramonda nathaliae, R. serbica, Ranunculus cacuminis, R. fontanus* and *Silene vulgaris,* whereas from the national CORINE list, 19 are present – *Aldrovanda vesiculosa, Asplenium macedonicum, Astragalus cernjavskii, A. physocalyx, Colchicum macedonicum, Crocus cvijici, C. pelistericus, Drosera rotundifolia, Isoetes phrygia, Osmunda regalis, Potentilla doerfleri, Ranunculus degeni, Salvia jurisicii, Sambucus deborensis, Silene paeoniensis, Thymus oehmianus, Tulipa mariannae, Viola arsenica* and *V. kosaninii*.

Photo 17. Photo of the only location within Macedonia (Churchulum, near Bogdantsi) of the species *Astragulus physocalyx* (Photo V. Matevski).

The existing legal regulations addressing the protection of plants include portions of the important floristic areas of the Republic of Macedonia and, within this framework, a certain level of protection has been achieved. Explicitly protected populations of species covered under these acts consist of: *Abies borisii-regis* (Braychino), *Aesculus hippocastanum* (Garska River, Drenachka River and Suvi Dol), *Arbutus andrachne* (Gevgeliya), *Betula pendula* (Neprtka), *Fagus sylvatica* (Kaloyzana), *Juniperus excelsa* (village of Kozhle), *Osmunda regalis* (Bansko), *Picea abies* (Shar Planina Mountain - Popova Shapka), *Pinus mugo* (Yakupitsa), the *Pinus nigra* forest (Mariovo), the *Platanus orientalis* forest (Iberliska River and Mokrino), *Quercus trojana* (Trpeytsa) etc. All of the important floristic sites have not been completely protected, however (although some are in the process of being added to the protected list).

Photo 18. Photo of *Sambucus deborensis*, a threatened species that grows in a restricted area near Debar (Photo V. Matevski).

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* Bern Convention, Appendix 1 – Strictly protected species

† EU Habitats Directive

Annex II – Animal and plant species of Community interest whose conservation requires the designation of special areas of conservation

Annex IV – Animal and plant species of Community interest in need of strict protection

Photo 19. Photo of the rare parasitic species, *Phelipaea boissieri*, on Kozyak Mountain (Photo V. Matevski).

Extinct or probably extinct higher plant species

Drainage activities which were undertaken in the past in most of the valleys of Macedonia, as well as the construction of hydropower reservoirs etc., have resulted in a conspicuous reduction in the populations of certain species and, in some cases, apparent extinction. Such extinct species include the following:

Acorus calamus – Struga: Crni Drim River

Allium obtusiflorum DC (*A. maritimum* Rafin) – Ovche Pole Plain

Gentiana pneumonanthe – Mavrovo Plain

Lysimachia thyrsiflora – Mavrovo Plain

Sagittaria sagittifolia – Pelagonia Marsh - village of Novaci

Box 4. Rare and threatened plant assemblages in the Republic of Macedonia.

Assemblage	**Location**	**Type of Threat**
assn. *Abieti-Piceetum scardicum*	Tetovska River	Forest desiccation
assn. *Aesculo hippocastani-Fagetum*	Village Izvor: Suvi Dol	Relict, rare
assn. *Camphorosmetum monspeliacae*	Ovche Pole Plain	Limited distribution, direct destruction
assn. *Caricetum elatae* subassn. *lysimachietosum*	Ohrid Lake: Studenchishte	Limited distribution, desiccation
assn. *Caricetum macedonicae*	Bistra, Pelister	Water capture/extraction
assn. *Castanetum sativae macedonicum*		Forest desiccation
assn. *Crypsidetum aculeatae balcanicum*	Ovche Pole Plain	Limited distribution, direct destruction
assn. *Cypero-Caricetum acutiformis*	Gostivar	Limited distribution, drainage
assn. *Diantho jakupicensis-Elynetum*	Yakupitsa	Limited area
assn. *Diantho kaimakczalanicensis-Festucetum*	Kaymakchalan	Limited area
assn. *Diantho scardici-Festucetum*	Shar Planina	Limited area
assn. *Edrayantho-Oxytropetum*	Bistra	Limited area
assn. *Ephedro-Prunetum tenellae*	Kavadartsi-Lyubash	Reforestation
assn. *Glycerietum maximae*	Pelagonia: village Chepigovo	Drainage
assn. *Hordeo-Caricetum distantis*	Gevgeliya, Skopye areas	Limited distribution, lowering of the groundwater table
assn. *Lemno-Spirodelletum polyrhizae* subassn. *aldrovandetosum*	Prespa: Ezerani	Limited distribution, water receding
assn. *Mariscetum*	Negortsi Spa	Limited distribution, fragmentation
assn. *Micromerio-Violetum kosaninii*	Yakupitsa, Kozyak	Limited area
assn. *Myriophyllo-Nupharetum*	Doyran Lake: Nikolich	Water receding
assn. *Osmundo-Thelipteretum*	Bansko	Limited distribution, land usurpation

assn. *Periploco-Alnetum glutinosae*	Monospitovo Marsh	Drainage
assn. *Phillyreo-Juniperetum excelsae*	Demir Kapiya	Forest fires
assn. *Pholiureto-Plantaginetum balcanicum*	Ovche Pole Plain	Limited distribution, direct destruction
assn. *Pinetum mugo macedonicum*	Yakupitsa	Forest fires
assn. *Pulsatillo macedonicae-Pinetum nigrae*	Karadzitsa	Forest fires
assn. *Querco-Carpinetum orientalis macedonicum*		Forest fires
assn. *Rindero-Acantholimonetum*	Galichitsa	Limited area
assn. *Scirpo-Alopecuretum cretici*	Monospitovo Marsh	Limited distribution, drainage
assn. *Sclerantho-Biserruletum pelecinae*	Mariovo: Gorge of Crna River	Construction of artificial reservoir
assn. *Seslerietum korabensis*	Korab, Bistra	Limited area

Photo 20. *Prunus prostrata*, a rare shrub species from Galichitsa Mountain (Photo O. Matevska).

2.4.5. Fauna

The European Red Data List includes 113 of the vertebrate species present within the Republic of Macedonia (30 fishes, 66 birds, 16 Mammals and one species of Reptile). Seventeen of the 20 endemic fishes are included within the category of globally threatened species. Seven are restricted to Ohrid Lake (*Acantholingua ohridana, Phoxinellus epiroticus, Rutilus ohridanus, Salmo aphelios, S. balcanicus, S. letnica* and *S. lumi*), six to Prespa Lake (*Alburnus belvica, Barbus prespensis, Chondrostoma prespense, Cobitis meridionalis* and *Rutilus prespensis*), one to Doyran Lake (*Sabanejewia doiranica*) and three endemic species occur within other aquatic ecosystems (*Gobio banarescui, Salmo pelagonicus* and *S. peristericus*).

Because the National Red Data List for Macedonia has yet to be prepared, the most important species to be protected at the national level are considered to be the endemic fish species. The remaining endemic vertebrate species should also be included, as well as some other specific vertebrate species whose ranges end in or pass through Macedonia (*Algyroides nigropunctatus, Coluber gemonensis, Cyrtopodion kotschyi, Lacerta agilis, Pelobates syriacus, Rana balcanica, R. graeca, R. temporaria, Testudo graeca, Triturus alpestris, Vipera berus* etc.).

The reason for the disappearance of species and/or the reduction of their populations is due primarily to human activity, but there are also global causes which have not been completely identified. If global factors endangering biodiversity, including changes in climate, are excluded, then all remaining essential factors having direct or indirect impacts on faunal diversity, the observed changes within ecosystems (especially aquatic and forest types), changes in the ozone layer, some fungal pandemics etc., are of anthropogenic origin.

Regarding the conservation of aquatic systems and their environs, where the greatest faunal diversity has been recorded, it is necessary to note some key factors which cause disturbances to natural conditions within biotopes and, thus, the reduction of biodiversity as a whole. These include:

- Changes made in localised or wider areas through habitat destruction, fragmentation and isolation;

- Hunting for commercial purposes and collection for scientific, hobby and other non-scientific uses;
- Colonisation by invader species;
- Insufficient knowledge regarding basic population parameters and the distribution of individual faunal groups.

Table 12. Threatened vertebrate species in the Republic of Macedonia.

Threatened species of Fishes	30
Threatened species of Reptiles	1
Threatened species of Birds	66
Threatened species of Mammals	16
Total number of threatened species	**113**

2.5. Species of economic importance (wild plants and animals)

2.5.1. Usage of wild plants and fungi

Pastures. Although pastures are used in livestock production and represent the most important economic non-cultivated plant resource, their total productivity, which is directly influenced by seasonal climatic conditions, has not been calculated to date. Pastures are managed by the Public Enterprise for Pastures at the national level. Most are not utilised, being present in the high mountains. In some of these high mountain pastures on the larger mountains (Shar Planina Mountain, Bistra, Korab, Yakupitsa, Suva Gora Mountain etc.), an inventory has been undertaken for the purpose of determining carrying capacities. This process should be continued in the future. The lack of significant grazing in these pastures has contributed to a change in the composition of herbaceous vegetation, the invasion of woody shrubs and the degradation of the humic layer.

Other species. There are legal regulations covering this group (*Regulations on the Manner of Use of Other Forest Products*, Official Gazette of the Republic of Macedonia 13/00), but they do not provide a mechanism for obtaining a precise assessment of the current status of wild plant species. Thus, one of the priorities is to prepare new regulations defining the sustainable use of these species.

Species of plants intended for human consumption yield both fresh, whole, semi-processed and fully processed products. The following groups of wild plants are of greatest economic importance for the Republic of Macedonia:

Mushrooms. Mushrooms appear to possess an enormous economic value for the local population; however, there is no published data on the number of collectors or the quantity of fresh wild mushrooms purchased domestically. Of the species collected locally for food, some (*Agaricus* spp.*, Amanita caesarea*, *Boletus* spp., *Cantharellus cibarius*, *Craterullus cornocopoides, Lactarius deliciosus*, *Macrolepiota procera* and *Morchella* spp.) can also be found in markets across the country.

The mushroom species most often purchased for export are: *Boletus aereus, B. edulis, B. pinophulus, B. reticulatus, Cantharellus cibarius* and *Morchella* spp. They represent an important export product (328,693 kg/year; estimated value $2,000,000) for the companies registered to purchase wild-collected mushrooms, but the real quantity collected per year is never known. Although a permit for the export of commercial species (i.e., not on the list of endangered species) can be obtained from

the Ministry of Environment and Physical Planning (MoEPP), no regional or local productivity data exist on which to base sustainable use restrictions.

Herbal teas. In the Republic of Macedonia, there is virtually no cultivated tea production. The little that does exist is insignificant compared with the wild collection performed by local citizens for personal use and for sale to various companies (e.g., Alkaloid, Bilka, Jaka, Koro etc). The amount of tea exported in 2001 was 1,127,825 kg, with a total value of $1,453,052. In other years, as much as $4.5 to 5 million were realised from tea exports.

Wild fruits and nuts. These consist mainly of high mountain fruits, the most important of which is the blueberry (*Vaccinium myrtillus*), a product used chiefly for export (in 2001, 83,284 kg worth $86,196). Blueberries are found in almost all high pastures (over 1,300 m msl). In recent years, there has been an increase in the collection of juniper berries (*Juniperus communis*) for the production of essential oils. By intensity of collection, after berries follow Dog rose (*Rosa canina*), Raspberry (*Rubus idaeus*), blackberry (*Rubus* spp.), Cornelian cherry (*Cornus mas*) and Blackthorn (*Prunus spinosa*). Wild apples, pears and cherries are used as ingredients in the fruit teas very much in demand for export. In addition, the collection of Chestnuts (*Castanea sativa*) is very widespread, with approximately 250,000 kg collected per year, intended mostly for the home market.

Timber/fuelwood. According to data obtained from Macedonian Forests in 2001, the legal timber harvest in the Republic of Macedonia was 520,915 m^3 (of which 463,840 m^3 were cut by local Macedonian Forests branches and 57,075 m^3 by private individuals in public forests). The total quantities of timber harvested included 417,355 m^3 of fuelwood and 97,837 m^3 of commercial timber. The tree species primarily harvested are: Beech (fuelwood and commercial timber), Oak (fuelwood and commercial timber) and Pine (commercial timber). Other species (Chestnut, Fir, Poplar and Walnut [*Juglans* sp.]) are of significantly lesser importance.

The deterioration of the security situation during the course of 2001 and 2002 contributed to a marked increase in illegal timber cutting, especially in the regions of Bitola, Kumanovo, Resen, the Shar Planina Mountain group, Skopye, Struga and others. At the present time, it would be difficult to make an accurate assessment of the actual magnitude of illegal harvesting, but it is assumed to be ongoing at the same intensity as before.

Horticulture. Traditionally, wild species of flowers, as well as decorative plants, are grown in home gardens. A small percentage are collected and sold in local markets, such as: *Buxus sempervirens, Colhicum autumnale, Crocus* spp*., Cyclamen hederifolium, Galanthus nivalis, Geranium* spp*., Helleborus odorus, Narcissus poeticus, Primula* spp*., Syringa vulgaris, Viola* spp. *etc.*

Medicinal uses. There are approximately 3,500 vascular plant species in Macedonia, of which 700 have medicinal properties; however, only 120 species are generally utilised. Their qualitative and quantitative distributions within the Republic have not been fully determined (i.e., a chorographic atlas of the medicinal plants has yet to be published). Available data do not reflect the current situation with medicinal plants, due to a lack of legal regulations for their collection, use, care, conservation, trade and export. Existing data regarding maximum annual quantities of medicinal plant material exported in the last decade (*Hypericum perforatum* [5,000 tonnes], *Lichenes* [1,200 tonnes], *Altahea officinalis* [80 tonnes], *Chamomilla recutita* [75 tonnes], *Tilia cordata* [60 tonnes] and *Gentina lutea* and *G. punctata* [3-4 tonnes]), indicate an alarming situation.

The collection and use of medicinal plants can be divided into three categories: personal use, retail/wholesale trade and other economic purposes. A mechanism for regulation and classification is necessary before the amount of dry plant material an individual can collect from an area can be determined and before a permit for this collection can be issued. The collection of medicinal plants for economic purposes in Macedonia varies widely with the species collected, the collectors themselves and the seasonal quantity of the collected material. The large seasonal demand by foreign buyers for specific plant species is most serious and is facilitated by certain local trade companies which have no previous experience in this field. Plant species which are used whole (i.e., with root and bark) are most threatened.

According to distribution patterns, the most threatened plants are those with limited ranges (i.e., they are present only in certain restricted areas; e.g., *Acorus calamus, Salvia officinalis* and *Sideritis scardica*) . Based upon data from the past ten years, the most troubling situations are with the species *Adonis vernalis, Arctostaphyllos uva-ursi, Colchicum autumnale, Gentiana lutea, G. punctata, Herniaria glabra, H. hirsuta, Hypericum perforatum, Lichenes,* various species within the family *Orchidaceae* (whose parts are used in the production of salep), *Sideritis raeserii, S. scardica, Thymus* spp. and others.

Other uses, including species used in foreign trade. Wild species are sometimes used in the cosmetics, alcohol and construction industries. Lichens used in the cosmetics industry are collected in the eastern and western mountains of Macedonia and then exported (the annual purchase reaches 600-800 tonnes dry weight; the exported amount in 2001 was 83,334 kg, valued at $79,624). Essential oils are extracted from cones, needles and seeds of Pine and other plant species. The exported amount in 2001 was 991,067 kg, valued at $758,463. The annual purchase of juniper berries by various organisations is 3,000-4,000 tonnes. Cattails, reeds and Willows are used in construction, either dried, woven, as thatch or in handicraft products. They are mainly collected on the lakes (Doyran, Ohrid and Prespa); however, this activity is on the decline.

