Republic of Armenia

First National Report

to *The Convention on Biological Diversity*

incorporating

A Country Study on the Biodiversity of Armenia

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Chapter 1. Physical and Socio-economic Description of Armenia

1.1 Geographic location and borders

The Republic of Armenia is a landlocked country with a total area of 29,74 km^2 (2,974,259 ha), located about 145 km from the Black Sea, 175 km from the Caspian Sea, 750 km from the Mediterranean Sea and 960 km from the Persian Gulf. It lies between 38^{0}50-41^{0}18 N and 43^{0}27-46^{0}37 E and measures 400km at its longest point (north-west to south-east), and 200km east-west, with a narrow projection (Zangezour) in the south-east. Armenia borders four countries (Georgia, Azerbaijan, Iran and Turkey), with a total of 1479km of border (Map 1).

The country of Armenia covers over 10% of the Armenian plateau, which is 500m higher than the neighboring Asia Minor and Iranian plateaus. Relatively recent volcanic activity on the Armenian plateau has resulted in large volcanic formations, and highlands consisting of a series of both small and large mountain massifs. A number of lakes (including Lakes Sevan, Van and Urmia) have also been formed as a result of tectonic activity in the Armenian plateau.

1.2 Physical geography

Since early geological history the land surface of Armenia, and the surrounding Armenian plateau, has been mountainous, with further mountain building occurring during the Cenozoic era (particularly after the Miocene). These complex tectonic shifts have resulted in a country dominated by a by a series of mountain massifs and valleys. The tectonic movements which created the series of folded ridges which dominate the country, also resulted in extensive volcanic activity. The climatic changes over the last million years have also left their mark on the country, with evidence of two glacial periods (Riss and Wurm) preserved on almost all mountains over 3000m.

Four main geographic/geological regions can be recognised within Armenia (Map 2), including:

- Mountainous ridges and valleys in the north-east of the country (highest altitude 3101m), which occur mainly in the basin of the River Kur (including the ranges of Virahajots, Bazumi, Pambak, Gougarats, Aregouni, and Sevan) and which are subject to extensive erosion.
- Regions of volcanic origin within Asia Minor, including the mountain ranges of Ashotsk, Aragats, Geghama, Vardenis, Sunik and Mount Aragats (4095m). These areas are covered by lava of relatively recent origin (upper Pliocene). Such regions are characterised by gentle slopes, and little evidence of erosion, although larger rivers have carved out deep gorges and canyons.
- A series of ridged mountains adjacent to the River Arax (ridges on the left bank along with the Urts-Eranossian, Teksar, Vaik, and Zangezour mountain ranges, including the peak of Kapoutdjugh at 3094m) constitute the Minor Caucasian system. This area is prone to intense erosion.
- The Ararat Valley represents the lowest part of the Ararat depression (which is still

undergoing tectonic movement). This area is covered with alluvial and prolluvial sediments.

As previously stated, Armenia is generally mountainous, with the lowest point being 375m above sea level (near the Debed River in the north of the country) and the highest recorded point being at 4095m (northern peak of Mount Aragats; Map 3). Overall, the average altitude across the country is 1850m, but the variations in altitude (up to 3700m, but more generally 1500-2000m; Table 1.1) have important effects on the climatic and landscape zones within the country.

Table 1.1 Absolute altitude range of territory of Republic of Armenia

Altitude above sea level (m)	Area (km^2)	%
up to 500	20	0.1
500-1000	2900	9.8
1000-1500	5430	18.3
1500-2000	9300	31.3
2000-2500	7290	24.5
2500-3000	3800	12.6
3000-3500	970	3.3
above 3500	30	0.1
TOTAL	**29740**	**100**

Furthermore, the position and gradient of slopes have important implications for the distribution of biodiversity in the country. The steepest slopes found are within mountain folds, but in contrast, over 74% of the land (21, 000 km^2) consists of slopes of up to 12^0, which are generally under cultivation. Among the ridged mountains and valleys of the Minor Caucasus, most forests occur on north-facing slopes.

1.3 Climate

A great range of climatic zones have been recorded within Armenia. The country is located centrally in the sub-tropical zone, and thus is prone to arid (desert and semi-desert) conditions. However, the altitudinal variation within the country results in further variation in climatic zones, in addition to existing latitudinal clines.

In general, the country receives a high amount of sunshine; ranging from 2600 hours per year (in Yerevan) to 2800 hours per year (shore of Lake Sevan). The average temperature throughout the year varies geographically from 2.7^0C (Mount Aragats) to 14^0C (at Meghri). July and August are usually the warmest months (Table 2), while average minimum temperatures recorded in winter vary geographically (from -3.1^0C at Meghri in the north-east, to -18.9^0C at Berdashen).

Table 1.2. Maximum average monthly temperatures in summer and annual rainfall in different altitude zones

Altitude zone	Average monthly temperature in summer	Annual rainfall (mm)
Low-level	24^0-26^0C	250-300
Mid-level	15^0-20^0C	400-600
High-level	10^0-15^0C	700-1000

Average annual precipitation is around 600 mm, but varies in different altitudinal zones (Table 1.2) Most precipitation occurs in the spring, while the second half of the summer is dry. Relative humidity averages 60% (ranging from 44% in summer to 80% in winter). Long-lasting snows exist on mountains over 1300m. In these areas snowfall may reach 2m, whilst snowfall reaches 0.5m on the lower steppes.

1.4 Water resources

Armenia has extremely limited water resources. In total the country receives a total of 18 km^3 water throughout the year, mainly from rainfall, however most of this is lost by evaporation.

Two major river systems are present in Armenia (Map 4; Annex 1), and these can be found in the Kur basin (7890 km^2 of rivers) and the Arax basin (21900 km^2 of rivers). The average density of river networks throughout the country is equivalent to 0.4 km/km^2. These rivers are mainly fed by snowmelt, rain and underground waters. Extensive flooding occurs in spring as a result of runoff from snow melt and heavy rainfall. Overall, the flow in rivers totals 7 km^3, however this may fall to 5 km^3 at some times. The rivers represent a potentially important resource, not just for water supply and irrigation, but also for hydroelectric power (estimated to be equivalent to 1.7 million kWt).

Armenia has a number of lakes (Map 4), of which the largest is Lake Sevan (see section 1.4.1). Details of the smaller lakes are summarised in Table 1.3. In addition to its rivers and lakes, a number of reservoirs have been constructed in Armenia (including Akhourian, Lake Arpa, Abaran, Azat, Spandarian, and Tolors; Annex 1) which help regulate water supply in the country.

Table 1.3 The main small lakes of Armenia

Name of lake	Location	Altitude (m above sea level)	Surface (sq. km)	Volume (1000 cm^3)	Max. Depth (m)	Average depth (m)
Kari	Near summit of Mount Aragats	3190	0.12	357	8	3
Akna	Near Mount Agzdahak	3030	0.8	2500	15	6
Arnot	Eastern slopes of Mount Geghama	2350	0.04	206	12.6	5.2
Gazana	At the head of Geghi river	3590	0.06	360	10	-
Kaputan	At the head of Kajarants river	3300	0.1	1500	22	-
Al	Mount Gharabagh	2990	0.6	180	4.5	3
Sev	Mount Ishkhanasar	2666	2	9000	7.5	5
Arpi	East of Ashotsk Basin	2025	22	100 000	8	4.2
Aighr	North of Ararat Valley	860	0.07	310	9.4	4.3
Parz	North of Areguni mountains	-	0.27	84	-	-

1.4.1 Lake Sevan

Lake Sevan is the largest lake in Armenia, and one of the largest alpine lakes in the world. It is located at 1916 m above sea level, between a series of mountain ranges (Gegham, Vardenis, Sevan and Areguni). Lake Sevan contains 80% of Armenian water resources (1585 billion m^3) which is over 35 times more than the volume of water in reservoirs, and this plays an important role in regulating the country's water balance. Lake Sevan also supports the agricultural, industrial and energy sectors in Armenia, with its waters having been used for energy generation and irrigation since 1933.