In 2002, the total amount of exported plant material, with the approval of the MoEPP, was 1,035,025 kg. According to data from the Department of Plant Protection (within the Ministry of Agriculture, Forestry and Water Management [MoAFWM]), the total quantity of medicinal plant material exported was 1,244,959 kg.

2.5.2. Use of wild animals

Hunting. Hunting is conducted through hunting associations combined under the Hunting Union of Macedonia. Macedonia is divided into 11 managed hunting areas, with 107 hunting sites for large game (47% of the total area, excluding lakes) and 145 hunting sites for small game (49% of the area). These hunting leases are managed both by the hunting associations themselves and by organisations working in the field of forestry. In addition, five enclosed areas totalling 4,041 ha for the breeding of large game and one pheasant farm with a yearly production capacity of 40,000 two-month-old pheasants have been established.

The greatest portion of the land area licensed for hunting consists of forests and forested areas. With the Law on Hunting, 127 species of game (24 fur-bearing animals and 103 birds) have been given special consideration. Unfortunately, protective measures for the care of forests and for the care of game often do not agree. Therefore, there is a need to coordinate such measures within the two sectors.

Fishing. Licensed fishing is allowed on all natural lakes, reservoirs and rivers, and encompasses both commercial and sport fishing. Fish species that are commercially important include:

Ohrid Lake: Bleak (*Alburnus alburnus*), Eel (*Anguilla anguilla*) and Ohrid trout (*Salmo letnica*). The greatest percentage of the total annual catch is from these three species. In the past, the annual catch in Ohrid Lake was 220-240 tonnes, 50% of which was trout. At present, this quantity is considerably less (under 100 tonnes). The trout catch has declined markedly, from the periods when over 140 tonnes were caught annually to the present catch of only 35 tonnes.

Prespa Lake: Prespa bleak (*Alburnus belvica*) and Carp (*Cyprinus carpio*). The annual catch in Prespa Lake is 100 tonnes.

Doyran Lake: Bleak, Carp, Perch (*Perca fluviatilis*), Roach (*Rutilus rutilus*), and Rudd (*Scardinius erithrophthalmus*). Traditionally, these species amount to 98% of the total fish catch. While the annual catch in Doyran Lake was formerly over 500 tonnes, in the last few years it has ranged from 70-90 tonnes/year. The annual catch in 2002 was only 25 tonnes and was dominated by Crucian Carp (*Carassius carassius*), with minor amounts of Carp and Perch.

As regards the fish catch in reservoirs, there are no valid statistical data. There are estimates that over 200 tonnes/year are caught from Tikvesh Lake alone, mostly Roach, followed by, in decreasing order, Carp, Wels (*Siluris glanis*)**,** Bleak, Perch and, to a lesser extent, Nase (*Chondrostoma nasus*) and Balkan vimba (*Vimba melanops*).

With respect to sport fishing, in addition to those species listed previously under commercial fishing, important species also include: Balkan vimba, Barbel (*Barbus barbus*), Mediterranean barbel (*B. meridionalis*), Brown trout (*Salmo trutta*), Chub (*Leuciscus cephalus*), Vardar chub (*L. delineatus*), Gudgeon (*Gobio gobio*), Nase and Wels. Again, there are no relevant data on the total fish catch by sports anglers. Occurrences of illegal fishing and the use of prohibited fishing gear cause grave concern. Using the basic data on the number of water bodies and their areas, estimates are that the annual fish catch in the Republic of Macedonia ranges from 800 to 1,200 tonnes; however, a major portion of the catch is not recorded.

Collection for medicinal purposes. In comparison with plants, the collection of animals for medicinal uses is rather insignificant. The restricted population of the Macedonian endemic subspecies of the European souslik (*Spermophilus citellus karamani*) is found on Yakupitsa mountain at the site, "Begovo Pole Plain." The Macedonian common name for this subspecies (Stobolka) is related to its use in traditional medicine, that is, it was believed to be able to cure 100 aches (sto bolki). Although the collection of European souslik has declined in recent decades, it does still occur, directly threatening the survival of this Macedonian endemic subspecies.

Other uses, including species used in foreign trade. Other animals used primarily as foreign trade items consist of several snails. Two of these are particularly important:

- The Edible (French) snail, *Helix pomatia,* the collection of which is forbidden according to the international Bern Convention. In addition, in compliance with IUCN, it belongs to the category of "vulnerable" species. The fact that this species is listed as purchasable but has a reduced population makes it very likely that its future collection and sale will be prohibited in order to rebuild the populations.

- The Roman (Turk) snail (*Helix lucorum),* for which there was no purchase limit until recently, is present throughout Macedonia. Approximately 200 tonnes used to be purchased annually, but its numbers have declined due to uncontrolled collection. This species has been recommended for protection and its collection, purchase and export will be regulated through the imposition of a temporary ban on these activities every two years. During the alternate years when collection, purchase and export (1 June - 1 October) are allowed, a quota of 40,000 kg of whole live specimens will be introduced. In 2001, 1,323,795 kg of whole snails (valued at $3,063,991) were exported from Macedonia.
- Permanent protection will also be provided to the Common snail (*Helix vulgaris*), a south-Balkan endemic species, the Striped snail (*Cepaea vindobonensis*), a southern and eastern European species, and the species *Helix figulina*, a south-Balkan endemic.

2.5.3. Assessments of sustainability

Due to the importance of biological resources, as well as the excessive and uncontrolled exploitation of wild plant and animal species, there is a serious danger that many will disappear. Because of this, there is a pressing need to adopt regulations concerning these species and to specify annual collection quotas.

2.6. Genetic diversity (gene-fund)

The importance of plant genetic material (including wild species, as well as the many local varieties and wild relatives of various crops) for the development of plant genetics and selection was emphasized for the first time within the Republic of Macedonia during the 1960s. Besides the collection, investigation, maintenance and use of genetic material from various local crops (which had a priority for study due to their importance in human nutrition), active investigations on the genetic diversity of natural populations of Angiosperms were also begun.

Since numerous endemic and relict species of national significance within Macedonia are actually or potentially threatened in their natural habitats, a loss of genetic diversity could become a reality. On the other hand, appropriate genetic investigations and maintenance of a gene-fund can, in large measure, be used as a means for the appropriate future reintroduction of lost species; conversely, the lack of such reintroduction could also be considered a serious threat to genetic diversity.

From a conservation standpoint, determining genotypes through defining the chromosome number in natural populations of higher plants is very important for the preparation of Red Data Lists and Red Data Books, as well as for the gene-banks with their various collections.

Of the flora of Macedonia, the *Chromosome Atlas of Angiosperms* indicates that 548 taxa of 171 genera and 30 families have been studied. The existence of such a survey of the chromosome numbers of these Angiosperms is a solid foundation for establishing a contemporary information technology database.

Access to plant genetic resources stored in gene-banks is not legally regulated in the Republic of Macedonia. The collections in the gene-banks are freely available for exchanges with any other gene-bank. All one must do is make a request by ordinary letter, since such cases are generally arranged through personal contacts. Macedonian

collections can not be found on the internet, nor are any portions of the databases present on other plant networks.

The number of varieties/species used in agricultural production within Macedonia is evidence of its great biological diversity. There are 129 recognised domestic varieties and 2,205 imported varieties used domestically. The Institute of Agriculture in Skopje, the Institute for Southern Crops in Strumitsa and the Tobacco Institute in Prilep maintain collections of local varieties.

With regard to domesticated animals, concrete measures for conservation of the Pramenka sheep "Karakachanska" have already been undertaken. With the assistance provided by the MoAFWM, a collection of 100 sheep and 12 rams has been established. The heads were placed in two independent locations for morphological characterisation. They are now also undergoing biochemical analyses of DNA and proteins in order to determine polymorphism within the micro-satellite bands and genetic markers. In the future, it is planned to cryogenically preserve a sufficient quantity of sperm and fertilised embryos, in order to facilitate the long-lasting conservation of genetic material.

2.7. Agrobiodiversity

Biological diversity in agriculture is one of the most critical areas of overall global biodiversity, with 75% of all food production based upon only about 100 plant species and domesticated animals. As civilisations developed, humans strove to create plant varieties and domesticated animals with more useful traits. The process of deliberate creation of varieties and breeds has been occurring for at least the past 50-100 years, and more specialised genotypes characterised by the term, "high input – high output," are now being promoted. As a result of the tendency to neglect traditional breeding, many old varieties and breeds have been permanently lost as genetic resources. Within Macedonia, the biological resources represented by indigenous varieties, breeds and species need to be preserved for the sake of economic, scientific, cultural, socio-economic and environmental interests.

2.7.1. Crops

Macedonia possesses significant agrobiological plant diversity due to its favourable geographic location and climatic conditions. The diversity of a large portion of the local species has not been adversely affected because agricultural production is not intensive in many regions. In such areas, indigenous species and locally-bred varieties are still grown, representing an important source of genetic material no longer appearing within the genotype of commercial species.

The major portion of the total arable land is used for field and garden production (84.2%), fruit and grape production (7.1 %) and pastures (8.5%). The trends in the production of individual crops vary by year, as evidenced by the disappearance of some crops (e.g., poppy, flax, hemp and cotton). The bulk of the crops produced consists of commercial varieties, the major portion of which are imported from abroad, with a minor number of locally-developed varieties, mainly created by the Institute of Agriculture in Skopye. A large number of small producers do continue to grow local varieties and indigenous species.

Wild relatives of crops. Most of the crops in Macedonia still have local wild relatives (*Avena* spp., *Cannabis sativa, Hordeum* spp., *Papaver* spp., *Triticum* spp. etc.). In fruit production, wild relatives are used most often, both for food and as

rootstocks. Fodder crops, mainly distributed within ploughed fields and meadows (natural or sown), were created by selection and cultivation of wild species. Some have been cultivated since long ago, and others began to be cultivated only recently.

2.7.2. Native breeds of livestock

Domesticated animals contribute 30-40% of the world's food production. Many of the breeds developed for specific climatic regimes or breeding zones appear not to be able to thrive under the conditions of modern livestock production. During the past 50 years, new, more productive breeds have been imported. Although the original imported breeds are still present in Macedonia, crosses between indigenous breeds/strains and imported breeds are known in several species:

Busha. Local breed of cattle found in highland and mountain areas. During the last 30-40 years, it was crossed with many imported breeds. According to official statistical data, Bushas comprise 50% of the total number of cattle raised.

Pramenka. Local breed of sheep represented by three strains: Karakachanska, Ovchepolska and Sharplaninska. The Karakachanska strain is considered to be endangered, while the other two strains are widely used in sheep production.

Domestic (Balkan) goat. Although its numbers are on the increase, it is difficult to make a clear distinction between this and other breeds.

Local primitive pig. Slow growing breed raised on ranges in several regions of Macedonia. Although it is a very primitive breed, more field and laboratory research are needed in order to clearly define its status.

Sheep dog - Sharplaninets. This indigenous breed developed in an independent, natural and authentic manner without any participation by humans, which is its great advantage. Its name derives from its place of origin (the mountain massifs of Shar Planina, Bistra, Korab and Kozhuf). Upon the request of the Kinological Association of Macedonia (KAM), the Federation Cynologique International (FCI) registered this animal under the name Sheep Dog – Sharplaninets. It is listed as having a dual country of origin, the Republic of Macedonia and Serbia and Montenegro.

3. Key threats to biodiversity

Within the Republic of Macedonia, there are many general reasons for the reduction or loss of biodiversity. They result from both direct and indirect impacts and threats, as well as from several more fundamental causes. These fundamental reasons derive mainly from the existing socio-economic problems within the State, with the direct and indirect threats resulting from impacts by various economic sectors.

3.1. Socio-economic context

Education. Within the last 50 years, the overall level of education of the Macedonian population has risen. Even though differences in educational approaches between urban and rural settings have diminished, 62.5 % of the illiterate population continues to live in rural areas. The low level of literacy among women and the rural adult population constrains development activities in all spheres. There is also a close relationship among education, natural population growth rate, quality of labour force and the sustainable use of biodiversity.

Education is a key factor in the promotion of the economic, social, ecological and cultural values of biological resources and biodiversity. The education sector should promote economic and social understanding of the importance and role of biodiversity. Special attention should be given to the most threatened natural resources such as water and soil, as well as to natural ecosystems and biodiversity in general.

Within their working plans and programmes, institutions in the fields of education, health services, information, culture and science are obligated to incorporate such material concerning biodiversity that will increase general understanding and will encourage active participation in the improvement of nature conservation. In Table 13, data concerning the educational structure and characteristics of the population by location are presented.

Table 13. Structure and characteristics of the population by location and education level (1994).

Census of 1994	Macedonia	City of Skopye	Other Towns	Villages
Illiterate*	5.4	2.9	3.6	8.6
Without school education †	6.6	3.5	4.4	10.5
Not completed primary school †	18.4	9.2	14.8	27.4
Primary school †	33.4	25.2	30.6	41.1
Secondary school †	32.3	46.7	38.4	17.7
Advanced and university †	8.7	15.1	11.3	2.5
Unknown †	0.6	0.3	0.5	0.8

* age 10 and older; † age 15 and older

Source: Calculations using data from the Census of 1994, Population, housing and agricultural businesses, Book V, Skopje 1996

Strengthening the social and economic security of the population. Two of the most noticeable characteristics of the past few years are the significant changes in societal structure (i.e., economic stratification of the population) and an increase in the number of impoverished Macedonian citizens.

The greatest proportion of the population of low economic status is concentrated in undeveloped areas and rural municipalities. Unless basic conditions are changed, their numbers may increase. The people in these communities possess and use few modern conveniences, do not have access to common social services and are insufficiently integrated into society.

Poverty produces a greater intensity of natural resource exploitation and causes large changes within natural ecosystems. The level of poverty has increased from 19.0% in 1997 to 22.3% in 2000. Those living in poverty include people with a low level of education, the elderly, families with small children, the unemployed and the portion of the population living in hill or mountain settlements. A high proportion of poor households are in rural areas. The gap between the rich and the poor is also increasing. More than one third of the population of the Republic of Macedonia lives in poverty, and many are hungry every day (23% have no money to buy food) (Report of the project on "Social Exclusion and Insecurity of the Citizens of Macedonia," Institute of Sociological and Political-Legal Research, Skopje, 2000). In 2000, around 77,000 households (or 15% of the total number) received social assistance, which amounts to 57% of the income established as the poverty level.

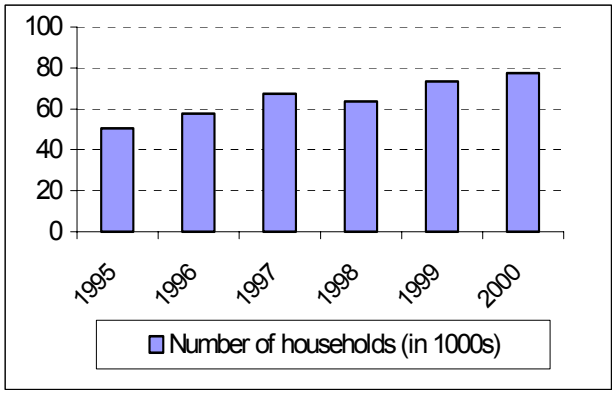

Figure 1. Number of households that received social assistance during the period 1995-2000.

Most of the poor have restricted access to income, education, health care and food, especially the populations in hilly, mountainous and undeveloped areas. They face poverty due to their limited access to arable land and because of migration, which seriously reduces the portion of the population capable of working. One of the factors that keeps people in poverty is the lack of adequate infrastructure, which particularly affects the population in undeveloped areas. This limits their access to those institutions providing public benefits – health, educational and cultural services; public administration etc.