The chemical composition of Lake Sevan is very distinctive, with significantly high levels of phosporus (0.32 g/m3) but low nitrogen levels (0.003 g/m3). Biological production in the lake is through microphytes (with a biomass of 7000 g/m^3), while phytoplankton is of less importance (biomass of 0.3 g/m^3). However, the chemical and ecological composition of the lake has changed considerably as a result of substantial declines in the water level over recent years.

During the period 1933 to 1981 the level of Lake Sevan dropped dramatically.This was the result of a number of factors which led to increased offtake of its waters, not the least the devlopment of hydroelectric power stations downstream. The lake system and its ecological balance were greatly disturbed by this process, which reduced the volume of the lake by 42%, with areas round the edges of the lake drying out. The consequences included changes in the temperature of the lake (heat release from its surface decreased by 2%), changes in circulation within the lake and increased acidity and eutophication, given favorable

conditions for algal growth (Table 1.4). The first signs of the lake's eutrophication were recorded in 1964, when green and blue algae blossomed in the lake. The changes in the conditions within the lake have led to degradation of the whole ecosystem, and changes in various processes within the area of the lake (including bio-degradation, sedimentation and diffusion).

The drainage of the lake also had important effects for the fauna. Drying of parts of the rocky bottom of the lake destroyed the principal trout breeding sites. In addition, around 10,000 ha of wetland and semi-wetland areas also dried out. These areas were previously used by up to 160 species of migratory birds, and only 50 of these species are now recorded. The populations of mammal and reptile species in the area have also declined significantly, and there is evidence of changes in species composition.

In response the problem of eutrophication, the decision was made to increase inflow to Lake Sevan from neighbouring rivers (including the River Arpa). Since 1982, between 250 and 270 million m^3 of water has been carried from the Arpa River each year, through the 48km long Arpa-Sevan tunnel. As a result, the volume of water in the lake has risen, and between 1984 and 1990 the level of the lake increased by 1.2m. In addition, a number of physio-chemical, biochemical and bio-production processes have stabilized, and changes in the lakes biota have been reversed, resulting in significant decreases in the levels of eutrophication.

However, demand for water from Lake Sevan for energy production rose dramatically during the period 1991 – 1995, and this resulted in a 2.2m drop the level of the lake, and further destabilization of physical, chemical and biotic processes, leading to build up of organic residues in the water of the lake. Analysis of the causes and effects of eutrophication in Lake Sevan indicates that mitigation of the negative processes associated with eutrophication will require an increase of 6m in the level of the lake. This will buffer the lake from changes in the related watersheds and from accumulation of organic matter from sediments. The problems associated with Lake Sevan have been analysed and an action plan has been developed for the lake by the World Bank (May 1998), which includes detailed activities for the recovery of the lake.

1.5 Land surface

A wide range of soil types are found in Armenia (Map 5), including 14 main soils. However, the country is extremely poor in fertile lands suitable for agriculture. In the Ararat Valley clay or clay-sand soil predominates, and the land is generally wet and rocky. In contrast, mountain meadow soils have the highest humus content (up to 12%, average 9%), which compares favorably to humus content in other areas (4-9% in forests, and 2% in deserts).

Table 1.4 Physical and ecological changes in Lake Sevan caused by the decline in water levels

Indicators	Previous levels	Current levels
Decline in level (m)	0.0	19.2
Altitude (m)	1916.2	1897.0
Area of watershed (km^2)	3475	3647
Area of lake surface(km^2)	1416	1244
Maximal depth (m)	98.6	79.4
Average depth (m)	41.3	26.2
Volume of water (km^3)	58.4	33.5
Water exchage rate (yrs)	40.7	25.0
Water transparency (m)	14.3	4.5
PH	9.2	8.7
Total ions (g / m^3)	720	680
Dissolved oxygen (g / m^3)	6.0	2.0
Mineral nitrogen (g / m^3)	0.003	0.16
Total nitrogen (g / m^3)	0.07	0.64
Mineral phosphorus (g / m^3)	0.32	0.007
Total phosphoros (g / m^3)	0.37	0.06
Bacteria ($10^6 kl / ml$)	0.4	1.0
Phytoplankton (g / m^3)	0.32	2.4
Biomass ($gC / m^2 / yr$)	91.0	463.6
Primary production ($Kkal / m^2 / yr$)	1000.0	5000.0
Microphytes ($t\ 10^3 / yr$)	900.0	26.0
Zooplankton (g / m^3)	0.45	0.70
Zoobenthos (g / m^2)	3.38	11.0
Fish (t / yr)	1000.0	2400.0

Erosion has affected much of the soil in Armenia, generally as a result of human activities (including unsustainable use of croplands and overgrazing), and certain soil types (particularly those associated with meadows) have been strongly affected by human influence.

1.6 Main landscape zones

The mountainous nature of Armenia results in a series of highly diverse landscapes, with variations in geological substrate, terrain, climate, soils, and water resources. These landscapes support a great variety of habitats, which support distinctive flora and fauna, and different human use. Seven distinct landscape zones are described in Armenia: deserts, semi-deserts, dry steppes, steppes, woodlands, sub-alpine and alpine lands (Table 1.5; Map 6).

Table 1.5 Areas covered by different landscape zones

Landscape belts	Altitude range (m above sea level)	% of national territory
Deserts and semi-deserts	700-1300	10
Mountain steppes	1300	37
(wet grassland)	(375-700)	-
(dry grassland)	(1300-1600)	-
Forests, trees and scrubland	600-2500	20
Alpine and sub-alpine meadows	2100	28

- ***Deserts and Semi-deserts*** occur in the Ararat Valley and adjacent mountain slopes at altitudes of 1200-1300m, in the Vaik lowlands, and the Meghri gorge. Sand accumulations in the Arax area result in a desert landscape, which are also found in saline lowlands. In these landscapes climate is dry and continental, with hot summers and moderately cold winters. The soils are generally of the semi-desert grey type, and have been managed for cultivation over the last millennia. Cultivation has required intensive irrigation, and these areas now support fruit, vegetable, flower, and wine production, but have suffered major impacts from human activities.

- ***Dry mountainous steppes*** are found at higher altitudes than semi-deserts (above 1500m) in the Ararat Valley, and some other areas, but are also found at lower altitudes (above 800m) in the lowlands to the north-east of the country, which were originally forested. The climate in the dry steppes is characterized by warm, dry summers and mild winters. A range of soils are found, but in the Ararat Valley these lands are typically stony. Irrigation of dry steppes allows cultivation of crops, vegetables and fruit, and these landscapes have also suffered severe human impact.

- ***Mountain steppes*** are the dominant landscape for most of the country, particularly at altitudes above 1500m (and at altitudes up to 2000m in the north, 2400-2500m in the south). Meadow steppes occur in the highlands, while patches of forest also occur on ridge tops among steppes in the north-east and Sjunik regions. Climate is generally moderate, with warm, cool summers, and moderate or cold winters. Soils generally have a humus content of between 6-7%. Steppes are used for agriculture (including cultivation of crops, vegetables, frost-tolerant fruit trees (in lower altitudes) and fodder plants (in highland areas).

- ***Forests*** generally cover the mid-zone of mountains, occurring at altitudes between 500m

and 2100m in the north (up to 2500m in the south). In central Armenia forests occur in small areas rather than as a continuous zone, and forests can be found on steep slopes, and other areas with limited human access. Soil types include red soil in the lowlands and forest gray soils in the highlands.

- ***Sub-alpine meadows*** occur at higher altitudes than steppes and forests, including highland mountain ranges. Climate is moderate with short, cool summers and long, cold winters. Much of the land here is meadow, with soils of high humus content.

- ***Alpine meadows*** occupy the highest altitudes above sub-alpine meadows (up to 3000m in the north, 3800m in the south). These meadows represent the principal pasturelands for the country, with meadow and alpine vegetation. Climatic conditions are severe, with long, cold winters, and annual temperatures average less than -4^0. Snow cover lasts up to 9 months, and permanent snows may occur in some areas.

- ***Azonal landscapes*** cover over 10% of the territory of the country, and occur independently of altitude (unlike the previously described landscapes). These include wetlands, as well as saline and alkaline lands, which cover about 25,000 ha, including areas in the Ararat Valley where the underground waters are close to the earth surface, resulting in water vaporization and salt precipitation. Upland wetlands are dominated by fresh (non-brackish) water, while lowland wetlands (particularly those around the River Arax) are usually drained in summer, resulting in high salinity.

1.7 The history, culture and people of Armenia

The Armenian plateau, including territory of the Republic of Armenia has been inhabited for over 600 thousand years, since man first arrived in the region. Paleolithic tools dating back more than 100 thousand years have been found in the country, which has a number of important stone age sites. During the Paleolithic era, hunting was widely practised, and the farming first developed. By the end of the Paleolithic and throughout the Mesolithic periods farming and animal husbandry continued, and replaced the previous hunter-gatherer existence. The Armenian Plateau is therefore regarded by some scientists as one of the original centres for early farming and livestock breeding in the world. Domestication of a range of plants and animals followed, as well as the development of metal use and early artificial irrigation.

It is believed that the Indo-European language family originated from the area around Armenia (the Armenian plateau, eastern Asia Minor and north-west Iran). The Armenian language is unique among Indo-European languages, and consists of two contemporary literary versions (Eastern and Western) which have developed from the original old Armenian, as well as over 40 dialects, and their sub-dialects.

In the 5^{th}- 4^{th} millennia BC Indo-European tribes migrated across the territories of Europe, Middle Asia and India. The Armenian people appear to have remained in the vicinity of the Armenian plateau since that time. During the Bronze age, mining of copper and tin occurred in the region, and the culture developed (including names and calendars). During 900-600 BC, the Armenian tribes unified, followed by rule by a series of royal dynasties. Armenia adopted Christianity as a state religion in 301 AD, while the Armenian alphabet was created

in 405 AD.

Over later centuries the Armenian state was weakened, and the country was torn apart by foreign conquerors. Since the 11th century the population of the Armenian Plateau has faced considerable changes. The population of Armenia has decreased from 7 million in the10th century, to 3 million at the beginning of the 20th century. Emigration and loss of lands has also been accompanied by immigration by other ethnic groups (particularly in the 12th and 13th centuries, during the Mongol and Ottoman conquests). The original native land of Armenians (the Armenian Plateau) became a multiethnic region, while the Armenian people became more widely distributed across the world.

However, despite this the Armenians have preserved their spiritual and cultural independence and remained faithful to their traditions. Armenian culture has also affected that of neighbouring countries, and has influenced cultures elsewhere in the world. Armenian architecture, urban construction and constructive art, medieval miniature painting, carpets, poetry, music, painting, farming and live-stock farming have an important place in world culture.

Today, over 97% of the population of the Republic of Armenia consists of native Armenians. Of 8 million native Armenians around the world, approximately 3.8 million live in Armenia (the rest living in around 60 different countries, notably in the Russian Federation, the USA, France, Georgia, and Iran).

1.8 Social-economic and political situation

Until the late 1980s Armenia experienced rapid growth (for example between 1960 and 1988 GNP increased by 30%, capital investments by 60%, and numbers of civil servants and workers by 40%). Despite its small size and population, Armenia had high levels of electricity per capita (4300 Kwt/hr), high average life expectancy (74 years), low infant mortality (5.7 per 100 births), and good levels of education and health care. As part of the Soviet Union, Armenia was distinguished as a country having a high level of natural resource use, with a multi-branched economy, with 170 types of industrial production, and 30 types of agricultural production.

However, the current situation is very different, and over the past decade almost all key indicators have constantly declined, as the country entered a deep economic crisis. For example, between 1989 and 1994 GNP fell from 4.5 billion USD to 652 million USD. This resulted from the effects of the disasterous Spitak eathquake in 1988, followed by substantial social and economic changes after the break up of the Soviet Union.

The Spitak earthquake of 1988 resulted in huge damage to the infrastructure and potential of the country. It affected 40% of country's total area and a third of the country's population. Many cities and villages were severely damaged, and a number were completely destroyed (including the city of Spitak and 58 villages). Industry (including food production) was severely affected, leading to widescale unemployment. The infrastructure of the region was severaly affected (including roads and railways, gas, electricity and water supplies), and widespread environmental damage was recorded. Around 25,000 deaths were recorded as a result of the earthquake, with a further 20,000 peoples were injured, and at least 500,000 were made homeless.

After the break up of the Soviet Union, all new republics underwent severe economic crisis. The crisis in Armenia was further increased as a result of local and regional disturbances, including blockades by Turkey and Azerbaijan, and war with Azerbaijan over the enclave of Nagorno-Karabagh. By the 1990s the Armenian economy was on the edge of collapse, with significant drops in production, and loss of many industries. Energy supply was restricted significantly for several years, and centralised supplies of gas, hot water and heating were cut off. By 1998, average monthly earnings had dropped to around 8000 drams (eqivalent to 16 USD) and almost 60% of the population were estimated to live below the poverty level.

However, the Armenian economy is now in a slow process of recovery, with increasing investments, capital construction, production and state support for social welfare. By the first half of 1998 the GNP had grown by 6.7% over the previous twelve months. Over the past years there have been significant socio-economic reforms in Armenia, including a shift to democracy, a market-based economy and land privatization. Decentralization is taking place in industry and agriculture, and the private sector now accounts for over half of production in the country. The legal system now encourages business development and foreign investment.

Compared to neighbouring countries, Armenia has enjoyed relative political stability since the break up of the Soviet Union. Foreign observers have remarked on the measures taken to establish a democratic and civil society, protect of human rights, and improve the legal system. Serious attempts have been made to integrate the country into the global economy, and to actively participate in international and regional organizations. Armenia implements a foreign policy aimed at establishment of friendly relations with all neighboring countries, trying to resolve all conflicts by solely political means, and has successfully established diplomatic and trade links with almost all other countries in the region (apart from Azerbaijan and Turkey).

1.9 The current status of the environment

The legacy of the Soviet Union and recent economic problems in Armenia have proved extremely damaging to the conservation and sustainable use of biodiversity and landscapes (see Chapter 6). Human impacts have seriously affected much of the natural landscapes of the country.

- **Forests** have been severely damaged, with approximately 8% of total forest cover being destroyed between 1992 and 1995. Use of forests for industrial needs has led to reduction of some forests to a half or a third of their original area. Deforestation has resulted in heavy erosion and consequent flooding, and further loss of forest margins.

- **Poor agricultural practices** have resulted in significant soil erosion from cultivated lands. Soil has been completely lost from a number of slopes, and every year thousands of hectares of land become unusable.

- **Overgrazing** of pasture by livestock, particularly in sensitive areas, has resulted in significant changes and losses in vegetation cover (20-40% in some cases), and reductions in vegetation density. Although overuse of these pastures has declined over the last

decade, there are still significant legacies from overgrazing.

- **Pesticide residue** is an important issue. Fertilizers and pesticides were extensively applied, with average pesticide imports equivalent to 9 kg / ha. This led to river pollution, reductions in soil quality, and changes in vegetation cover.

- **Mining and chemical industries** caused significant pollution of natural landscapes. Overall, 8,000 ha were directly affected by industrial operations, across almost all lowland landscapes, and greater areas have been indirectly affected by pollution. Furthermore, significant areas are still used for storage of industrial waste. In the vicinity of Alaverdi Mining Plant industrial waste had significant impacts on the ecosystems, with the loss of local species of fauna and flora. Lands in the vicinity of this plant show contamination with heavy metals up to 35km away (a total of 1100 km^2). Furthermore, the releases of large volumes of industrial waste release led to heavy flooding downstream. However, closure of the plant has led to reduced levels of pollution in the area.

- **River pollution** has increased as a result of increasing human pressure. Annually around 200-250 million m^3 of polluted water reaches ground water reserves, of which 56% comes from the industry and energy sector, 26% from domestic use, and 18% from agriculture. A number of major rivers are now heavily polluted, and cannot be used for agriculture or irrigation, and may pose a threat to the conservation of biodiversity. However, the current social-economic crisis has resulted in issues such as soil and water pollution being overlooked.