Little progress has been made in the area of disposable income. Funds available for personal consumptive use within the Republic of Macedonia decreased by 30% per household during the period 1998-2000. This has brought about changes in the structure and manner of consumption. Food, housing, fuel, lighting, health and hygiene costs have increased while, at the same time, funds available to purchase clothes, shoes and household items or to be set aside as savings have decreased. This is indicative of a low living standard and quality of life.

The unemployment rate is high and continues to rise. In comparison to the beginning of the period of transition, unemployment has doubled. In 2000, according to official statistics, the unemployment rate was 32.1%, which indicates the breadth and severity of the problem. The time spent searching for a job averages over four years for 59.4% of unemployed persons (1999 data).

Possibilities for social security and poverty eradication. Because poverty is a complex, multidimensional problem, there is not one, universal solution. Poverty is linked to a lack of control over resources such as skills, knowledge and capital. Therefore, in order to make advances against poverty, it is necessary to apply a multidimensional approach addressing those economic, social and natural factors that will generate an acceptable income and create basic social services for the citizens. In order to achieve this goal it is necessary to:

- Introduce equal opportunities for all citizens, while promoting economic and social development;
- Strengthen the educational system and enable the people to earn a living in a sustainable manner;
- Include the local population in the conservation and sustainable use of biological resources and the sharing of the benefits of natural resources within the region.

Political pluralism and market economy. The 1991 Constitution defines the Republic of Macedonia as a sovereign, independent, democratic and social State with its civil government based upon the democratic election of representatives. It is a government which also allows the citizens to express themselves directly through referenda and in other manners and forums.

Political pluralism has its main pillars in the form of political parties, a market economy allowing private ownership and local self-government by municipalities. The Constitution guarantees the basic personal and political freedoms specified under international law: the right to live, the right to liberty, the right to express one's ethnic affiliation, the protection of one's physical and moral integrity, the prohibition of discrimination and equality before the law. Citizens enjoy equal rights to candidacy in elections and other functions, both at the local and national levels, without any fear of discrimination.

The Constitution guarantees economic and social freedom and other citizens' rights including: the right of property ownership, the right to work, the right to strike, the right to inherit, the right to social insurance and social care, the right to health care, the right to a healthy environment, the right to education etc. The principles of market freedom and entrepreneurship, fundamental values of the constitutional order of the Republic of Macedonia, allow for broad opportunities to strengthen the economy and to increase the productivity of labour and private initiatives in all areas of the economic system. Nevertheless, the current unsatisfactory environmental legislation may accelerate biodiversity loss.

3.2. Key economic sectors affecting biodiversity

Agriculture (including hunting and forestry). This sector has been providing a relatively stable contribution to the GDP (by method of production) of about 11% over the course of the last several years (or, more precisely, 10.9% in 1997, 11.4% in 1998 and 11.0% in 1999). During this same period, capital expenditures have experienced relatively high fluctuations.

The total area of agricultural production has noted a declining trend (which is the main indicator of non-sustainable and inefficient utilisation). This same trend can be seen in arable land, which fell from 658,000 ha (1996) to 598,000 ha (2000). Arable land area typically completely covers valley relief. In the case of pastures, which

comprise the remaining areas of agricultural production, an opposite or increasing trend has been observed, from 632,000 ha (1996) to 636,000 ha (2000).

Photo 21. View of Ovche Pole Plain.

The current state of agriculture is burdened with many problems: agrarian overpopulation in the lowlands and the need for deagrarianisation; fragmentation of agricultural areas and the need for their more effective use; poor quality of equipment and the need for modernisation; and the degradation of soils.

Deagrarianisation in Macedonia has been conducted in a spontaneous, disorganised, premature and excessive manner. Because of this, the portion of the total population working in agriculture decreased from 22% (according to the 1981 census) to 14.7% in 1991 and to 11.8% in 1994.

From an economic standpoint, the poor quality of equipment and infrastructure is the next problem to be solved in the field of agriculture. This is one of the main reasons for the increasing dependence on natural weather and land conditions.

The most significant progress over the course of the past decade has been made in privatisation of the socially owned and cooperative sector and the associated denationalisation of land, that is, the return of agricultural areas to their former owners. The land was taken during agrarian reforms in 1945 and nationalisation in 1953.

Agriculture is a sector posing a severe threat to the biological diversity of the Republic of Macedonia, especially due to the current unfavourable conditions and negative development trends.

Forestry. Forestry is a sector which has been neglected for a long period and inadequately treated by the economic policy makers. Such a course is based upon its limited contribution to the GDP. This may be further evidenced by the fact that, in the official statistical methodology, forestry is combined with agriculture, making it impossible to glean explicit information on its sole contribution to the GDP. It is possible, however, to draw certain conclusions regarding the capital expenditures made in this sector over the course of the last several years. An analysis of the magnitude of investments in the forestry sector confirms its low significance. More specifically, in 1997 the modest share forestry received out of the total sum of capital expenditures in the Macedonian economy was only 0.9%. It decreased in subsequent years to 0.4% in 1999 (Source: *Statistical Yearbook of the Republic of Macedonia* 2001, State Statistical Office, Skopje, p.397).

Forests in the Republic of Macedonia cover 950,594 ha, representing 37% of the total land area. By growth form, high forests constitute less than 30% of the total forest cover, while low forests account for 70%. As a result, only one-third of the forests are considered to be suitable as a source of raw materials for the lumber industry.

Photo 22. Mixed forests on Kajmakchalan Mountain.

Over the course of the last 10 years, the average gross volume of timber harvested has totalled 1,033,000 m^3, of which 76% (786,000 m^3) originated from State-owned forests and 24% (247,000 m^3) from private ones. Statistical data on the timber harvested from private forests are not available. At present, it is not possible to make a satisfactory estimate of the tree harvest, nor is it possible to estimate the level of utilisation of harvesting equipment.

Usage, by category, of timber harvested from State-owned forests has also been economically inefficient for a long period of time. Fuelwood is the predominant use, with a share of more than 75% of the total volume of harvested timber. Wood intended for industrial processing, that is, sawing for lumber, constitutes less than 20%. Inefficient economic utilisation is evidenced by the fact that the highest and best usage of logs, for veneer, either does not occur or exists only in negligible quantities. Construction of forest roads has been increasing, allowing better access to remote areas.

Foreign trade within the lumber industry has been experiencing an upward trend. This industry has noted a much higher increase in imports relative to exports, which have also increased, but at a much lower rate. The lumber industry share of the GDP of the Republic of Macedonia is very low (0.3%).

Usage of forests during the period of transition has not experienced any dramatic change, although the manner of management has undergone a transformation (a public company for forestry management was established). Although the name has been changed, the same former enterprises have essentially remained in place, controlling the same forest areas and using the same forestry management planning.

Impacts to biodiversity from forestry activities are primarily manifested within the forest ecosystems themselves. Impacts from forest roads (erosion), over-harvesting (illegal), and ecosystem-wide changes in nutrient cycling resulting from the huge quantities of biomass (i.e., waste) left behind after harvesting differ in each different forest ecosystem.

Changes occurring within indigenous forest types which result from the introduction of alien tree species or from modifications to natural vegetation caused by the planting of inappropriate species (e.g., Arizona cypress [*Cupressus* sp.], Black pine and Douglas-fir [*Pseudotsuga menziesii*]) are of particular relevance.

Fisheries. There are no published data on the total income from the fishery industry in the Republic of Macedonia. According to official statistical data, the consumption of fish in the Republic amounts to around 7,500-8,000 tonnes/year, or consumption of 3.4-3.7 kg per capita. Officially, domestic production meets only 13.2-13.5% of this total annual demand.

The current political and economic circumstances within the country and region have had an adverse impact on fisheries. Total fish production in 1999 was about 420 tonnes (249.3 tonnes of Trout, 138 tonnes of Carp and 30.3 tonnes of other species). Unfortunately, this is less than half of the fish production recorded for 1990, when total production amounted to 1,000 tonnes. The general assessment of changes to fishing in open water bodies within Macedonia is negative. Drastic reductions in the annual fish catch in the three natural lakes have been noted.

Photo 23. View of Lake Doyran.

Doyran Lake, recorded in world scientific literature as one of the most productive lakes in Europe, used to have average annual fish production of 180 kg/ha. In the past, as an integral part of the State fisheries economy, it played an important role in supplying the population with fish. Its average annual catch represented 50% of the total national fish catch (prior to the beginning of more intensive construction of artificial fishponds). The main reason for the drastic reduction in fish stocks within Doyran Lake is its catastrophic hydrologic condition.

Although fishing is the main manner for utilising the fish stocks of aquatic ecosystems, planned and organised fishing does not significantly adversely impact

biodiversity. The current trend of intensive, uncontrolled fishing, however, does impact fish populations and leads to an unbalanced ecosystem by reducing the populations of one fish species while favouring others. The intensive culture of fish in artificial fishponds is recording a steady increase, and may help meet some of the demand for edible fish.

The status of fish biodiversity in rivers is significant for several reasons. A drastic decline in the population densities of certain species has been recorded, other species that used to be integral parts of the ichthyofauna of some watercourses can no longer be found and there has been a change in the horizontal distribution of some species. In addition, in several lakes and reservoirs, exotic species are now present, introduced without any justification either by error or as a result of ignorance.

Industry. In terms of its contribution to the Macedonian GDP, industry still occupies the leading position in the Macedonian economy, despite the fact that, from the beginning of the process of transition, industry's average share has been declining. It is interesting that, during the last years of the past decade, industry contributed about 18% to the Macedonian GDP. Capital expenditures in industry tend to maintain rather stable levels compared with total investments in the Macedonian economy as a whole.

Photo 24. Photo of Macedonian industrial capacity.

Some of the current problems faced by industry in Macedonia include: a disproportionate share by certain industries (traditional and raw materials related branches, which are characterised by low productivity, low levels of capital reserves, low revenues and few exports); lagging technical knowledge and technologies, a low level of modernisation and a high incidence of age-related equipment failure; low productivity and over-employment; insufficient utilisation of facilities; and poor export capability.

The decline in the productivity of this sector reached -15%/year at the beginning of the last decade. More recently, industry has experienced somewhat of a revitalising trend, that is, many years have seen positive growth (4.5% in 1996, 2.9% in 1997, 4.5% in 1998, -2.5% in 1999 and 5.0% in 2000).

The industrial sector of Macedonia contributes both direct and indirect adverse impacts to the environment (air, water and soil). Industry also significantly adversely affects both human health and biodiversity due to its geographic distribution, old technology, failure to apply technical and technological standards for the treatment of gaseous pollutants, poor management of effluents and wastes, use of toxic production materials and dirty energy resources, non-compliance with environmental codes etc.

Construction. Construction is a significant sector, holding a distinct position in Macedonia. In terms of available capacity, it exceeds the market within the country, which was a situation inherited from the former Socialist Federal Republic of Yugoslavia.

The construction sector in Macedonia has undergone a great upheaval during the last several years. Its contribution to the generation of domestic macroeconomic aggregate variables has exhibited a decreasing trend, from 10.4% in 1980 to 4.6% in 1990. A minor improvement was recorded in 1995 (7.3%), when the first modest signals of a Macedonian economic recovery appeared; however, in the course of the next two to three years, its contribution to the GDP had stabilised at about 5%.

Photo 25. View of the quarry at Demir Kapiya.

The construction sector adversely affects biodiversity through: air pollution, new impacts to natural land areas, use of mechanisation, noise, pollution of aquatic ecosystems and soils (due to the disposal of waste materials from construction and demolition activities), destruction of habitats and their fragmentation and isolation. There are no specific data available on the extent of these impacts in the Republic of Macedonia.

Mining. There is no relevant economic information specific to the mining sector, because this sector is incorporated within the established category of metallurgy. In the Republic of Macedonia, this sector is represented by the extraction of both metals and non-metals. The mining of lead and zinc ore (eastern Macedonia), iron ore (central and western Macedonia), coal (south-western Macedonia) and non-metals, mainly marbles and travertines (central and north-eastern Macedonia), dolomites, lime, silicates, ceramic clay, feldspar, gypsum, diatomaceous earth etc., is of particular importance.

Photo 26. Flotation within the mine Toranitsa.

In the past, the non-metals industry contributed 2.2% toward the economic structure of the country; however, since the establishment of the value-added tax (VAT) for industry and metallurgy, it now represents 2.7% of total current production.

The main activities causing negative impacts on biodiversity are excavation, the opening of new mines and pollution caused by wastewater from the flotation process and from slag piles.

Energy. The energy sector (together with gas and water supplies) participates in the GDP of Macedonia with a modest 4.5%. This percentage was maintained throughout the second half of the 1990s. The share of capital expenditures in electricity (25%) is relatively high compared with overall investments in the social, cooperative, mixed and State-owned sectors.

The most important domestic energy resources available for use in the future are coal reserves (for the next 10-15 years), fuelwood, hydropower and geothermal energy. It is necessary to decrease the consumption of fuelwood, to be accompanied by a gradual increase in the areas of solar energy, wind power, biomass etc. This is certainly related to the status of the payment balance that would either provide for or prevent the importation of adequate technologies for utilisation of these types of energy.

Photo 27. Transmission line / Kozyak Dam.

This sector impacts biodiversity through electricity generation (pollution of air, soil and water), transportation and distribution (fragmentation of habitats).

Transport. The transportation sector of the Republic of Macedonia is experiencing conditions similar to those present within the overall Macedonian economy, that is, a lagging behind the current trends seen in other countries. In general, it can be stated that the existing transportation and communication systems in the Republic of Macedonia are not yet fully developed. One of this system's most serious problems is its lack of modernisation.

Photo 28. The highway from Demir Kapiya to Gevgeliya.

Another major problem faced by the transportation sector is its configuration, that is, the routes of the main transportation lines. Due to Macedonia's multi-decade existence within the confines of a wider community (the former Socialist Federal Republic of Yugoslavia), its overall transportation infrastructure is characterised by marked development of the main, north-south highway corridor (a part of European Corridor 10). In contrast, the east-west corridor (part of European Corridor 8) has been almost completely neglected. In addition, Macedonia has a relatively low density of railway networks (27 km of railway lines per 1,000 km^2, i.e., 339 km of lines per million inhabitants).

Despite all of these problems, transportation as a sector has been gradually increasing its contribution to the GDP over the last several years. Thus, from a 6.1% GDP share in 1997, its share increased to 7.3% in 1998 and to 8.2% in 1999.

The transportation sector impacts biodiversity through the fragmentation of habitats, as well as through air pollution and noise. Considering the current circumstances in the Republic of Macedonia, these impacts are low by comparison with those of developed European countries. Nevertheless, this is one of the most severe potential threats to biodiversity in Macedonia.

Tourism and recreation. At present, touristic and catering activities employ around 10,000 people (2,895 of whom are female), or only 3.2% of the total number of employed persons in Macedonia. Total revenues generated by tourism and catering activities during 2001 amounted to €8.5 million or 2.0% of the GDP.

With regard to tourist turnover, the total number of tourists in the Republic of Macedonia in 1990 was 974,537, spending a total of 3,099,508 nights. Since this period, primarily due to social and political events in this region of the Balkans, tourist turnover appears to have experienced a permanent decrease, reaching its lowest value in 1997, when the country was visited by only 476,025 tourists who spent a total of 1,587,146 nights.

Photo 29. Mavrovo / Popova Shapka recreational centre.

Considering the scope of the term 'biodiversity,' it is absolutely undisputable that tourism and biodiversity are in an uninterruptible interaction with each other. While biodiversity has a positive effect on tourism, tourism has a negative impact on biodiversity. One notable case is the illegal construction of various touristic structures on the shores of Macedonian natural lakes. Adverse impacts are evident not only in the degradation of surrounding upland ecosystems, but also in the direct pollution of the lakes themselves. There are many specific examples of this (Lagadin on Ohrid Lake, 1,200 weekend houses around Mavrovo Lake within Mavrovo National Park etc).