Chapter 2. The Biological Diversity of Armenia

2.1 Historical evidence for the development of biodiversity

Over geological time the biological wealth of the Republic of Armenia has been well represented in the fossil record. The area is rich in fossils including woody plants dating from the upper Cretaceous period (including pine, plane and poplar). Miocene sedimentary rocks have revealed information on the trees of that time (including spruce, fir, cedar, walnut, oak, chestnut, birch, horn-beam, ash, and lime). Of a total of 169 fossil tree species (representing 85 genera and 44 families) from different geological periods, 47 currently exist in the country. Most of the current flora species evolved during the Miocene, representing the basic vegetation cover and forests.

A series of climatic modifications have played an important role in determining the current landscapes, ecosystems and biodiversity of Armenia. Changes in vegetation coincided with continentalization of climate during the Pliocene, when plants of the more humid sub-tropics were gradually replaced with more tolerant and deciduous plants, such as Greek walnut (*Juglans* spp.), Oriental beech (*Fagus orientalis*), and Georgian pine (*Pinus* spp.). However, in particular areas, relicts of the earlier flora remained, such as Oriental pine (*Pinus* spp.) and yew (*Taxus baccata*). At this time forests were superceded by vegetation dominated by xerophytes. During the later Pliocene and Pleistocene a series of glaciations occurred in the Caucasus, which affected the existing ecosystems, resulting in reductions in primary sub-tropical forests, and growth in secondary habitats typical of the temperate zone. At this time some boreal forest species appeared, including birch (*Betula pendula*), service-tree (*Sorbus domestica*) and bird cherry (*Prunus padus*). After glaciation the flora became further dominated by xerophytes, as more arid-zone habitats emerged.

It appears that vegetational shifts during the Pliocene were accompanied by the immigration of arid-zone faunas, perhaps from Iran, thus accounting for the unique vertebrate and invertebrate fauna currently found in the Arax Valley. At the same time, reptiles of European origin, such as the meadow viper (*Vipera ursinii*), grass snake (*Natrix natrix*), sand lizard (*Lacerta agilis*), and meadow lizard *(L. praticola*) also migrated into Armenia. It appears that a number of reptiles may also have reached Armenia from the Middle Asian deserts, including the race runner (*Eremias arguta*), pond turtle (*Clemmys caspius*), and toadhead agama (*Phrynocephalus persicus*). During the glaciations, some relict populations of fauna in northern Armenia appear to have survived in forest refugia which were not under ice.

The evolution of fish in Armenia has followed a pattern similar to that shown by terrestrial species. The composition of fish species changed during glaciations as species reliant on warm conditions were lost from high altitude lakes, streams and rivers. Although such species later reinvaded rivers upstream (such as the rivers Arax and Kur) they failed to reenter lakes which had since become isolated from such river systems. The fish isolated in lakes have thus evolved into a series of endemic species and sub-species (including trout, 'koghak' and others).

Armenia's position at the junction of biographic zones is also clearly demonstrated through its birdlife, which includes representatives of European and Asian avian faunas. The country

also lies on bird migration routes of international importance. Typically the bird fauna in the north of the country is most similar to European and Caucasian faunas, while that in the south is more similar to those found in Iran, north Africa, the Mediterranean, the Caspian, and Asia Minor.

In more recent years, mid-zone forests have declined substantially, while dry mountain forests, steppes, and scrubby woodland in arid zones, and their associated fauna, have expanded. Human activities have severely affected the ecosystems and biodiversity of Armenia, resulting in the decline and extinction of a number of plant and animal species.

2.2 History of research on biodiversity and quality of information

2.2.1 Micro-organisms

Armenia has a long history of the use of microbes for the production of food and medicines. Excavations indicate the production of foodstuffs reliant on fermentation (cheese, beer, wine) as early as the 8th-7th centuries BC (Teishebaini, Urartu). The development of the science of microbiology in the late 19th century, led to extensive research in Armenia, particularly in relation to yoghurt production (matsoon). During this century, micro-organisms from soil, foodstuffs, fermentation, and other sources have been extensively studied in Armenia, by national and foreign scientists, resulting in the documentation of many new species and types, some of which have important commercial uses.

2.2.2 Flora

The botanical resources of Armenia, and their use, have been studied since the 15th century (A. Amasiatzi), with more extensive inventories, basic vegetation assessments and detailed studies of herbal use being made in the 19th century (e.g. Rade, Grinevetski, Shamiramyan). Vegetation mapping and geo-botanical studies have been carried out since the 1920-30s, starting with an inventory of pastures and rangelands. Since then a number of distinct floristic regions have been determined, and vegetation of all the main habitat types has been studied to some extent. Furthermore the distribution and chemical composition of plants of industrial and commercial value were also investigated.

At present all groups of Armenian flora (lower and higher plants) are not equally well known - the best studied being fungi and flowering plants. As the result of extensive research a seven volume work was published documenting fungi and related groups ('The Microflora of Armenia'). However, this was not exhaustive and a further three volumes are still to be published on studies of other fungal groups. Extensive studies of higher vascular plants have been carried out since the 1950s (the work of A. Takhtadjian), and have culminated in the production of nine volumes documenting dicotyledonous vascular plants ('The Flora of Armenia'). A further two volumes on monocotyledons will soon be published. However, in comparison to these two groups, other flora are less well studied.

2.2.3 Fauna

Although records of the animals of Armenia date back to the 4th century AD, and have been described by national and foreign naturalists since then, the first systematic study of the

fauna of the region was published in 1841 ('The Fauna of Caspio-Caucasica', Eichvald). Indeed, until the Soviet era most of the extensive zoological surveys were conducted by foreigners.

This changed in the 1930s, through the work of one of the founders of zoological study in Armenia, A. Shelkovnikov. His work resulted in monographs devoted to various insects and birds. Further zoological studies followed, including the publication of 'The Fauna of Armenia' in 1954 (S. Dal), and work on herpetology (in particular, parthogenesis in lizards). Since the 1950s zoological research has continued on various groups (including molluscs, arachnids, beetles, ticks, amphibians, reptiles, and birds), with studies focusing on their taxonomy, zoogeography, ecology and behavior, as well as issues relating to their conservation.

2.2.4 Agrobiodiversity

Although knowledge of plant and animal breeding dates back many centuries (see Chapter 4), it was during the 19th and early 20th centuries that systematic research into the diversity of cultivars and of native breeds of livestock started (including the work of Vavilov and Tamashian). A number of scientists have worked on crop diversity, studying issues such as genetic diversity within and between varieties, identification of varieties, wild relatives, and their natural habitats. These studies have aided the development of new varieties, and a series of high-yield crops have been produced. Such research and plant breeding still continues today.

2.3 Diversity of micro-organisms

The diverse landscapes and climates of Armenia support a wide diversity of micro-organisms, and these have been relatively well studied compared to other countries. In particular, the distributions and ecological relations of different micro-organism groups and the altitudinal zonation in soil micro-organisms have been studied. Much if this work has been done by a number of institutes focusing on microbiology (Institute of Microbiology of the National Academy of Science, Republican Centre for Micro-organisms, and the Institute of Biotechnology, Ministry of Industry). A range of micro-organisms are important in maintaining ecological balance, soil quality and human health. Of particular interest are the micro-organisms used in food production (cheese, yoghurt, wine and bread), and there is a long history of selection of strains of yeast and lacto-bacteria in Armenia. The need to preserve a wide range of commercially important micro-organisms represents an important issue relating to the conservation of agrobiodiversity. The breadth of knowledge about micro-organism diversity is illustrated below.

2.3.1 Soil micro-organisms

- **Nitrogen-fixing micro-organisms**, (including nitrogen-bacter) are the best studied group of soil microflora. Distributions of different species have been described from various soil types, and from the root systems of plants; a new species (*Azotobacter nigricans*) has also been described. Tuber bacteria have been described widely within Armenia, and species recorded from different plant groups include *Rhizobium simplex, R. leguminosarum, R. meliloti, R. phaseoli, R. lupinus,* and *R. trifoli.*
- **Sulphate-removing bacteria** have been studied in saline areas of the Ararat valley, where they occur in damp soils with high levels of sulphate and organic matter. Soil treatment (sulphur acid washing) resulted in a decline in these bacteria and affected their role in sulphate removal.
- Bacteria which favour extreme conditions (of heat, cold, salinity, and alkalinity) have been extensively studied, including their biological components. About 1000 species of such bacteria are maintained at the State Micro-organism Bank.

2.3.2 Chemolitotrophic and phototrophic bacteria

- **Sulphide-oxidising bacteria**, and other groups with similar oxidation capabilities, are well studied. A number of new species (and sub-species) have been described, including *Leptospirillum feroxidans, Thiobacillus organoparus* and *Sulfobacillus thermosulfidooxidans asporogenes* Such micro-organisms are used in bacteria leaching, and in bacteria washing of metals and in copper refining.
- **Photosynthetic bacteria** are common in the mineral waters of Armenia. These include both sulphur bacteria (such as *Chromatium buderi* and *C. vinosum*) and the more widely spread non-sulphur bacteria such as *Rhodopseudomonas (Rhodobacter) palustris, R. spheroides, R. acidophilus, R. capsulatus,* and *Rhodospirillum rubrum*. In saline waters photosythetic, alkaline-tolerant species are found (*Ectothiorhodospira, Thiospira* and *Thiocystis*).

2.3.3 Lactic-acid bacteria

- **Lactic-acid bacteria**, used in fermentation of dairy products, have been well studied in Armenia, and the results from such studies have been applied to a selection of new strains for use in the dairy industry. A wide range of species, including heat- and saline-tolerant forms, have been described. A number of cultures are found in milk only in Armenia, and are not used in neighbouring countries (e.g. *Lactobacillus xylosus, Streptococcus uberis, Leuconostoc paramesenteroides*). Specific lactic-acid bacteria have long been used in the production of yoghurt, where the main species used are *Lactobacillus bulgaricus, L.helveticus, L fermentum, Streptococcus faecalis, Str. bovis,* and *Str.cremoris.* Similarly, the bacteria used in cheese making differ from those elsewhere in the Former Soviet Union.

2.3.4 Yeast (Saccharomycetes)

- **Yeasts** have been studied in relation to the production of wine and bread. Yeast strains used in baking (*Saccharomyces cerevisiae*) have been isolated, including cultures of heat- and salt-tolerent strains. In wine production, naturally occurring yeasts and those used in fermentation have been well studied. Many of these have been shown to be very productive, including *Saccharomyces cheresienis (*var. *armeniensis),* an alcohol-tolerant culture used in sherry production.

2.4 Plant diversity

The enormous diversity of plants in Armenia has been described based both in terms of classification (algae, fungi, moss and higher plants), and by ecosystem. The botanic diversity of the country reflects its position between major floristic regions, with both Mediterranean and boreal (Caucasian) floras being recorded. The extent of knowledge of different floristic groups (particularly fungi and higher plants) is described below, and the numbers of species described in different floristic groups is summarised in Table 2.1.

Table 2.1. Plant diversity in Armenia

Group	Number of species recorded
Algae	388
Fungi	4166
Lichens	2600
Mosses	430
Vascular plants	c. 3555
TOTAL	**c. 11,139**

2.4.1. Algae

2.4.1.1 Terrestrial algae

Algae occur both in soil and in water bodies, but are relatively under-studied in Armenia. In total, 143 species of algae are recorded from soil or other substrates, mainly including green, yellow-green and blue-green algae, and bacillariophyta (Table 2.2).

2.4.1.2 Aquatic algae (phytoplankton)

A total of 245 species of phytoplankton have been recorded from the water systems of Armenia. These include representatives of the following groups: Cyanophyta (69 types); Chlorophyta (58); Bacillariophyta (101); Charophyta (2); Dinophyta (3); Xanthophyta (4); Phyrophyta (1); Rhodophyta (1); and Euglenophyta (6). Most of these are freshwater species, although some forms are found in brackish water in the Ararat Valley. Over 97 species have been recorded from Lake Sevan alone, among which the Chlorophyta are the most diverse (47 species), and Bacillariophyta are also well represented. Rivers and streams within the

Lake Sevan watershed also show diverse algal communities (125 species), and which characteristically include species associated with high altitude, fast-flowing rivers. Other rivers , such as the Arpa and the Masrik, also show high algal diversity (75 and 67 species respectively).

Table 2.2 Numbers of genera and species of different groups of soil algae in Armenia

Group	Genera	Species	Widely distributed species characteristic of Armenia
Cyanophyta	27	71	*Gloeocapsa minuta, Merismopodia glauca, Microcystis pulverea, Anabaena variabilis, Oscillatoria brevis, Phormidium autumnale*
Bacillariophyta	15	38	*Cymbella parva, Diatoma vulgare, Fragilaria pinnata, Navicula dicephala, Nitzschia amphibia, Pinnularia borealis*
Xanthophyta	12	14	*Botrydiopsis arhiza, Vaucheria pachyderma, Tribonema elegans*
Chlorophyta	11	20	*Chlamydomonas conferta, C. elliptica, Chlorococcum humicola, Chlorella vulgaris, Ulothrix variabilis*
TOTAL	**65**	**143**	

Phytoplankton found in Lake Sevan were previously considered unusual, relative to other large lakes in Western Europe, being adapted to oligotrophic (nutrient poor) conditions. However, many of these species disappeared during euthropication of the lake. Indeed, species such as *Anabaena flos-aquae* and *A. lemmermanii* flourished, and contributed to the algal bloom which occurred in 1964. By the 1970s species such as *Melosira granulata* and *M. islangica* dominated the phytoplankton community of the lake, but further eutrophication in the 1980s reduced their numbers (although a recent upturn in numbers has been recorded).

2.4.2 Fungi

Fungi are well studied in Armenia, and around 4200 species or sub-species have been described among the higher fungi (Myxomycota) and slime-moulds (Eumycota; Table 2.3). Research has established distribution patterns for some fungi in the country. Fungi are sub-divided into two main groups: micromyocytes and macromyocytes.

Table 2.3 Number of genera and species of different groups of fungi described from Armenia

Group	Subgroup	Genera	Species
Myxomycota		21	44
Eumycota			
	Mastigomycotina	8	125
	Zygomycotina	23	140
	Ascomycotina	227	960
	Basidiomycotina	226	1144
	Deuteromycotina	133	1753
TOTAL		658	4166

2.4.2.1 Micromyocytes

- **Parasites and pathogens**. Micomyocytes recorded in Armenia include a large number of parasitic and pathogenic forms (125 species of Peronosporales, and 395 species of hyphales). Other groups include rust fungi (Uredinales; 225 species) which cause crop damage, and powdery mildews (Erysiphales; 115 species). A further 550 species of saprophytic and parasitic fungi are recorded (Sphaeropsidales).

- **Soil fungi.** Many micromyocytes occur in soil (541 species) and some have important medicinal use (e.g. *Penicillium, Aspergillus* and *Fusarium*).

- **Aquatic fungi.** Fungi have an important ecological role in the water bodies of Armenia. Some species act as parasites on fish, but most contribute to bio-degradation, and thus in maintaining water quality. About 200 species of aquatic fungi have been described (mostly belonging to the genera *Achlya, Anguillospora, Blastocladia, Clavariopsis, Saprolegnia, Tetracladium,* and *Tricladium),* in lakes with different altitudes, aspects and pollution levels.

- **Toxic fungi.** Of particular importance are micromyocytes that pollute foodstuffs and produce toxins (including species of *Aspergillus, Penicillium, Fusarium,* and *Alternaria*).

- **Carnivorous fungi.** Around 25 species of carnivorous fungi are found in Armenia, the most widely spread being species of *Arthrobotrys*.

2.4.2.2 Macromyocytes

A total of 1182 species of macromyocytes are recorded in Armenia (Table 2.4), including 284 species of edible fungi (mushrooms). Many edible species are in the genus *Agaricus* (such as *A. campestris* and *A. bisporus*; Fig. 12). Other important edible species are *Pleurotus ostreatus, Suillus granulatus, Lepista personata, Lactarius deliciosus.* In addition, a further 59 species of poisonous fungi have been recorded (including *Amanita phalloides, A. pantherina, Hypholoma fasciculare, Inocybe* spp. and *Cortinarius* spp.).