Sectoral analysis. A careful analysis of the previously presented data will show that not all sectors impact biodiversity equally. A preliminary ranking of the main economic sectors by their impact on biodiversity includes:

- Agriculture, which had a particularly severe impact on biodiversity in the decades following World War II. Serious threats to fish diversity in the Republic of Macedonia are caused by over-fishing (especially in Ohrid Lake);
- Transportation sector, especially due to the fragmentation of habitats;

- Energy sector, which represents a threat to biodiversity for several reasons, including pollution, construction of hydropower reservoirs and, especially, the transmission of energy;
- Industry and mining;
- Tourism, which also poses a serious threat to biodiversity. In this context, illegally constructed weekend settlements and incomplete communal infrastructure in the main tourist resorts are of particular concern;
- Construction, which creates a threat due to the use of agricultural land of high cadastral class for non-productive purposes. This sector would not be ranked very highly, however.

The most important secondary benefit related to the protection of biodiversity in the Republic of Macedonia would be the adoption of an inter-sectoral approach. Such an approach toward problem solving is considered to be a matter of some urgency. The Strategy and the Action Plan for biodiversity protection can be considered a first step toward this goal.

3.3. Underlying causes of biodiversity loss

The basic factors which have led to the current unfavourable state of the environment in the Republic of Macedonia in all spheres, including biodiversity, include general historical processes, a bad socio-economic situation, an unstable political situation, inadequate spatial planning and inappropriate land use.

Several main reasons for the permanent loss of biological diversity can be distinguished:

- A low level of education and a lack of information, especially in rural areas, which has contributed to a low awareness among the general public of the relationship between human activities and the environment, the sustainable use of biological resources and the sustainable transfer of biotechnology;
- Reduced and unstable economic influence by the State, in addition to the military actions that have been convulsing the region for a long period of time;
- Growing poverty, which does not recognise the principles of sustainable development. It is manifesting itself through illegal forest and other resource overuse, hunting and fishing excesses, non-sustainable development of agriculture etc.;
- Inadequate and incomplete legislation which fails to clarify duties or address the overlap in responsibilities and competencies within the agencies liable for enforcement;
- Non-compliance with existing regulations;
- Lack of spatial planning regulations for areas with special natural values;
- Uncontrolled urbanisation, deagrarianisation (in the traditional sense) and industrialisation. These are the main processes that disturb the environmental balance (considering the cumulative effects of pollution);
- The continual process of migration of the population from villages to towns. Increased concentrations of people in urban centres represent a growing problem not only from a global, socio-economic aspect but also from a spatial aspect;

- The mechanism of earning a profit under highly competitive market conditions, the permanent trend toward globalisation and the favouring of newer, more profitable plant varieties and animal breeds which have fully supplanted the indigenous, low producing and less profitable genetic types.

3.4. Main direct threats to biodiversity

Several direct threats to biodiversity, distinct to Macedonia, can also be identified. All play a specific role in the reduction of biodiversity, but they are not all equally significant.

3.4.1 Habitat loss, modification and fragmentation

In the Republic of Macedonia, habitat loss, modification and fragmentation have been occurring from prehistoric times to the present; however, these processes have intensified over the past few decades, and are mainly related to conversion and degradation of land, together with the fragmentation of habitats.

Land conversion. The loss of natural habitats due to conversion is most evident within aquatic habitats, particularly swamps and marshes. During the decades following World War II, almost all of the major swamps and marshes were drained, chiefly for two reasons: to acquire new agricultural areas and to combat malaria. Because of this, marsh biocoenoses became seriously endangered, fragmented or threatened with extinction.

Another method of habitat modification is through transformation. In Macedonia, this is seen particularly as a result of artificial reservoir construction. In the past, during the construction of more than 20 major reservoirs, no regard was given as to whether valuable habitats would be destroyed.

Currently, the conversion of natural habitats into agricultural uses does not represent a serious threat to biodiversity.

Land degradation. One of the most serious reasons for the loss of habitats (or portions thereof) is inadequate planning for the expansion of urban centres, weekend homes and tourist/recreation zones. The situation is similar with respect to the major and minor industrial complexes which, due to lack of adequate controls, are constructed in various natural or semi-natural habitats.

Fragmentation of habitats. The main cause of habitat fragmentation is traffic infrastructure. Some main roads, for example, intersect habitats that serve as biocorridors for vertebrates, especially large mammals. An increase in traffic or the construction of new, limited access highways could completely disrupt such corridors. Railways are very underdeveloped compared with roads and do not represent a significant threat to natural habitats.

Fragmentation of aquatic habitats (e.g., the upper and middle courses of rivers and streams) is a frequent occurrence within the country. Additionally, recommendations for biological minimums for watercourses and for the construction of fish passages are not observed. A further example of habitat fragmentation concerns aerial transmission lines, some of which pass through national parks.

It is obvious, then, that the loss, modification and fragmentation of habitats have negative impacts and jeopardise the inventory of biodiversity.

3.4.2. Overuse of biological resources

Overgrazing of grasslands and pastures. The Republic of Macedonia has approximately 650,000 ha for use as summer and winter pastures (hilly and high-mountain zones). Pasture degradation is chiefly due to the expansion of shrubby vegetation, resulting from a lack of grazing rather than from overgrazing. The increasing dominance of shrub vegetation reduces biodiversity because grass communities are more heterogeneous and richer in species. In this manner, the types of habitats in the landscape are changing.

Over-hunting/fishing. Even though hunting management plans and a Public Enterprise for Game Wardens and Hunting Inspections exist, poaching is still at a high level. In addition, occurrences of illegal fishing and the use of prohibited fishing gear (including certain types of nets, chemicals and explosives) cause grave concern.

Trade in wildlife (animals, fungi and wild plants). Unfortunately, complete current data on the commerce in natural products do not exist; therefore, it is not possible to make an assessment of how trade in wildlife affects biodiversity. Prior to 2002, there was no information on the export of wild species, nor any sanctions to prevent it.

Photo 30. Photo of *Gentiana* sp. on Kaymakchalan Mountain.

Implementation of the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES), which regulates the control of international trade in wild species, faces many difficulties in the Republic of Macedonia. These are due primarily to an overlap in administrative responsibilities, especially within the MoAFWM, but also due to a lack of personnel in the departments responsible for the inspection and control of trade.

Water extraction. As a result of the arid climate and the hydrologic regime within the Republic of Macedonia, extraction of water from the upper and middle courses of rivers and streams is very common. Unfortunately, the priority of providing safe drinking water seldom takes protection of natural watercourses into consideration. Water extraction (i.e., water supply systems) is under the purview of the MoAFWM (Administration for Water Management). In cases of major water withdrawals, new construction projects must provide for the continuance of an ecological minimum water flow, which is often calculated as the flow of the smallest recorded watercourse in the watershed. With such projects, several serious problems can occur:

- Accurate flow measurements are unknown for most of the small waterways in Macedonia;
- Inadequate ecological minimums may be chosen;
- Control (or compliance) mechanisms and methods for sanctioning are lacking.

A general lack of monitoring for any type of water extraction operation is also widespread. The problem of water extraction is serious enough to be ranked among the basic threats to biodiversity in Macedonia.

3.4.3 Pollution of the environment

Water pollution. Surface waters in the Republic of Macedonia are seriously endangered by various sources of physical, chemical and biological pollution. The trend toward the dramatic deterioration of water quality in riverine ecosystems was first noted in the mid-1970s. It resulted from the development of heavy industry and an increase in urban populations on the one hand, and a complete disregard for the problem of communal and industrial wastewaters, on the other. The state of eutrophic aquatic ecosystems is also alarming. Although direct efforts have been undertaken for the protection of Ohrid Lake, little has been done to protect Prespa Lake, even though they are one unique hydrological, relict system. In addition, the major reservoirs Strezhevo, Tikvesh Lake and Turiya are also under great pressure.

In general, there is no continuous monitoring of the state of the groundwater, with analyses being made only on an as-needed basis. Only those aquatic systems located high in the mountains are relatively unspoiled, but past military operations which took place on Shar Planina Mountain are likely to have had some adverse impacts on even these.

Terrestrial and soil pollution. Soil pollution in Macedonia is extensive and represents a serious threat to biodiversity. There are several distinct sources of pollution, characteristic of the conditions in Macedonia – industry and mining, overuse of pesticides and fertilisers (in the past), improper disposal of wastes, transportation etc.

Air pollution. Air and soil pollution are closely related. The most frequent pollutants of the air in urban or industrial centres are SO_x, NO_x, CO_x, chloro-fluorocarbons (CFCs), smoke and breathable dust (< 10 μm) and high concentrations of heavy metals.

According to the economic indicators, industrial production in the Republic of Macedonia has experienced a steady decrease over the past ten years, resulting in a reduction in air pollution (except in the region of Veles). The reverse is true regarding traffic, which has seen a steady increase in passenger vehicles and a corresponding increase in the total amount of air pollution generated. This continues to be a problem, especially in urban centres, primarily Skopye. Additionally, the age and poor maintenance of the vehicles and the low quality of fuel increasingly burden the air with pollutants.

Even so, it can be concluded that air pollution is not a key threat to the biodiversity of the Republic of Macedonia.

3.4.4. Introduced and invasive species

In Macedonia, most of the invasive plant species are found on ruderal sites and in some aquatic ecosystems. An example is the species *Elodea canadensis* (Elodea), which was first introduced into Ohrid Lake through the channel Studenchishte in 1957. It is an invasive weedy species which rapidly reproduces and expands, out-competing the indigenous submersed macrophytic species and occupying their habitat.

Another invasive species is the Asian *Ailanthus altissima*, which has spread throughout large areas of lowlands and is characterised by a high reproductive capability. Over the past few years, a large number of new American species have also been recorded. With regard to forestry and reforestation, careful consideration must be given to the excessive planting of monocultures of Douglas-fir.

Most of the introduced and invasive species of fauna belong to the superclass *Pisces* (11) and class *Mammalia* (8). Invasive species from the other vertebrate classes (*Amphibia*, *Reptilia* and *Aves*) have not yet been found among the introduced species which are periodically recorded.

3.4.5. Climate change

On the basis of an evaluation of the impacts of climatic changes on biodiversity, the future horizontal and vertical distribution of plant and animal species are expected to change, (i.e., migration toward the north and/or migration to higher elevations). Such changes will particularly affect the relict plant and animal species living in high mountain zones.

According to results presented by the MoEPP in the First National Report on Climate Change, the areas most sensitive to climatic changes are the refugial zones: Taor Gorge; Treska River gorge; Crna River, including the gorges of the Raets and Blashnitsa Rivers; Jama; Mavrovo-Radika; Pelister; Ohrid-Prespa and Nidze-Kozhuf. Within these zones, many refugial phytocoenoses are present which would be endangered by temperature increases and by distributional changes in precipitation. Increases in temperature would also dramatically affect alpine pastures.

In contrast, thermophilic communities, such as the *pseudomaquis* (a type of Mediterranian shrubland), would expand their ranges into northern regions and higher altitudes.

3.4.6. Natural disasters

Natural disasters do occur, but only infrequently and with minor intensity. Nevertheless, Macedonia is a seismic area, a large part of its territory is arid or semiarid and there are frequent landslides, avalanches etc.

Droughts are frequent natural calamities. In addition to the droughts of short duration which are characteristic for a major portion of the country, there are also extended periodic droughts, which cause great economic hardships for agriculture, as well as serious damage to the natural inland mesophilic ecosystems. Examples of this include a reduction in the growth rates of forests, defoliation and increased susceptibility to parasites and other pests, the desiccation of marsh ecosystems, disturbances to the hydrology of aquatic ecosystems (Doyran and Prespa lakes) etc.

Due to the low intensity, low frequency or narrow scope of avalanches, floods and landslides; the ecosystems' ability to adapt to arid conditions; and the limited extent of fires, natural disasters are not considered to be serious threats to biodiversity in the Republic of Macedonia.

3.4.7. Other factors

Other factors that can have negative impacts on biodiversity or cause a chain of effects are:

- Lack of, or inappropriate, legal regulations on the conservation of biodiversity, lack of clarity in institutional authority, overlap of responsibilities and authorities and lack of enforcement of the legal regulations which do exist;

- Low public and institutional awareness of the importance of biodiversity and insufficiently developed awareness among non-governmental organisations (NGOs);
- Economic instability, low standard of living and unemployment, which strongly contribute to the overuse of biodiversity;
- Inappropriate implementation of spatial planning guidelines;
- Armed conflicts in certain regions within the country, which pose serious and direct threats to natural resources. The government of the Republic of Macedonia does not yet have full control over some of these areas;
- Erosion, a serious problem developing as a result of previous and current agricultural practices in Macedonia;
- Incomplete research on various aspects of biodiversity in Macedonia: there are no Red Data Lists or Books, vegetation maps, pedologic maps, maps of ecosystems and habitat distribution, lists of characteristic and endangered species, information systems nor databases, and there are few professional, scientific and institutional personnel working in the field of biodiversity;
- Insufficient personnel in the institutions of the governmental system: MoEPP, inspection services, customs, Fund for the Environment etc.;
- Poor interagency co-operation;
- No monitoring system for biodiversity (except for partial monitoring in the three national parks).

There are other less important factors which can also cause a chain of effects negatively impacting biodiversity, including various forms of non-sustainable uses of natural resources in all economic sectors.

The specific direct causes of biodiversity loss are many and varied. Most of them are common to all types of biodiversity, while some are category specific. Very common causes include:

- Inadequate management of aquatic ecosystems;
- Drainage of marshes and swamps;
- Construction of hydropower reservoirs in river gorges;
- Lack of water treatment plants (for riverine and lake ecosystems);
- Mine excavations and other geological works;
- Construction of ski lifts, transmission lines, television transmitters and other antenna systems;
- Loss of habitats (or portions thereof) during unplanned expansion of urban centres, weekend settlements and tourist/recreation zones;
- Modification of habitats;
- Fragmentation of habitats, due mainly to traffic infrastructure, where highways intersect habitats that are important as vertebrate corridors (particularly for large mammals). When aquatic habitats are artificially fragmented, recommendations for maintaining ecological minimum flows in watercourses are not followed;
- Destruction of areas with natural halophytic and meadow vegetation;
- Uncontrolled destruction of forests, forest fires, clearing for building sites, construction of roads and railroads, expansion of tourist settlements and forest desiccation;
- Uncontrolled collection of medicinal plants and wild animals;

- Illegal collection of rare plants (especially endemic plants) by professional and commercial collectors, illegal collection of birds' eggs and certain species of butterflies etc.

4. Legal and institutional framework for biodiversity conservation

4.1. Constitutional basis

The term "biodiversity" is not used in Macedonia's highest legal framework – *The Constitution of the Republic of Macedonia*. The wording of the Constitution, however, is broad enough to provide protection for those resources included within this concept. Such constitutional phrases include: environment, nature, natural heritage, flora and fauna, good of the common interest etc.

The constitutional mandate for the protection of biodiversity in the Republic of Macedonia consists of seven key elements, to wit:

- *Environmental protection and restoration are fundamental values of the constitutional order of the Republic* (Article 8, Paragraph 1, Item 10);
- *Everyone has the right to a healthy environment in which to live* (Article 43, Paragraph 1);
- *Everyone is obliged to promote and protect the environment* (Article 43, Paragraph 2);
- *The Republic provides conditions for the exercise of the right of citizens to a healthy environment* (Article 43, Paragraph 3);
- *The freedom of the market and entrepreneurship can be restricted by law only for reasons of defence of the Republic, protection of nature/wildlife or public health* (Article 55, Paragraph 3);
- *All the natural resources of the Republic of Macedonia, the flora and fauna, amenities in common use, as well as the objects and buildings of particular cultural and historical value as determined by law, are items of common interest for the Republic and enjoy particular protection* (Article 56, Paragraph 1);
- *The law regulates the mode and conditions under which specific items of common interest within the Republic can be ceded for use* (Article 56, Paragraph 3).

As a result, the constitutional framework seems to be a solid platform for establishing and developing a coherent system of nature conservation, under which a clear model of biodiversity conservation can be promoted.

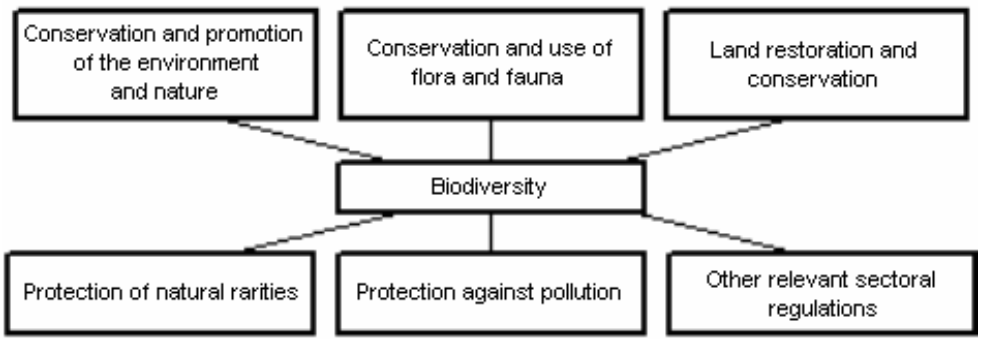

Figure 2. Scheme of the existing model of biodiversity protection.

Box 5. Previous Macedonian Constitutions (in chronological order).

1946 *Constitution of the People's Republic of Macedonia*

- No specific legal provisions addressing biodiversity

1963 *Constitution of the Socialist Republic of Macedonia*

- Protection of natural rarities (Article 32)

1974 *Constitution of the Socialist Republic of Macedonia*

- Special protection of the good of the common interest (Article 104-107)
- Protection of Human environment (Article 108)
- Conservation of nature, natural sites and rarities (Article 244, Paragraph 2)

4.2. Legal basis

In the existing legal system of the Republic of Macedonia, matters of biodiversity conservation are neither separated nor identified as particular objects of regulation. On the contrary, the existing legislative implementation of biodiversity conservation is a fragmentary approach, splitting some of its provisions among multiple series of regulations and including others within the regulations of not clearly related sectors. Some regulations are unintelligible or even contradictory.

Such an approach has complicated any acknowledgement of the existence of a biodiversity conservation system as a distinct entity. In addition, it has negatively influenced the implementation of the subject regulations.

These issues notwithstanding, the legislative basis for the existing system of biodiversity conservation contains over 100 regulations, of which the most numerous are the laws of the related sectors (Table 14).

Table 14. Normative basis for the system of biodiversity conservation.

Type of Authority	**Number**
Constitution	1
Laws	45
International agreements	20
Regulations	3
Statutes	15
Decisions by local communities	25
Total	**109**

Generally speaking, Macedonian legislation dealing with biodiversity conservation is in serious need of reformation both from the aspect of the legislative concept itself, as well as from the standpoint of its structure within the related sectors. The legislative protection of biodiversity should be established upon a high standard of conservation.

Law on the Conservation and Promotion of the Environment and Nature

In order to establish the constitutionally guaranteed right of citizens to a healthy living environment, the Law on the Conservation and Promotion of the Environment and Nature was adopted in 1996. It contains general guidelines for the conservation of the environment and nature, and establishes the requirement for wise use of Macedonia's natural heritage. At the same time, it establishes the rights and obligations of the State to create appropriate conditions for conservation and improvement of the environment and nature, as well as the rights and duties of other legal and physical entities in this sphere.

This law also regulates the method of disposal of household and technological wastes and the manner in which the long-term use of natural resources must be conducted in order to safeguard the life and health of humans, as well as the plant and animal kingdom.

The law was passed with the ambitious goal of representing an "Eco-Constitution," that is, a general regulatory system that would universally declare the basis for the "environmental conservation system" and "the system for the conservation of nature." This goal notwithstanding, within the legal conception of the law, these two systems are actually presented as a whole legislative unit (i.e., as one unique system for conservation). Throughout the text of the law, no clear legal distinction between the terms "environment" and "nature" is made. Consequently, the existing legal system has many weaknesses and deficiencies, especially from the aspects of the conservation and use of nature (Box 6).

Box 6. Key deficiencies in the current law.

- Problem with differentiation between the terms "environment" and "nature" (i.e., using them merely as generic terms);
- Problem with differentiation between the terms "conservation" and "promotion" (i.e., using them merely as generic terms);
- Invalid terminology identifying protected objects under the category "natural wealth" and categorising them under the non-constitutional term "specific natural wealth";
- Invalid definition of the phrase "conservation of nature" and equating it with "conservation of the natural heritage";
- Marginalising the value of and necessity for more appropriate systematic regulatory measures for nature conservation as a whole, but especially biodiversity conservation, geodiversity conservation, maintenance of the natural balance and conservation of the natural heritage;
- Inappropriate methodologies, lack of comprehensive legislation and inefficiency of basic instruments for conservation of the natural heritage, biodiversity and other elements within the system of nature conservation;
- Inappropriate organisation of nature conservation at the national governmental level, especially concerning biodiversity and natural heritage conservation (i.e., management and oversight of protected areas);
- Insufficient number of declarative and directive regulations.

It is recommended that the provision on nature conservation be excluded from the Law on the Conservation and Promotion of the Environment and Nature and be regulated separately.

Laws on flora and fauna

The protection and use of flora and fauna are not covered by only one law. On the contrary, there are eight laws for this purpose, each adopted according to the type of object or type of economic activity it governs. These laws are:

- *Law on Fishing* (1993): regulates the use, direction and conservation of fish stocks in waters where fishing is allowed.
- *Law on Hunting* (1996): regulates the keeping, breeding, conservation, hunting and use of game animals.
- *Law on Cattle Breeding* (1997): regulates the keeping and trade of livestock, receipt of livestock products, and production of and trade in livestock fodder.
- *Law on Forests* (1997): regulates the care, use and conservation of forests.
- *Law on Pastures* (1998): regulates the management, promotion and use of State pastures.
- *Law on Plant Protection* (1998): regulates the protection of plants from diseases, health control related to the trade of plants, production and use of materials for the protection of plants and equipment/measures for preventing harmful consequences to human and animal health from the use of such materials, as well as protection of the environment and nature.
- *Law on Veterinary Health* (1998): regulates the protection of animal health from diseases, veterinary examinations and procedures, protection and promotion of the environment and nature, fees and expenses for veterinary services, and the manner in which veterinary activities are conducted.
- *Law on Seeds, Seedlings and Materials for Propagation, Recognition, Approval and Protection of Varieties* (2000): regulates the production and trade of seed material, seedlings and plant breeding material, as well as the acceptance, approval, and conservation of plant varieties (except seed material and seedlings from forests).

All cited laws have been adopted in order to revive the constitutional concept of "special protection for the good of the common interest," by which, activities harming this constitutional category may be curtailed. The fact is that, in almost every special law cited, an attempt has been made to achieve a balance between the public's interest in "conservation" and "use" of "natural wealth" as an "economic category." It must be stressed, however, that in this scheme, the scales have been tipped toward "use" at the expense of "conservation."

The current manner in which flora and fauna are regulated demands that there be certain adjustments to the legislative concept, especially in light of the need for the creation of a harmonised system of nature conservation.

Box 7. Elements of the system for conservation of flora and fauna.

Forests:

- Prohibition against destroying forests*
- Prohibition against cutting rare species of trees in forests*
- Prohibition against destruction of marks and signs in forests or cutting of trees possessing marks or signs
- Prohibition against overgrazing by livestock and gathering of acorns in forests*
- Prohibition against setting fires in open areas less than 200 m from the margin of a forest*
- Prohibition against producing sparks or similar activities less than 200 m from the margin of a forest* that could accidentally start a fire
- Prohibition against polluting forests by depositing waste materials
- Prohibition against purchasing or processing trees which have no forestry stamp or special identifying documents
- Prohibition against selling or reselling by persons* of wood cut from forests owned by the State

Game:

- Prohibition against hunting, pursuing or disturbing game during any period temporarily or permanently closed to hunting
- Permanent prohibition against hunting of specially protected species of game
- Prohibition against killing, taking young or destroying the nests, lairs or eggs of protected game
- Prohibition against setting fires in fields of stubble, weeds or other plant wastes within hunting reserves

Fishery resources:

- Prohibition against fishing during spawning seasons or periods closed to fishing
- Prohibition against fishing within water bodies that are temporarily or permanently closed to fishing
- Prohibition against harvesting fishes that are under the minimum legal size
- Prohibition against fishing with "osti," spear guns or the use of hands alone
- Prohibition against fishing for rare or vulnerable fish species within some or all water bodies
- Prohibition against polluting waters used for fishing with harmful or dangerous substances
- Prohibition, within waters used for fishing, against fencing with permanent or temporary structures which restrict the free passage of fishes
- Prohibition against extraction of water from fishing areas

Plants:

In order to prevent the appearance and dispersal of plant pests, the authorised Minister can conduct the following prohibitions:

- Temporary ban on certain areas and/or raising of certain species/varieties

of agricultural and forest plants
- Prohibition against trade of plants originating from both infected and non-infected areas
- Prohibition against importation or transportation through Macedonia of certain plant species

*exceptions are allowed only in cases defined by the specific law

For over five decades (since 1945), the valuable objects that comprise the natural heritage of the Republic of Macedonia have been officially called "natural rarities." It is a key concept that encompasses both mobile and stationary components, as well as living and edaphic natural elements which, according to their scientific, aesthetic, health, cultural, educational, tourist/recreational and other valuable functions as cultural objects, are under the special protection of the community. Conversely, in some newer laws, the terminological and conceptual identification of these selfsame objects is replaced by a new legislative phrase and concept – "specific natural wealth." In addition, according to the various ratified international agreements, the terms "natural heritage," "protected areas" and similar phrases are also in use. In short, from the aspect of terminological identification of the objects in question, there is a great deal of confusion.

Table 15. Acts dealing with natural rarities conservation.

Acts		**Objects**
Type	**Number**	**Number**
Laws	6	8
Local community decisions	27	27
Resolutions	42	42
Total	**75**	**75**

Activities connected with natural rarities conservation are organized into three laws:

- *Law on the Protection of Natural Rarities* (1973)
- *Law on the Protection of National Parks* (1980)
- *Law on the Protection of Ohrid, Prespa and Doyran Lakes* (1977), which also has a provision for promulgating regulations.

In accordance with the cited Laws, the conservation of natural rarities has been established based upon a model of individual protection (i.e., according the status of "protected object" within a particular category), by which a natural rarity may be designated only by means of a special act for protection. Thus, the type of act for protection and the process by which the act is adopted are related to the type of natural rarity to be protected. It then follows that some types of natural rarities are protected by national law, while others by decision of the local community on whose territory the specific object is situated. Before a specific act or resolution is passed determining the category of a natural rarity, there must first be an investigation of the natural character of the area.

Within the Republic of Macedonia, the experiences of the past 50 years demonstrate that there has not been an appropriate policy for the conservation of

natural rarities, especially because of the failure to give full attention to the necessary "promotion of natural rarities" from within the category now known as "protected areas."

According to official information, which was based upon previous scientific research, there are 116 designated natural rarities, covering about 18% of the land surface of the Republic of Macedonia. The actual network of protected areas currently includes only 77, however, covering an area of 184,187 ha or 7.14 % of the land surface.

Currently protected natural properties and those yet to be protected are distributed throughout Macedonia. Most of them are located in the western part of the country, with some also being present in regions with high levels of tourism.

Table 16. Number of objects currently protected and needing protection.

Code	Classification	Authority	Natural Objects	
			Protected	**Not Protected**
01	***Nature Reserves***			
011	*Common Nature Reserves*			
0111	National Parks	State	3	2
0112	Strict Nature Reserves	State	2	9
0113	Scientific-Research Reserves	State		14
0114	Sites of Special Natural Character	Local community	3	14
0115	Characteristic Landscapes	Local community		
012	*Special Nature Reserves*	State		
02	***Natural Monuments***	Local community / State	48	
03	***Natural Sites of Historic Importance***	Local community		
04	***Areas outside Nature Reserves Containing Certain Plant and Animal Species***	State	21	
Total			**77**	**39**

The classification system for considering protected properties as natural rarities does not correspond to the scheme developed by IUCN or the United Nations Environmental Programme's (UNEP) World Conservation Monitoring Centre (WCMC). In this regard, harmonisation of the national classification system for protected areas with international standards (number, name and definition of categories of protected areas) will be one of the priority tasks in developing new legal measures for nature conservation, specifically of biodiversity.

Taken as a whole, the current legislation addressing natural rarities conservation is generally outdated. In addition, the existing system has many legislative gaps created by the nullification of a great number of regulations and the delayed passage of new regulations to take their place.

Box 8: Deficiencies in legislation regarding natural rarities.

- Outdated regulations;
- Existence of large legal gaps;
- Outdated protection model;
- Lack of efficient instruments for protection;
- Problems in delineating jurisdiction between the central and local governments;
- Overlapping of responsibilities among governmental Ministries and other bodies and institutions at the central governmental level;
- Lack of implementing legislation;
- Lack of review of declaratory acts;
- Lack of correlation with international terminology and protection standards;
- Inappropriate treatment of matters pertaining to the management of protected areas.

Laws on land use and development

For certain aspects of biodiversity conservation in the Republic of Macedonia, the following laws regarding development and land are pertinent:

- *Law on Agricultural Land* (1998), which regulates the use, management and protection of agricultural lands;
- *Law on Protection against Damage to Farm Fields* (1990);
- *Law on the Reorganisation of Land* (1976);
- *Law on the Redistribution of Land* (1990);
- *Law on Construction Sites* (2001);
- *Law on Spatial and Urban Planning* (1996), according to which measures for conservation of the environment and nature are obligatory in every type of plan. In addition, there is a provision for the passing of special "Spatial Plans for National Parks."

Laws on pollution

With regard to biodiversity conservation, this group of laws is especially relevant:

- *Law on Water* (1998), which regulates the legal status of waters, their manner of use, protection of waters from pollution, interstate waters etc.;
- *Law on Waste* (1997), which regulates the transportation and storage of waste in order to protect the environment and nature;
- *Law on Hazardous Waste Transport* (1990);
- *Law on Public Utilities* (1997);
- *Law on Public Hygiene Maintenance and the Collection and Transport of Communal Solid and Technological Wastes* (1998);
- *Law on Protection against Air Pollution* (1974), which regulates the conditions and measures for the prevention of air pollution in order to protect flora and fauna;

- *Law on Protection against Ionising Radiation and on Radiation Safety* (2002), which regulates the system of controls over sources of ionising radiation, as well as protecting the population and the environment from exposure to ionising radiation.