Table 2.4 The diversity of macromyocytes found in Armenia in relation to different taxonomic levels

Class	Number of taxa			
	Series	Families	Genera	Species/ Subspecies/forms
Pyrenomycetes	5	11	28	95
Discomycetes	5	19	99	219
Heterobasidiomycetes	4	4	14	27
Homobasidiomycetes	7	41	183	761
Gasteromycetes	8	17	25	80
TOTAL	29	89	349	1182

There are three main ecological niches filled by macromyocytes - parasites, symbiotes and saprotrophs. The more common saprotrophic fungi are summarised in Table 2.5.

Table 2.5 Numbers and examples of fungi organised by substrate

Main substrates of saprotrophic fungi	Number of species	Species with wide distributions
Wood	502	*Pleurotus ostreatus, Flammulina velutipes, Schizophyllum commune, Hypholoma fasciculare,Pholiota destruens, Polyporus varius*
Humus	279	*Macrolepiota procera, Agaricus silvaticus, Lycoperdon perlatum, Calvatia utriformis, Geastrum fimbriatum, Bovista nigrescens, Hygrocybe conica*
Litter	105	*Clitocybe gibba, Strobilurus esculentus, Collybia dryophila, Lepista nebularis, Auriscalpium vulgare*
Dung	73	*Ascobolus glaber, Saccobolus violascens, Coprinus ephemerus, Conocybe pubescens, Stropharia semiglobata, Coprinus comatus*
Plants	39	*Calloria fusarioides, Phialea urtikae, Cyathicula coronata, Stictis stellata, Pleurotus eryngii, Nectria dacrymycella*
Sand	22	*Barlaea modesta, Helvella atra, Rhizina inflata, Sarcosoma globosum, Gyrophragmium dunalii, Tulostoma volvulatum, Podaxis pistillaris*

2.4.3 Lichens

Lichens are a widespread group, with over 26,000 species recorded worldwide from all major ecosystems (from deserts to alpine tundra). However, lichens have not been particularly well studied in Armenia, with most work conducted in the Lake Sevan watershed. Around 300 species have been described in Armenia (of which 190 are from the vicinity of Lake Sevan). Most of the lichens described are of a crust form (40%), which typically grow on rock. Other described forms are foliate, fructate and umbilicate. Lichens are found on a range of substrates including rocks, trees, soil, moss and as parasites (Table 2.6). Although lichens are not considered to be of economic importance in Armenia, some species could be used as a source of antibiotics and as environmental indicators of air quality. Further work is needed to document lichens, and to determine their conservation status, and appropriate Red Data Book listings.

2.4.4 Mosses

Mosses are relatively simple plants, with a wide distribution, but generally associated with damp areas. Globally, around 25,000 species of moss have been described, of which 430 species have been recorded in Armenia, mainly in mountain and forest habitats. Of these, around 108 species are considered to be rare (including: *Dicranoweisia intermedia, Orthotrichum urnaceum, Antitrichia curtipendula, Pterogonium gracile,* and *Lindbergia brachyptera),* but are not currently included in the Red Data Book. Of particular importance is the occurrence of *Sphagnum* moss (a glacial relict) at four wetland sites.

Table 2.6 Examples of lichen species associated with different substrates

Substrate	Examples of species
Rocks	*Verrucaria hochstetteri, Lecidea umbonata, Aspicilia calcarea, Lecanora muralis, Ramalina capitata, Xanthoria elegans*
Trees	*Parmelia glabra, Lecanora carpinea, Physcia dubia, Candelaria concolor*
Soil	*Psora globifera, Collema cristatum, Cetraria islandica, Parmelia vagans*
Moss	*Diploschistes muscorum, Caloplaca cinnamomea*
Parasites	*Bilimbia microcarpa*

2.4.5 Vascular plants

2.4.5.1 Terrestrial plants

Most groups of higher plants are represented in Armenia (Table 2.7), including peat-moss, horse-tails, ferns, gymnosperms (open-seed flowering plants) and angiosperms (closed seed flowering plants). A brief overview of each of these groups is presented below.

Table 2.7 Number of species of different groups of higher plants found in Armenia

Group		Number of species
Peat-mosses		2
Horse-tails		6
Ferns		38
Gymnosperms		9
	Ephedraceae	(2)
	Taxaceae	(1)
	Pinaceae	(1)
	Cupressaceae	(5)
Angiosperms		c. 3500
	Monocotyledons	(800)
	Dicotyledons	(2700)
TOTAL		**c. 3555**

- **Peat-mosses.** In Armenia the most common peat-moss is *Selaginella helvetica*, which occurs in most sub-alpine meadow wetlands in the north-east of the country.

- **Horse-tails.** Six species of horsetails are found in Armenia, mainly in relatively damp areas in forests, river valleys and shorelines. The most common species are *Equisetum arvense, E. palustre,* and *E. ramosissimum*, and although of no commercial use, many were used for traditional medicine.

- **Ferns.** Of the 10,000 species of ferns described globally, a total of 38 species of ferns are

found in Armenia, the most common species include male fern (*Dryopteris filix-mas*), *Ophioglossum vulgatum, Cystopteris fragilis, Polypodium vulgare, Athyrium filix, Asplenium* spp. and *Trichomanes* spp. Compared with other groups of higher plants ferns have limited economic value, although they do have some decorative, edible and medicinal uses.

- **Gymnosperms.** Of some 600 species of gymnosperms described world-wide, only nine species are recorded in Armenia, including some introduced species. Genera represented include juniper (*Juniperus*; 5 species), pine (*Pinus;* 1 spp.), yew (*Taxus;* 1 spp.) and *Ephedra* (2 spp.).

- **Angiosperms.** These are the most diverse and abundant group of higher plants in Armenia, and represent almost 50% of the overall flora of the Caucasus. More than 3500 species of higher vascular plants of 200 families grow in Armenia, in total covering approximately 30,000 km ^{2} of the land surface of the country. As well as common temperate zone species, a number of endemic and relict forms, with restricted distributions, are found (Chapter 3). In addition, there is high diversity among cultivated species (Chapter 4). The diversity of plants found in Armenia reflects not just its bio-geographical position, but the range of landscapes and habitats represented in the country.

2.4.5.2 Aquatic and wetland plants

A total of 417 plant species (of 67 families) are known to occur in the rivers and lakes of Armenia. Most of these (58%, 246 species) belong to ten plant families (Table 2.8). Not surprisingly, plant families associated with water or damp sites are particularly well represented in this flora (Cyperaceae and Potamogetonaceae).

Table 2.8 Key families of aquatic plants in Armenia, and the number of species recorded in each family

Family	Species
Cyperaceae	73
Potamogetonaceae	49
Fabaceae	25
Cariophilaceae	16
Ranunculaceae	15
Asteraceae	15
Rosaceae	14
Juncaceae	13
Salicaceae	13
Polygonaceae	13

In general, relatively few aquatic plants are found in the rivers and lakes of high mountains (only 10% of the aquatic flora is recorded above 2700m), most are found at mid- (1200-2700m) or low- (<1200 m) altitude (50% and 40% of the flora, respectively). Studies of the distribution of aquatic plants in Armenia have identified some key sites for these plants:

- Lakes of mid-altitude and in steppes are particularly rich in water and marshland plants.
- Many rare species (such as *Nymphae alba, Salvinia natans,* and *Carex ohemica*) are found in the relict lowlands lakes in Lori region.
- The Metsamor (Sevajur) river supports many aquatic and marshland species, including nationally and regionally rare species. This is partly explained by its high water quality and slow speed.
- The Lake Sevan basin supports flowering water plants in its upper waters (above 6 m), while algae flourish at greater depths.
- Despite the large-scale drainage and destruction of marshland in vicinity in Lake Sevan, some populations of reeds, rushes, (*Juncus*), reed mace (*Typha*) and sedge (*Carex*) can still be found close to springs and emerging groundwater.
- A limited number of aquatic plants are found in forest lakes. Ponds in shady woodlands (such as those of beech and oak) tend to be dominated by algal blooms, and where flowering aquatic plants do occur, their cover is relative sparse.