Other relevant sector legislation

Other related laws which directly or indirectly affect biodiversity include:

- *Law on Concessions* (2002), which regulates the manner, process and general conditions for obtaining concessions for items of common national interest, as well as the development of related activities, but only where a special law has been passed providing the opportunity for such concessions;
- *Law on Energy* (1997), which regulates protection of the environment and nature from adverse impacts arising from energy-related objects, devices and installations;
- *Law on Mineral Raw Materials* (1999), which determines the requirements for geologic exploration, exploitation of mineral raw materials and measures for environmental protection, as well as the stipulation that geologic exploration within protected areas be done only with governmental approval;
- *Law on Public Roads* (1996);
- *Criminal Code* (1996), which establishes 17 related criminal acts (Box 9);
- *Law on Investment* (1990);
- *Law on Property and Other Material Rights* (2001);
- *Law on the Organisation and Operation of Public Administrative Bodies* (2000);
- *Law on Local Self-Government* (2002);
- *Law on Fire Fighting* (1986);
- *Law on Protection against Natural Catastrophes* (1977);
- *Law on Foreign Trade Operations* (1996), which provides the opportunity for the government to prohibit the importation and transportation of waste through the nation's borders, or to determine special conditions for this type of import/export.

Box 9. Crimes dealing with matters of biodiversity.

Within the Criminal Code, the following crimes dealing with matters of biodiversity have been established:

- Pollution of the environment (Article 218);
- Production of harmful products for treating livestock or poultry (Article 220);
- Misrepresentation in providing veterinary services (Article 221)
- Transmission of infectious diseases among animal and plant life (Article 222);
- Pollution of livestock fodder or water (Article 223);
- Destruction of crops by using harmful substances (Article 224);
- Unauthorized seizure or occupation of real estate (Article 225);
- Destruction of forests (Article 226);
- Causing of a forest fire (Article 227);

- Hunting unlawfully (Article 228);
- Fishing unlawfully (Article 229);
- Endangerment of the environment with waste materials (Article 230);
- Bringing of dangerous materials into the country (Article 232);
- Torture of animals (Article 233);
- Damage or destruction of natural rarities (Article 264);
- Unauthorized seizure or occupation of natural rarities (Article 265);
- Carrying abroad of natural rarities (Article 266).

4.3. International agreements

Bilateral co-operation

The Republic of Macedonia has signed additional bilateral acts which address the conservation of biodiversity:

- **Albania**: Memorandum of Understanding and Co-operation in the fields of environmental conservation and sustainable development.
- **Austria**: Statement addressing the intention to establish friendly relations and co-operation in the field of environmental conservation with the province, Lower Austria.
- **Bulgaria**: Contract for co-operation in the field of conservation of the environment and nature.
- **Croatia**: Contract for co-operation in the field of conservation of the environment and nature.
- **Czech Republic**: Agreement for co-operation in the fields of the environment, nature and spatial planning.
- **Greece**: Memorandum of Understanding and Co-operation.
- **Russian Federation, The**: Agreement for co-operation in the field of conservation of the environment and nature.
- **Serbia and Montenegro**: Agreement for co-operation in the field of the environment.
- **Switzerland**: Contract for a monitoring system for rivers in the Republic of Macedonia.
- **NGO Consortium**: Memorandum of Understanding for the conservation of the four species of European vulture.

Box 10. Co-operation with the EU.

In the Stabilisation and Association Agreement between the Republic of Macedonia and the EU, it was established that both parties to the Agreement would develop and strengthen ways for co-operation in dealing with the degradation of the environment and in supporting sustainable use, as well as in protecting and conserving forests, natural habitants, flora, fauna and biodiversity.

International co-operation

The 30 international and regional conventions, protocols and their amendments (multilateral acts) applying to matters of biodiversity conservation are an integral part of the internal legal system of Macedonia.

In ratifying the subject acts, the State has accepted a great many obligations. While some of them have already been undertaken, most are yet to be discussed in the national legislature. As a result, it is correct to state that the existing national legislation concerning biodiversity conservation is not in accordance with the ratified international conventions and protocols. Thus, a legislative priority in the sphere of biodiversity conservation should be application of the various provisions of the international agreements.

Box 11. Ratified international agreements.

- *Convention on Wetlands of International Importance Particularly as Waterfowl Habitat* (Ramsar, 1971) – ratified 1977;
- *Convention on the Protection of the World's Cultural and Natural Heritage* (Paris, 1972) – ratified 1974;
- *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES) (Washington, 1973) – ratified 1999;
- *Convention on the Conservation of Migratory Species of Wild Animals* (Bonn, 1979) – ratified 1999;
- *Convention on the Conservation of European Wildlife and Natural Habitats* (Bern, 1982) – ratified 1997;
- *Agreement on the Conservation of Bats in Europe* (London, 1991) – ratified 1999 (Amendment to the Agreement – ratified 2002);
- *Agreement on the Conservation of African-Eurasian Migratory Birds* (Hague, 1995) – ratified 1999;
- *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal* (Basel, 1995) – ratified 1997;
- *Convention on Biological Diversity* (Rio de Janeiro, 1992) – ratified 1998;
- *Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters* (Aarhus, 1998) – ratified 1999;
- *Convention on Environmental Impact Assessment in a Transboundary Context* (Espoo, 1991) – ratified 1999;
- *Convention on Long-Range Transboundary Air Pollution* (Geneva, 1979) – ratified 1997, including eight protocols which were not ratified;
- *Convention on the Protection of the Ozone Layer* (Vienna, 1985) – ratified 1990;
- *Montreal Protocol on Ozone Layer Depleting Substances* (Montreal, 1987) – ratified 1994 (three amendments to this Protocol were also ratified: London, 1990 [in 1998], Copenhagen, 1992 [in 1998] and Montreal, 1999 [in 1999]);
- *United Nations Convention to Combat Desertification in Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa* (UN, 2000) – ratified 2002.
- *UN Framework Convention on Climate Change* (New York, 1992) –

ratified 1997;

- *European Convention on the Protection of Vertebrate Animals used for Experimental and Other Scientific purposes* (Strasbourg, 1986) – ratified 2002;
- *European Convention on Landscape Diversity* (Florence, 2000) – ratified 2003.

Box 12. International agreements in the process of ratification.

- *European Convention for the Protection of Pet Animals* (Strasbourg, 1987).

Box 13. Non-ratified international agreements.

- *Convention on the Protection and Use of Transboundary Watercourses and International Lakes* (Helsinki, 1992);
- *Convention on Forests (UN Forum on Forests)??*;
- *Cartagena Protocol on Biosafety* (Montreal, 2000).

4.3. Institutional framework

Governmental agencies

In addition to the Macedonian Parliament (with its authorized commissions) and the national government, as the main responsible entities, biodiversity conservation falls within the responsibilities of two Ministries, including certain of their agencies, offices, services and inspectorates.

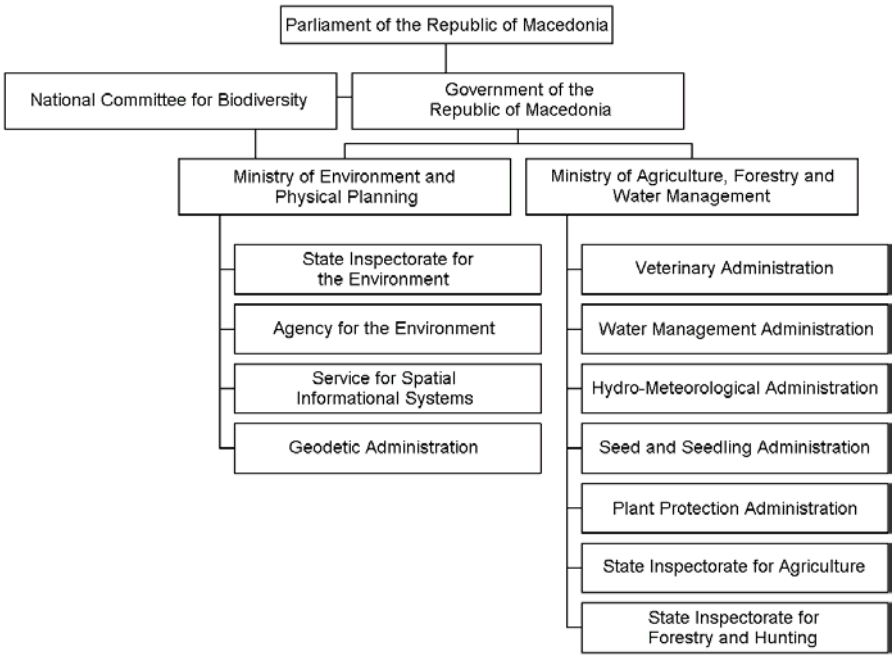

Figure 3. Scheme of State agencies and biodiversity authorities.

Box 14: National Committee for Biodiversity.

The National Committee for Biological Diversity, established by a decision of the government of the Republic of Macedonia as a State obligation arising from the *Convention on Biological Diversity,* is composed of twenty distinguished scientists and experts having made significant achievements in the field of biodiversity conservation. Its objectives are to monitor the implementation of the convention at the national level, and to contribute to the making of quality decisions.

The **Ministry of Environment and Physical Planning** conducts activities related to:

- Monitoring of the state of the environment;
- Conservation of water, soil, flora and fauna;
- Protection of the air and ozone layer from pollution;
- Protection from noise and radiation;
- Protection of biodiversity, geodiversity, national parks and protected areas.

Within the Agency for the Environment are two special organisational units:

- Department for Biodiversity
- Department for Conservation of Specific Natural Treasures

The **Ministry of Agriculture, Forestry and Water Management** conducts activities related to:

- Agriculture, forestry and water management;
- Use of agricultural land, forests and other natural resources;
- Hunting and fishing;
- Protection of livestock and plants from diseases and pests;
- Other issues determined by law.

Public institutions

The organisational structure of the public institutions authorized to conduct activities related to biodiversity is very specific. These institutions may be divided into two main groups:

- Public institutions in the field of conservation and management
- Public institutions in the sphere of education and science

The public institutions for conservation and management are all under the auspices of three different Ministries (Table 17). On the other hand, some of the public institutions in the sphere of education and science have special organisational forms as they relate to the topic of biodiversity (Figure 4).

Table 17. Public institutions for conservation and management and their related Ministries.

Responsible Ministry	Public Institution for Conservation and Management
Ministry of Environment and Physical Planning	National Parks Administration
	Mavrovo National Park
	Pelister National Park
	Galichitsa National Park
Ministry of Culture	Macedonian Museum of Natural History
	Zoological Garden – Skopje
	Zoological Garden – Bitola
Ministry of Education and Science	Hydro-Biological Institute – Ohrid

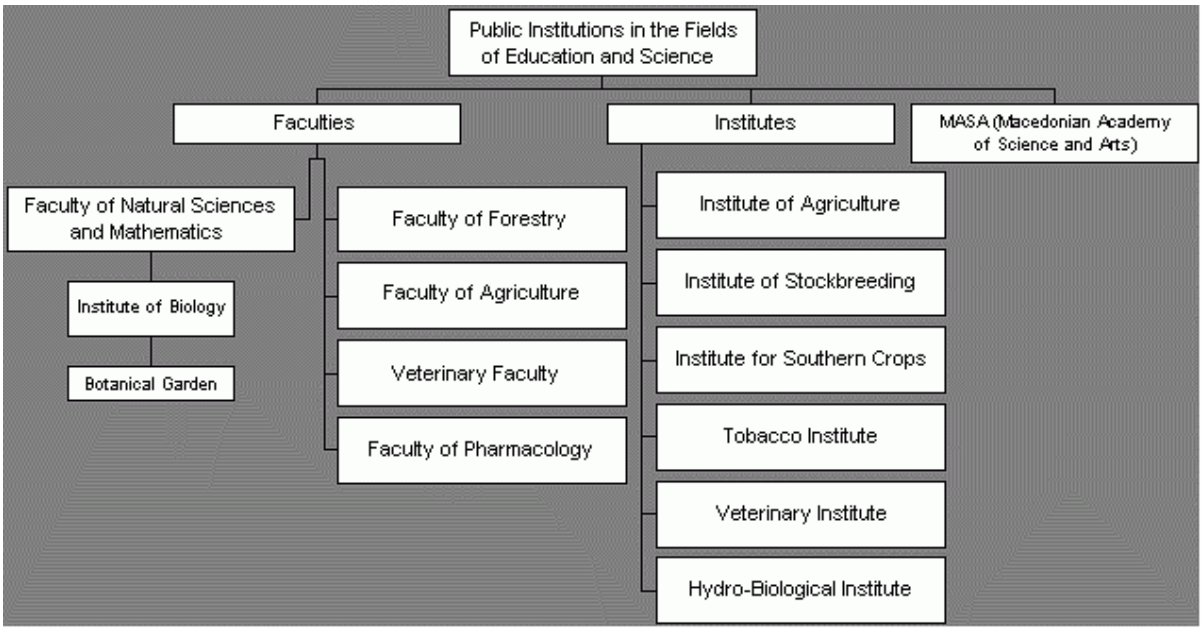

Figure 4. Organisation of the public institutions in the sphere of education and science as it relates to the topic of biodiversity.

Local structures

The new law regarding local communities delegates the authority for environmental conservation to the local community level. As of yet, however, there are no organisational structures specifically for biodiversity conservation in place in local communities. In the domains where special structures for environmental conservation do exist, they are incorporated within other related areas (e.g., urban planning, public utilities etc.).

Non-governmental structures

Within the Republic of Macedonia, over 50 citizens' associations related, to a greater or lesser extent, to the issue of biodiversity conservation exist and work.

Box 15. Deficiencies within NGOs' biodiversity programs.

- Lack of finances for NGO activities;
- Problems with creation of a suitable working environment (e.g., work space, equipment, supplies etc.);
- Lack of employed personnel;
- Lack of consideration to their public mandate under the law.

The NGOs within this domain generally work at a local level, managing particular program activities. Their work can not be deemed very useful, especially from the standpoint of improving public awareness about biodiversity conservation. The empowerment of the role of the non-governmental sector in the field of biodiversity conservation should be one of the State's priorities.

Box 16. Deficiencies in the institutional framework for biodiversity conservation.

- Lack of a separate body within the State administration for the protection of nature (i.e., inappropriate organisational structure regarding biodiversity conservation and protection of the natural heritage, including ex-situ conservation);
- Problems with defining jurisdictions related to biodiversity conservation among the Ministries, other State officials and local communities;
- Inappropriate control of institutes and other public institutions by the central government;
- Lack of a network of authorities, co-ordination bodies and institutions for biodiversity conservation at the local level;
- Avoidance by public authorities of legally permissible opportunities to delegate certain responsibilities for biodiversity conservation to non-governmental organisations;
- Lack of co-ordination and co-operation between the authorities and other interested groups within the system of biodiversity conservation;
- Inappropriate organisation of measures for applying the provisions of ratified international agreements.

Education and public awareness

Public institutions in the field of education have a legal obligation, within their working plans and programmes, to provide conditions for acquiring knowledge and creating a positive attitude toward the conservation and restoration of nature and the environment. This obligation applies to each public educational institution, starting with primary school.

Similarly, public institutions in the fields of education, health, information, science and culture have a strict legal obligation to develop public awareness concerning protection of the environment and nature.

To date, specific research concerning the presence of the subject *biodiversity conservation* within the educational plans and programmes of public institutions dealing with education has not been conducted. In addition, there are no comparative

analyses of university teaching plans and programmes in the fields of biology, forestry, agriculture, veterinary medicine, environmental law and other educational areas with regard to the subject of biodiversity conservation. After the ratification of the Aarhus Convention in 1999, a Macedonian Information Centre, which deals with issues concerning the environment and nature, and an Office for Public Relations were formed within the MoEPP.

Box 17. Electronic and published media.

Typically, the published and electronic media do not give enough attention to the problems of biodiversity conservation, especially when there is a need for relevant systematic monitoring.

Box 18. Main objectives of the Office for Public Relations within the MoEPP.

- Supplying information to the public regarding different aspects of the environment;
- Improving education in the field of protection of the environment and nature;
- Supplying accurate and precise information to the public concerning activities undertaken by the institutions of the government, NGOs and citizens, including successful ecological initiatives;
- Increasing public awareness and understanding of important ecological problems and options for possible solutions;
- Obtaining useful information from citizens and organisations that have personal and/or specialized knowledge of the resources and problems of the environment and nature that can not be gained in other ways;
- Providing information about decisions concerning ecological priorities and resolutions which reflect public opinion.

Network of Protected Areas

The network of protected areas currently includes 77, covering an area of 184,187 ha or 7.14% of the land surface. According to the *Spatial Plan of the Republic of Macedonia: Conservation of Natural Heritage*, 116 areas and natural objects covering 18% of the land surface are designated for protection.

○ Surface geomorphologic features	✿ Floristic features
◉ Subterranean geomorphologic features	♣ Dendrologic/forestry features
◡ Hydrologic features	◢ Faunal features
Memorial natural monuments	◈ Geologic-paleontological, minerological-petrographic features

IUCN Category I - Strict Nature Reserves; 12,730 ha (0.49%)

◢ Ezerani
◢ Tikvesh

IUCN Category II - National Parks; 108,388 ha (4.21%)

Mavrovo
Galichitsa
Pelister

IUCN Category IV – Sites of Special Natural Character; 2,338 ha (0.09%)

♣ Leskoets
♣ Vodno
♣ Kozhle

IUCN Category V – Areas outside Nature Reserves Containing Certain Plant and Animal Species; 2,647 ha (0.10%)

♣ Garska River
♣ Golem Kozyak
♣ Drenachka River
♣ Iberliska River
♣ Kaloyzana
◢ Katlanovo marsh
♣ Menkova meadow
♣ Neprtka
♣ Popova Shapka
♣ Rupa
♣ Ruchitsa
♣ Suvi Dol
♣ Tumba
♣ Cham Chiflik

IUCN Category III - Natural Monuments; 58,084 ha (2.25%)

○◡◢ Ohrid Lake
○◡◢ Prespa Lake
◡◢✿ Doyran Lake

○◉◡◢ Matka gorge
○◡◈✿ Katlanovo landscape
○◈✿✪ Markovi Kuli
Monospitovo marsh
○◉◢ Demir Kapiya
♣ Gazi Baba Arboretum
♣ Gol Chovek
✿ Drenochka gorge
◈♣ Karshi Bavchi
♣ Murite
♣ Konche
♣ Morodvis
◡ Vevchani springs
◉ Upper Slatino cave
♣ Oak (Kochani)
♣ Oak (Orashats)
✿ Kermes oak
○ Duvalo
◈ Zvegor
◈ Zrze
♣ Aspen
◈ Banychko Kale
◈ Kale
◈ Kalnitsa
◈ Karaslari
○◡ Gradeshka River canyon
○◡ Koleshino waterfall
○ Konopishte
♣ Macedonian oak
◈ Monastery
◈ Orashats
◢ Ostrovo
◉ Mlechnik cave
◉◢ Ubavica cave
♣ Eastern planetree (Smolare)
♣ Eastern planetree (Koleshino)
♣ Eastern planetree (Ohrid)
♣ Eastern planetree (Struga)
♣ Eastern planetree (Tetovo)
◈ Prevalets
♣ Rechitsa
♣ Eastern planetrees
♣ Black poplar
♣ Black mulberry
♣ Black walnuts

Box 19. IUCN Category III.

Example of IUCN Category III – Natural Monuments

Demir Kapiya – This is the longest gorge of the Vardar River (19 km). It passes through limestone and volcanic rocks that divide the Tikvesh valley on the northwest and the Gevgeliya-Valandovo valley on the southeast. The entrance into the gorge is an especially impressive canyon, 0.9 km in length, with various different karstic shapes on its slopes. The Demir Kapija gorge is among the richest ornithological reserves in Europe. The rare birds of prey which can sometimes be seen include the Golden eagle (*Aquila crysaetos*), Long-legged buzzard (*Buteo rufinus*), Short-toed eagle (*Circaetus gallicus*), various falcons (*Falco naumanni* and *F. peregrinus*), Griffon vulture (*Gyps fulvus*) and Egyptian vulture (*Neophron percnopterus*). Other rare and scientifically important bird species are also present in this area. In the Demir Kapija gorge, important mammal, reptile and insect species are also present, as well as rare and endemic plant species (*Calodonia macedonica, Kitaibelia vitifolia* and *Lilium martagon*).

5. Problem analysis

5.1. Current loss of, or effects on, biodiversity

The present status of biodiversity in the Republic of Macedonia is a consequence of the environmental conditions in which its components (species and ecosystems) are developing, global changes and anthropogenic impacts.

Aquatic and wetland ecosystems are the most endangered. The assn. *Myriophyllo-Nupharetum* (Doyran Lake) has almost disappeared, whereas assn. *Lemno-Spirodelletum polyrhizae* subassn. *aldrovandetosum* (Prespa Lake) is threatened with extinction.

Relict lowland marsh communities can be found only in a generally fragmented state, with six being particularly endangered (assn. *Caricetum elatae* subassn. *lysimachietosum* – Ohrid Lake, near Studenchishte; assn. *Cypero-Caricetum acutiformis* – Gostivar; assn. *Glycerietum maximae* – Pelagonia; assn. *Mariscetum* – Negortsi Spa; assn. *Osmundo-Thelipteretum* – Bansko and assn. *Scirpo-Alopecuretum cretici* – Monospitovo Marsh).

With regard to meadows, the most endangered are those associations developing on very wet terrain (assn. *Hordeo-Caricetum distantis* – Gevgeliya and Skopye). Three communities among the halophytic vegetation are most endangered, particularly assn. *Camphorosmetum monspeliacae*.

Among forest vegetation, nine forest phytocoenoses are endangered: assn. *Aceri heldreichii-Fagetum* – Yakupitsa and Shar Planina Mountains; assn. *Alnetum viridis* – Belasitsa; assn. *Carici elongatae-Alnetum glutinosae* – Polog and Debartsa; assn. *Daphno-Cytisanthetum radiati calcicolum* – Galichitsa and Yablanitsa; assn. *Ephedro-Prunetum tenellae* – Kavadartsi and Lubas; assn. *Juglando-Aesculetum hippocastani* – Suv Dol, near Izvor, and Yablanitsa; assn. *Periploco-Alnetum glutinosae* – Monospitovo Marsh; assn. *Periploco-Fradzinetum angustifoliae-pallisae* – Negortsi Spa; and assn. *Tilio cordatae-Fagetum* – Drevenicka Mountain.

Within the lower plant groups**,** the best available knowledge is on phylum *Bacillariophyta*. Nine species are considered to be extinct and 107 are endangered. As for the Fungi, a Preliminary Red Data List has been developed, including 67 endangered species from phylum *Basidiomycota* and 12 from *Lichenes*.

Among the higher plant groups, the most endangered group is that of Angiosperms (280-300 endangered species), ferns (15), mosses (20) and Gymnosperms (7). Five species of Gymnosperms are considered to be extinct.

The current faunal diversity of the Republic of Macedonia is facing great pressure resulting from direct and indirect anthropogenic impacts. Thus, as many as 113 vertebrate species are included in the category of threatened species, which is 22.3% of the entire vertebrate fauna (17 are Macedonian endemic species).

Invertebrate faunal diversity suffers from even greater anthropogenic pressure, which has led to a reduction in the populations of large numbers of species and may eventually lead to extinction. Special attention and care needs to be paid to 650 endemic invertebrate taxa, many of which are limited to the three natural lakes (Doyran Lake – 11, Prespa Lake – 18 and Ohrid Lake – 209).

Despite a large amount of research, there is still not enough information concerning the current status of the populations of a large number of endemic species nor the direct threats to their survival.

5.2. Direct causes of biodiversity loss

The direct causes of biodiversity loss are many and varied. Most of them are common to all types of biodiversity, while some are specific to either flora, fauna or ecosystems:

- Inadequate management of aquatic ecosystems;
- Drainage of marshes and swamps;
- Construction of hydropower reservoirs in river gorges;
- Lack of water treatment plants (for riverine and lake ecosystems);
- Mine excavations and other geologic works;
- Construction of ski lifts, transmission lines, television transmitters and other antenna systems;
- Loss of habitats (or portions thereof) during unplanned expansion of urban centres, weekend settlements and tourist/recreation zones;
- Modification of habitats;
- Fragmentation of habitats, due mainly to traffic infrastructure, where highways intersect habitats that are important as vertebrate corridors (particularly for large mammals). When aquatic habitats are artificially fragmented, recommendations for maintaining ecological minimum flows in watercourses are not followed;
- Destruction of areas with natural halophytic and meadow vegetation;
- Uncontrolled destruction of forests, forest fires, clearing for building sites, construction of roads and railroads, expansion of tourist settlements and forest desiccation;
- Uncontrolled collection of medicinal plants and wild animals. Illegal collection of rare plants (especially endemic plants) by professional and commercial collectors, illegal collection of birds' eggs and certain species of butterflies etc.

5.3. Underlying causes of biodiversity loss

The basic factors which have led to the current unfavourable state in all environmental spheres within the Republic of Macedonia, including biodiversity, include general historical processes, a bad socio-economic situation, an unstable political situation, inadequate spatial planning and inappropriate land use.

In the desire to accomplish economic development at any cost, a general trend toward the erosion of moral and traditional societal values has been observed, neglecting the principle of sustainable development. Instead, natural resources are used beyond the limits of their sustainability, which produces a tangible threat of extinction for endangered plant and animal species and varieties, and thus impinges upon traditional rural landscapes. Aiding in this process is the poor awareness by the citizens of Macedonia of the issues surrounding the conservation of national biological resources and the possibilities for their sustainable use. This situation is particularly evident with those biological resources (wild plants and animals) which have economic value. On the one hand, the State has not developed legal regulations to facilitate the sustainability of populations. On the other, in a rush to achieve quick profits (often by people living at the bare subsistence level), wild species are collected

uncontrollably and without any care for their normal reproductive processes or for environmental impacts resulting from their disappearance.

Several basic reasons for the permanent loss of biological diversity can be distinguished:

- A low level of education and a lack of information, especially in rural areas, which has contributed to a low awareness in the general population of the relationship between human activities and the environment, the sustainable use of biological resources and the sustainable transfer of biotechnology;
- Reduced and unstable economic power of the State, in addition to the military actions that have been convulsing the region for a long period of time;
- Growing poverty, which does not recognise the principles of sustainable development. It is manifesting itself through illegal forest and other resource overuse, hunting and fishing excesses, non-sustainable development of agriculture etc.;
- Inadequate and incomplete legislation which fails to clarify duties or address the overlap in responsibilities and competencies within the agencies liable for enforcement;
- Non-compliance with existing regulations;
- Lack of spatial planning regulations for areas with special natural values;
- Uncontrolled urbanisation, deagrarianisation (in the traditional sense) and industrialisation. These are the main processes that disturb the environmental balance (considering the cumulative effects of pollution);
- The continual process of migration of the population from villages to towns. Increased concentrations of people in urban centres represent a growing problem not only from a global, socio-economic aspect but also from a spatial aspect;
- Stagnation of the economy, use of outdated technologies, poor quality of energy sources – resulting from low economic power – and lack of treatment of wastewater and waste gases, which leads to deterioration of the air, soil, surface water and groundwater quality;
- Outdated spatial planning with insufficient continuity, improper land use changes, construction of infrastructure systems and previous agricultural conversion;
- The mechanism of earning a profit under highly competitive market conditions, the permanent trend toward globalisation and the favouring of newer, more profitable plant varieties and animal breeds which have fully supplanted the indigenous, low producing and less profitable genetic types.

5.4. Key sectors affecting biodiversity

On the basis of the analysis of data in Section 3.2, a preliminary ranking of the main economic sectors can be made in accordance with their effects on biodiversity:

- Agriculture had a particularly severe environmental impact in the decades following World War II. Most of the marshes and swamps were drained, and arable land was expanded into other natural habitats without regard for their importance. Another serious threat to biodiversity was the enlargement of agricultural land surfaces during the period of nationalisation, when the areas

of natural vegetation at the edges of cultivated fields were destroyed. This, in turn, led to a loss of important biocorridors. In more recent times, the reduction of agricultural activities in rural (especially hilly) areas has contributed to the full degradation of the centuries-old appearance of the Macedonian landscape.

- The reduction of livestock and the gradual abandonment of traditional practices of cattle management (i.e., widespread grazing in favour of feedlots) has reduced the amount of carrion in the environment and may have already led to the extinction of two vulture species.
- Uncontrolled fishing is a serious threat to fish diversity, especially in Ohrid Lake.
- In the transport sector, habitat fragmentation is an important threat to many mammals, especially large ones. It has been the norm to use the cheapest proposed alternative and abandon the ones that are potentially the most appropriate for the undisturbed existence of wild species.
- The energy sector results in several types of impacts, such as environmental pollution, construction of hydropower reservoirs and transmission of energy.
- Industry and mining rank high on this list. Environmental pollution caused by industry has declined over the past several years due to a reduction in the capacity of industrial plants; however, in individual cases, pollution is growing as a result of the use of low-quality fuels and the lack of functional treatment systems – both a result of a deficiency in financial resources. This sector causes the degradation of soils over large areas through the activities of surface mining, slag deposition, disposal of technological wastes from smelting and energy complexes, creation of industrial landfills of harmful and dangerous wastes and failure to reclaim abandoned mining areas and landfills. Systems for the treatment of waste gases and communal and industrial waters do not exist and, consequently, the quality of surface waters and groundwater deteriorates.
- Tourism affects biodiversity, especially through illegal weekend settlements and poor communal infrastructure in the main touristic lake and mountain centres. An important additional aspect is the inappropriate behaviour of tourists when outdoors due to their low awareness of natural sustainability.
- Construction activities contribute to the conversion of agricultural lands with high levels of productivity to non-productive purposes, especially in the vicinity of larger settlements and cities, as well as to the abandonment of existing cultivated lands, resulting in a loss of agriculturally productive areas. Even so, this sector can not be ranked highly.

5.5. Constraints to conservation

- A strategy for the high quality conservation of biological diversity is lacking.
- The *National Environmental Action Plan* is now outdated.
- Legislation is not harmonised with that of the EU.
- There is insufficient implementation of the existing legislation on biological diversity.
- Inspections are inefficient.
- The judicial system is inefficient.

- Implementation of the provisions of the signed and ratified conventions related to biodiversity is insufficient.
- Implementation of the principle of sustainable development and sustainable use of natural resources is neglected.
- Responsibilities overlap within the governmental Ministries of the Republic of Macedonia.
- Long-term and short-term plans with defined priorities for activities leading to biodiversity conservation do not exist.
- There is a lack of an independent institution which could be directly focused on the problems of monitoring and conservation of biodiversity.
- Continuous monitoring of biological diversity and habitats in harmony with European and world standards does not exist.
- Institutes and laboratories dealing with these issues are detached and lack appropriate technical equipment and personnel.
- A unique data bank on the biological diversity of Macedonia, with an analysis of impacts leading to its increase or reduction, does not exist.
- Registers (Red Books) of endangered plant and animal species do not exist.
- Literature on biological diversity is insufficiently available.
- Transparency between the governmental sector, scientists, the non-governmental sector and the business sector is low.
- Efforts of NGOs in the field of biological diversity are insufficient, in spite of their increasing number.
- Knowledge and education of the public is unsatisfactory.
- There is a shortage of financial resources for the development of activities for biodiversity conservation and promotion.
- There is a lack of interest within the international community for investing in biological diversity conservation due to insufficient information and a lack of engagement by the Macedonian government in these matters.
- Implementation of science in the practical conservation of biodiversity is insufficient.
- There is a failure to conduct both strong supervision and law enforcement in the area of biodiversity conservation.
- Education and instruction of the younger generation is incomplete or there is poor coverage of the principles of biodiversity in the educational process.
- The relationship between citizens and natural resource richness, which is the necessary ingredient for quality primary conservation, is not properly developed.
- Influence by special interest groups and the general politicisation of environmental issues are counterproductive.