2.5 Animal diversity

As a result of its biogeographical position, diversity of landscapes, variations in altitude and mountainous nature, Armenia supports a wide range of animal species. Such diversity is outstanding compared to other countries of the region. Many of the species that occur exist at the edge of their range, or in separate isolated populations, and are therefore of particular interest for zoologists and conservationists. A brief outline of the invertebrate and vertebrate fauna is presented below, and the number of species recorded in different groups is summarised in Table 2.9.

Table 2.9 Animal diversity in Armenia

Group	Number of species recorded
Invertebrates	c. 17,000
Fish	31
Amphibians	8
Reptiles	53
Birds	349
Mammals	83
TOTAL	**c. 17,524**

2.5.1 Invertebrates

2.5.1.1 Terrestrial invertebrates

Invertebrates have been less well studied than vertebrates in Armenia, as in most countries. Around 17,000 species of invertebrates have been recorded in the country, of which 90% are insects (key groups are shown in Table 2.10). Studies have been conducted on around 30% of invertebrates, and although the beetles (Coleoptera) are well studied, other groups such as Ephemeroptera (mayflies) and Neuroptera (lace wings) are not well known. A number of invertebrates are considered to be threatened including 7 molluscs, 15 grasshoppers, 1 homopteran bug, 10 hymeropterns (bees, wasps and ants), 40 butterflies and moths, 20 beetles and 4 flies.

2.5.1.2 Aquatic invertebrates

A range of planktonic invertebrates are found in Armenia's water systems (totaling 124 species), including 46 species of rotifers (Rotatoria) and 78 crustaceans (Crustacea).

- Different rotifer species are associated with different water bodies. The most common include *Brachionus rubens, Ketatella quadrata, Filinia longiseta, Pedalia fennica,* and *Conochilus hippocrepis.* The greatest diversity of rotifers was previously found in the lakes Sevan, Arpi and Gilly (although the latter has since been drained).

- Among the crustaceans, both planktonic and pelagic forms are found. Common species include *Chirocephalus skorikowi* (in the vicinity of Lake Sevan, among other sites), and *Lepthesteria dahalensis* (Lori and Sevan regions). A total of 16 species of *Phyllopoda* are recorded from Armenia. Copepods include *Diaptomus* (7 spp.) and *Cyclops* (16 spp.).

In addition, a wide range of benthic species are found in Armenian water bodies (316 spp; Annex 2).

- A range of benthic species have been studied relatively well. These include: oligochaete worms, leeches, gastropods, bivalve molluscs, amphipods, dragonflies, mayflies, stoneflies, caddis flies, hemipteran bugs, flies, and beetles.
- A range of species are also found within the mud at the bottom of lakes and rivers. These include sponges (such as *Ephidatia fluviatilis* in Lake Sevan), flatworms, nematode worms, and copepods.
- Amphipods are found in a range of sites, among them are *Unionidaes* spp. (Ararat valley and warm reservoirs in the north), and *Potamion potaimon* (widespread in fast-flowing watercourses). In addition, and introduced species, *Astacus leptodactylus,* is proliferating in reservoirs and watercourses.

Table 2.10 Numbers of species of specific invertebrate taxa found in Armenia

Taxonomic group			**Number of species**
Type	**Class**	**Series**	
Mollusca			
	Gastropoda		141
		Planilabiata	1
		Ectobranchia	2
		Discopoda	5
		Basommatophora	24
		Stylommatophora	109
	Bivalvia		14
		Actinodontida	2
		Astartida	12
Arthropoda			
	Arachnida		
		Scorpiones	3
		Aranei	302
		Acarina	c. 2000
	Insecta		
		Odonata	15
		Orthoptera	150
		Blattodea Mantodea Dermaptera Phasmodea	} 20
		Homoptera	400
		Hemiptera	500
		Hymenoptera	470
		Lepidoptera	570
		Coleoptera	1200
		Diptera	200

2.5.2 Fish

Fish belonging to five orders are found in Armenia (Salmoniformes, Cypriniformes, Siluriformes, Cyprinodontiformes, Perciformes). A total of 31 species of fish are recorded in Armenia, including nine endemic species or sub-species (Chapter 3). Important and widely distributed species are shown below (Table 2.11), of which up to six are introduced (non-native) species.

2.5.3 Amphibians

A total of eight amphibian species are found in Armenia (Table 2.12). Most of these species are generally widespread (European marsh frog, *Rana ridibunda*; brusa frog, *R. macrocnemis;* European green toad, *Bufo viridis;* European tree frogs, *Hyla arborea shelkovnikovi*, and *H. savigni*), along with the endemic Syrian spadefoot toad (*Pelobates syriacus*). In addition, a further species was recently found in Armenia – an isolated population of banded newts (*Triturus vittatus*) outside their normal distribution.

2.5.4 Reptiles

Armenia is recognised as having one of the most interesting reptile faunas in the former Soviet Union (FSU). Of 156 reptiles recorded from across the FSU, a total of 53 are present in Armenia, many of which are both endemic and threatened (Table 2.13).

2.5.4 Birds

The position of Armenia, and its varied ecosystems and climate, result in relatively high bird diversity in this country. Bird faunas of Europe, the Mediterranean and the Middle East are represented. A total of 349 bird species are recorded from Armenia, and birds constitute over 60% of the vertebrate fauna of the country (Table 2.14). The lakes of Sevan and Arpi, along with the Ararat Valley are of great importance for wetland birds, and are used by migrating species. Together these sites support 145 species of waders and waterbirds.

Table 2.11 Fish species found in Armenia and comments on their distribution and abundance

Species	Common and local name	Comments on distribution and abundance
Salmoniformes		
Salmo isshkhan	Sevan trout	Endemic species which occurs in Lake Sevan and surrounding rivers; four subspecies also recorded.
Salmo trutta m.fario	Trout (karmrakhait)	Once widespread in rivers, now declining
Salmo caspius	Caspian salmon	Not well studied
Salmo gairdneri irideus	Pacific salmon	Mainly found in fish farms
Coregonus lavaretus sevanicus	Whitefish (Sevan sig)	Artificially selected; common in Lake Sevan since the level decrease and the main commercial fish
Cypriniformes		
Leuciscus cephalus orientalis	Chub (Caucasian tepough)	Widespread in water bodies, except Lake Sevan and some high altitude lakes
Chondrostoma cyri leptosoma	Nase (kura yentaberan)	Not well studied
Barbus lacerta	Barbel (kura beghlou)	Shows great ecological flexibility and much inter-population variability; relatively rare.
Ctenopharingodon idella	Grass carp (white amour)	Oriental species introduced with the aim of improving water quality in marshy lakes and irrigation systems; raised on fish farms
Varicorhinus capoeta capoeta	(kura koghak)	Several races have developed in Lake Sevan and its tributaries
Carassius auratus	Goldfish (silver tsatsan)	Widely distributed as a result of fish farms; now common in Lake Sevan and the second most important commercial fish species
Hypophthalmichtys molitrix	Silver carp (lainachakat)	Important species for fish farms
Cyprinus carpio	Common carp (getatstatsan)	Introduced to a number of sites (including lakes in Lori marshes and reservoirs of Ijevan and Dilijan.
Rutilus rutilus schelkovnikovi	Roach (Armenian karmrakn)	
Alburnoides bipunctatus armeniensis	Schneider (Armenian tarekhik)	
Blicca (Abramis) bjoerkna derjavini	White bream (Armenian goustera)	
Siluriformes		
Silurus glanis.	Wels catfish (loko)	Widely distributed in the Arax rivers system, but rarely found in lakes; declining through over-fishing; not well studied
Cyprinodontiformes		
Gambusia affinis	Mosquito fish	Represented by two sub-species of American origin; originally introduced to combat malaria (feed on mosquito larvae)
Perciformes		
Spp. unconfirmed	Perch	Recorded in 1992 in water bodies of the Ararat Valley; not identified or assessed as yet.