5.6. Opportunities for conservation

Within the framework of the currently established mechanisms, there are certain activities aimed at further extension of the scope and efficiency of biodiversity conservation in the Republic of Macedonia. Some of them are:

- Development of legal and strategic documents on biodiversity;
- Approximation of the national legislation to that of the EU and other international conventions;

- Inclusion of biodiversity conservation within the spatial planning process;
- Development of mechanisms for impact assessment (Environmental Impact Assessment [EIA] and Strategic Environmental Impact Assessment [SEIA] studies);
- Increase in the number of projects in the sphere of biodiversity study and conservation, financed by international and national sources;
- Strengthening of the MoEPP, as well as the accompanying scientific and professional institutions;
- Strengthening of co-operation between the MoEPP, NGOs and scientific institutions.

6. Biodiversity Strategy and Action Plan

The Biodiversity Strategy and Action Plan are based on the results of the Country Study for Biodiversity of the Republic of Macedonia. For this purpose, a series of workshops was organized. The proposals and suggestions from all relevant institutions, NGOs and individuals arising through the public discussion process have been incorporated into the final draft.

6.1. Biodiversity Strategy for Macedonia

The National Biodiversity Strategy consists of:

- The Overall Aim for biodiversity conservation within the Republic of Macedonia, which should be attained during the period 2004-2008 and over which the Biodiversity Action Plan will operate;
- The changes that are expected in key elements of biodiversity and other sectors in support of the Guiding Objectives;
- The Strategic Principles for development of the BSAP comprising the mechanisms and techniques that should be used in achieving the proposed changes.

6.1.1. The Overall Aim

The Overall Aim of the BSAP of the Republic of Macedonia is to give a vision of what the Biodiversity Strategy and Action Plan will achieve:

> TO CONSERVE BIODIVERSITY AND USE BIOLOGICAL RESOURCES IN A SUSTAINABLE MANNER FOR THE WELFARE OF THE PEOPLE, TAKING IN CONSIDERATION THE UNIQUE NATURAL VALUES AND THE RICH TRADITION OF THE REPUBLIC OF MACEDONIA.

6.1.2. Guiding Objectives

The Guiding Objectives establish the results that should be achieved through implementation of the BSAP. The order in which they are presented does not indicate any particular importance:

1. To incorporate conservation and sustainable use of biodiversity within all governmental policies, strategies, plans and programmes by 2006;
2. To increase biodiversity conservation and restoration by 30%, through proportionate internal and external investments;
3. To increase human resources and improve technical capacity building within those institutions connected with biodiversity conservation by 30%, in order to engender projects for research and with practical application, by 2008;
4. To improve the co-operation and exchange of information among governmental, scientific, private and NGO sectors by 30%, through realisation of joint projects, by 2006;
5. To establish a database for species, habitats and protected areas by 2005;

6. To improve the management system within the existing protected areas (in accordance with international standards) and to extend the network of protected areas by 50% by 2008;
7. To reduce the number of threatened species by 5% by 2008;
8. To implement sustainable forestry management by 2008;
9. To approximate national legislation in accordance with EU directives, and to incorporate the provisions of adopted international conventions into the legislation of the Republic of Macedonia by the end of 2007;
10. To introduce appropriate mechanisms for stimulating biodiversity conservation and deterring biodiversity loss outside of protected areas by the end of 2005;
11. To increase public awareness of conservation issues throughout the community by 100%, based upon previously established levels of knowledge, by 2008;
12. To establish a law obliging the preparation of EIA and SEIA studies for all environmental programmes, plans and interventions by 2005.

6.1.3. Strategic Principles

Strategic Principles have been developed from the principles of the Convention on Biological Diversity, issues that are specific to the Republic of Macedonia and issues that were raised during the BSAP planning process.

In order to achieve the Overall Aim and the Guiding Objectives, interested groups should be governed by the following Strategic Principles:

1. Integration of the conservation and sustainable use of biodiversity into the overarching priorities of the country – economic and social development and poverty eradication;
2. Equal sharing of the responsibility for the conservation and sustainable use of biodiversity by everyone, because all citizens are dependent upon the full range of its important values, including ecological, social, economic, genetic, scientific, educational, cultural, recreational, aesthetic and intrinsic values;
3. Adoption of appropriate measures for in-situ conservation of natural ecosystems and species, restoration of degraded ecosystems and recovery of threatened species;
4. Adoption of appropriate measures for ex-situ conservation of biodiversity components;
5. Achievement of successful conservation and sustainable use of biodiversity through actual and integrated cross-sectoral planning of activities, including the participation of all interested groups;
6. Overcoming of the lack of information and knowledge concerning biodiversity as a basic prerequisite for successful planning and conducting of conservation measures;
7. Not using a lack of full scientific certainty as a reason for postponing measures to avoid or minimize a significant threat to biodiversity;
8. Use by society of all measures to enhance and complement existing international, national and local resources, including institutions, agreements, financial mechanisms, plans and programmes relating to the conservation and sustainable use of biodiversity;

9. Regular monitoring and evaluation of the effectiveness of measures for the conservation and sustainable use of biodiversity in order to determine their success, applying lessons learnt to other activities;
10. National and local agencies of the country being ultimately responsible for the management, conservation and sustainable use of biodiversity, with the assistance of external agencies being necessary and welcomed;
11. An expectation of a broad range of environmental, economic and social benefits resulting from the substantial investments required for biodiversity conservation;
12. Legislation taking international obligations into account, co-ordinating between sectors, and providing an enabling environment for biodiversity conservation through suitable incentives.

6.2. Biodiversity Action Plan for Macedonia

The Action Plan encompasses specific activities which should be realized in order to achieve the Overall Aim and the Guiding Objectives enumerated within the Biodiversity Strategy for Macedonia. During the next five years, the Republic of Macedonia should implement the provisions for conservation and sustainable use of biodiversity in accordance with the Strategic Principles outlined in the Biodiversity Strategy (Section 6.1.3.). On the basis of the Strategic Principles, Strategic Approaches have been developed. Each Strategic Approach consists of a series of actions and more specific activities. The actions may be considered as generic items to be accomplished, without specifying how they should be done. In contrast, the activities explain how an action will be achieved, including details. Within the Biodiversity Action Plan for Macedonia, the following Strategic Approaches have been developed:

A. In-situ conservation (connected with Strategic Principle 3)
B. Ex-situ conservation (connected with Strategic Principle 4)
C. Sustainable use of biodiversity (connected with Strategic Principles 1 and 5)
D. Institutional improvement (connected with Strategic Principles 5, 8 and 10)
E. Investigation and monitoring (connected with Strategic Principles 6 and 9)
F. Public awareness and education (connected with Strategic Principles 2 and 6)
G. Impact assessment (connected with Strategic Principles 6 and 7)
H. Incentive measures (connected with Strategic Principles 1 and 8)
I. Legislation (connected with Strategic Principle 12)
J. Financial resources for implementation of the BSAP (connected with Strategic Principles 8, 10 and 11)
K. Co-ordination and implementation of the BSAP (connected with Strategic Principles 8 and 10)

Each of the listed activities is correlated with other closely associated activities elsewhere in the Action Plan and Guiding Objectives. Duration, estimated budget, outputs, and priority are also provided. All of these data are presented in separate columns in the tabular Action Plan and are explained below:

Number of the Activity: In the first column, a unique code for each activity is given.
Name of the Action or Activity: A brief heading or description of each action or activity is shown.

Related Activities: In this column, other closely associated activities elsewhere in the Action Plan are indicated. This information allows cross-referencing with other related activities which could have a joint implementation or joint budget.
Related Guiding Objectives: This column indicates toward which of the guiding objectives each activity is expected to contribute in order to achieve the overall aim of the Strategy. The numbers in this column correspond with to the numbering of the Guiding Objectives in section 6.1.2.
Duration: This column indicates when each activity should take place during the five year implementation period (2004-2008) of the Action Plan. When " 2004-> " is present in this column, it indicates that the activity will last longer than the duration of the Action Plan.
Estimated Budget: The estimated budgetary category for each particular activity is indicated in this column. These categories are approximately as follows:

- Category I (indicates a budget of up to US $100,000)
- Category II (indicates a budget in the range of US $100,000 – US $500,000)
- Category III (indicates a budget over US $500,000)

Outputs: For each particular activity, verifiable achievements and outputs are listed.
Priority: The relative priority for each particular activity on a three-point scale is given. "I" indicates the highest priority, "II" medium, and "III" the lowest. The determination of priority was made by taking into consideration the relationship of the activity to the Overall Aim and the Guiding Objectives, the urgency for undertaking activities addressing threatened biodiversity components, financial implications etc. In some cases, the priority may not necessarily indicate importance; instead, it may indicate that other activities must be completed first before it can be initiated.

The members of the working group involved in the preparation of the Biodiversity Strategy and Action Plan (BSAP) for Macedonia, especially the members of the Core Team, have been given the enormous responsibility of proposing a strategic document that would include all aspects of conservation and sustainable use of biodiversity. Moreover, this document is intended to be the framework and direction for all future activities that the Republic of Macedonia ought to undertake during the period ending in 2008. Considering that this is the first national document of its kind ever prepared within the Republic of Macedonia, it is easy to see why it is so voluminous, incorporating most of the activities necessary for the conservation and sustainable use of biodiversity. Although the members of the working team and interested groups are acutely aware of the extent of this document, the working group decided it would be better to submit a larger Action Plan than accept a document in which certain necessary activities were missing.

6.3. Implementation of the Biodiversity Strategy and Action Plan

The earnest desire of the government of Macedonia is that the Biodiversity Strategy and Action Plan (BSAP) be implemented effectively, based upon realistic possibilities existing within the Republic of Macedonia and supported by local and foreign experts, with financial support from the national budget, as well as from foreign donors.

In accordance with its legislative responsibilities, the leading Ministry for implementation of the BSAP will be the Ministry of Environment and Physical Planning (MoEPP).

Because of the complexity of the problems encompassed by the concept of biodiversity conservation and also because some of the related responsibilities are included under the auspices of other Ministries or governmental sectors (i.e., outside the purview of the MoEPP), the government will establish a Steering Committee to provide oversight.

The MoEPP will serve as president of the Steering Committee. The other permanent members will consist of:

- Deputy Ministers from the Ministries of Agriculture, Forestry and Water Management; Economy; Local Self-Government; Education and Science; Culture; and Finance;
- President of the National Committee on Biodiversity;
- Two representatives from the National Committee on Biodiversity;
- President of the Steering Committee of the BSAP Project;
- Director of the Agency for the Environment within the MoEPP;
- One representative from the administrative structure dealing with protected areas;
- One representative from a non-governmental organisation (NGO);
- One representative from the Chamber of Commerce of the Republic of Macedonia.

Responsibilities of the Steering Committee

- To oversee and co-ordinate the implementation of the BSAP;
- To approve the annual implementation programmes and reports for the BSAP;
- To submit proposals to the government of the Republic of Macedonia for the promotion of existing programmes and to develop new ones in order to provide effective, long-term biodiversity conservation within a broad scope;
- To co-ordinate the financial mechanisms for implementation of the BSAP;
- To stimulate the process of implementation and planning within the framework of the BSAP at all levels;
- To determine and propose to the government the necessary requirements in terms of technical and human resources in order to implement the BSAP.

The Steering Committee will have at least two annual meetings, with more frequent meetings as necessary. The MoEPP will represent the Steering Committee before the government of the Republic of Macedonia.

In order to work more effectively, the Steering Committee will establish various Expert Groups. The work of the Steering Committee and the Expert Groups will be organised by appropriate programmes and statutes.

The Steering Committee will determine the number of Expert Groups and assign the members within each group. The members of each Expert Group will choose a group president who can be present at meetings of the Steering Committee (but only upon the invitation of the Steering Committee president and without the right to vote).

The Expert Groups will have the obligation to check all documents produced by the Steering Committee, as well as provide appropriate recommendations for more effective implementation of the BSAP to the Steering Committee.

The BSAP Co-ordinating Body will be a unit established within the Agency for the Environment, a part of the MoEPP. The director of this agency will be the co-ordinator for the unit. The Co-ordinating Body will be authorised and responsible for:

- Co-ordination and monitoring of the operational implementation of the BSAP;
- Collaboration with the Expert Groups in order to achieve more effective implementation of the BSAP and nature conservation;
- Collaboration with the Expert Groups and responsible persons of related institutions in order to develop indicators for monitoring the implementation of the BSAP;
- Collaboration with related institutions responsible for the implementation of the BSAP and summarisation of their individual annual programmes and reports into one main unit programme and report to be presented to the Steering Committee for adoption;
- Providing continuous maintenance of the internet web site for the BSAP (i.e., regular updating with appropriate biodiversity data);
- Planning specific activities within the framework of the BSAP, preparing annual programmes and plans and harmonising them within the limits of the national annual budget;
- Seeking opportunities for financial support from foreign donors for the activities planned within the BSAP;
- Preparation of a list of priorities within specific fields to be proposed to the Steering Committee for implementation and presentation to foreign donors;
- Preparation of annual reports concerning the current status of biodiversity within the State, with their presentation to the Secretariat of the *Convention on Biological Diversity* (with prior approval by the Expert Groups and the Steering Committee);
- Suggesting revisions to the BSAP based upon the current situation;
- Organisation of the meetings of the Steering Committee and the Expert Groups, including technical and programme preparation;
- Transferring information connected with the implementation of the BSAP to all stakeholders and individuals.

6.4. Monitoring of the Implementation of the Biodiversity Strategy and Action Plan

Monitoring of the implementation of the BSAP will be carried out using indicators previously developed and compiled for that purpose. The indicators will be prepared by the BSAP Co-ordinating Body and Expert Groups and approved by the Steering Committee.

In designing the monitoring plan, several questions are worthy of consideration for determining the indicators. Such questions include:

- To what extent have the planned activities achieved their outputs?
- To what extent have the overall objectives of the plan been achieved through these activities?

- Concerning completed activities, what lessons have been learnt within the BSAP implementation process or, in other words, what was done correctly and where were mistakes made?
- What gaps exist in the BSAP?
- How can the further development of existing activities or the addition of new ones fill in these gaps such that quality conservation of nature might be attained?

Monitoring and evaluation of the implementation of the BSAP will be achieved through the process of planning and reporting, a process whereby the previously determined indicators will be the basis for successful assessment.

Planning process

On the basis of the five-year plan of activities included in the BSAP, the national budget will support the preparation of annual programmes and operational plans.

The preparation of these budget-supported annual programmes and operational plans will be accomplished through a synchronised system addressing all relevant topics under the five-year programme of activities included within the BSAP.

The programmes for the implementation of the BSAP should be prepared in the following order:

- Related institutions
- Co-ordinating Body within the MoEPP
- Steering Committee

The Annual Programme and Operational Plan prepared by the Steering Committee will be submitted to the government of Macedonia for approval.

Reporting process

Based upon the specific operational plans which are supported with financial resources from the national budget, progress reports will be generated using the same order of preparation as in the planning process.

The government will approve the annual reports prepared by the Steering Committee.

The BSAP is a dynamic document. On the basis of the annual reports for activities and actions undertaken during each year, any gaps, shortages or new priority issues will be determined, allowing the BSAP for the following year to be improved and changed.

After the implementation period of five years, an evaluation of the results achieved will be made in order to facilitate the preparation of a new five-year BSAP that will be proposed to the government for adoption.