Table 2.12 Number of amphibian species in different families, including number of common and rare/threatened species

Family	Total number of species	Number of common species	Number of rare, threatened or data deficient species
Salamandrida	2	-	2
Bufonidae	1	1	-
Pelobatidae	1		1
Hylidae	2	2	-
Ranidae	2	2	-
TOTAL	**8**	**5**	**3**

Table 2.13 Number of reptile species in different families

Order / Family	Number of species	Number of common species	Number of rare, threatened or indeterminate species
Testudines			
Emididae	2	1	1
Testudinidae	1	-	1
Sauria			
Gekkonidae	1	-	1
Agamidae	2	1	1
Anguidae	2	1	1
Scincidae	4	-	4
Lacertidae	17	11	6
Serpentes			
Typhlopidae	1	-	1
Boidae	1	-	1
Colubridae	18	10	8
Viperidae	4	1	3
TOTAL	**53**	**26**	**27**

Table 2.14 Number of bird species in different orders

Order	Total number of species	Number of common species	Number of rare, endangered and indeterminate species
Gaviformes	2	-	2
Podicipediformes	5	4	1
Pelecaniformes	4	-	4
Ciconiformes	13	6	7
Phoenicopteriformes	1	-	1
Falconiformes	35	13	22
Anseriformes	28	13	15
Galiforme	7	3	4
Gruiformes	13	4	9
Charadriiformes	62	41	21
Columbiformes	8	7	1
Cuculiformes	2	2	-
Strgiformes	7	4	3
Caprimulgiformes	1	1	-
Apodiformes	2	2	-
Coraciiformes	5	4	1
Piciformes	8	4	4
Passeriformes	146	121	12
TOTAL	**349**	**229**	**12**

2.5.5 Mammals

The mammals represent the second largest vertebrate class in Armenia, after birds, with 83 species recorded in the country (Table 2.15). Over the last 10 years research has identified the presence of seven bat species which had not previously been recorded. These included the grey long-eared bat (*Plecotus austriacus*), barbastelle (*Barbastella barbastella*), Leisler's bat (*Nyctalus leisleri*), Nathusius's pipistrelle (*Pipistrellus nathusii*), Savi's pipistrelle (*Pipistrellus savii*), particoloured bat (*Vespertilio murinus*) and the European free-tailed bat (*Tadarida teniotis*).

Table 2.15 Number of mammal species in different orders and families, including number of common and rare/threatened species

Order / Family	Total number of species	Number of common species	Number of rare, endangered and indeterminate species
Insectivora			
Erinaceidae	2	-	2
Talpidae	1	-	1
Soricidae	7	1	6
Chiroptera			
Rhinolophidae	5	2	3
Vespertilionidae	17	7	10
Mollossidae	1	-	1
Rodenta			
Leporidae	1	1	-
Hystricidae	1	-	1
Capomyidae	1	1	-
Scinridae	2	1	1
Muscardinidae	2	-	2
Dipodidae	2	-	2
Zapodidae	1	-	1
Muridae	17	13	4
Spalacidae	1	-	1
Carnivora			
Mustelidae	5	3	2
Ursidae	2	2	-
Hyaenidae	1	-	1
Canidae	3	2	1
Felidae	6	3	3
Artiodactyla			
Suidae	1	1	-
Cervidae	2	-	2
Bovidae	2	-	2
TOTAL	**83**	**37**	**46**

Chapter 3. Endemic, relict, rare and threatened species in Armenia

3.1 Flora

3.1.1 Endemic plant species

Armenia is positioned at the junction of several bio-geographical regions, and consequently contains a wealth of botanical diversity. However, these bio-geographical zones are well linked, and the lack of isolation results in relatively few endemic species. Overall, 106 species of endemic plants are recorded (representing 3% of the total Armenian flora, and 1.5% of flora found across the Caucasus ; Tables 3.1, 3.2; Map 7).

In addition, Armenia contains a number of regional endemics which are also found at a limited number of sites in neighbouring countries. For example, *Campanula massalsky* only grows in one site outside Armenia (in Turkey), and *Cousinia gigantolepis* only grows in the southern province of Armenia and in sites in northern Iran. Overall, over 300 species are endemic to the Armenian-Iranian region.

Table 3.1 Number of endemic species within different plant families

Family	No. of endemic species	Family	No. of endemic species
Asteraceae	26	Rubiaceae	2
Rosaceae	24	Campanulaceae	1
Scrophulariaceae	8	Caprifoliaceae	1
Fabaceae	7	Dipsacaceae	1
Brassicaceae	6	Euphorbiaceae	1
Caryophyllaceae	5	Geraniaceae	1
Poaceae	5	Hypericaceae	1
Boraginaceae	4	Liliaceae	1
Apiaceae	3	Linaceae	1
Grossulariaceae	2	Malvaceae	1
Limoniaceae	2	Polygalaceae	1
Orobanchaceae	2		

The endemic flora of Armenia is of relatively recent origin (dating from the Quaternary or Holcene), with no ancient endemic species recorded. This reflects the relatively recent diversification of flora in the region, which has resulted in the current botanical richness of Armenia. The distribution of endemics corresponds closely with climate, and most are found in the southern and central arid zones of the country (Table 3.3). In particular the regions of Daralagiaz and Yerevan show high numbers of endemics (with 38 and 36 species respectively).

Table 3.2 Number of endemic species in different genera

Genus	Number of species	Genus	Number of species
Pyrus	12	*Tragopogon*	2
Pserphelus	8	*Minuartia*	2
Centaurea	7	*Ribes*	2
Astragalus	5	*Acantholimon*	2
Verbascum	5	*Orobanche*	2
Rosa	4	*Alchemilla*	2
Cousinia	3	*Crataegus*	2
Isatis	3	*Rubus*	2
Stipa	3	*Galium*	2
Scorzonera	2	*Scrophularia*	2
Sonchus	2		

3.1.2 Relict plant species

Relict species, which have been preserved since geological time practically unchanged, are an important component of Armenia's botanical diversity. It is estimated that between 150 and 200 relict species occur, although accurate determination is limited by gaps in the fossil record. Some species (such as Oriental beech *Fagus orientalis*, which originated in the Tertiary period) are well adapted to today's conditions, and compete well with younger species. Other relicts are widely spread but are only associated with particular habitats (e.g. yew, Caucasian rosebay), while some species are restricted to specific sites or refuges (e.g. Oriental plane *Platanus orientalis* and male fern *Dryopteris filix-mas*). There is also evidence of relict fungi species occurring in deserts and steppes including *Podaxis pistillaris* and *Battarea phalloides*).

3.1.3 Rare and declining plant species

Threatened plant species have been recorded from all regions (Table 3.4; Map 8). Many of the rare and threatened plants in Armenia are associated with wetlands; water-marsh systems alone contain 45 plant species which are considered to be in need of conservation attention. The greatest threat to wetland plants has been drainage of marsh and wetlands for agriculture Around 20,000 ha of wetland sites have been drained across the country, resulting in inevitable damage to these ecosystems and associated flora. However, a number of other threats affect water plants.

- A number of species (including yellow water lily (*Nuphar luteum),* bogbean *(Menyanthes trifoliata),* and flowering rush *(Butomus umbellatus)* were lost when Lake Apri was converted into a reservoir.

Table 3.3 Distribution of endemic species according to Armenian floristic regions and altitude zones

Region	Altitude					Total
	low	mid	High	Sub-alpine	Alpine	
Upper Akhurian	-	2	4	1	-	4
Shirak	4	18	14	2	-	19
Aragats	-	4	5	4	4	8
Lori	1	5	4	2	-	6
Ijevan	4	16	14	7	3	20
Aparan	2	12	12	7	1	15
Sevan	2	16	20	8	2	22
Geghama	-	13	13	10	7	20
Yerevan	13	27	18	7	-	36
Daralagiaz	8	29	22	11	-	38
Zangezour	6	16	13	8	4	24
Meghri	2	14	13	6	3	17
TOTAL	**19**	**55**	**43**	**23**	**10**	**-**

Table 3.4 Rare and threatened wetland and water-plants in different regions

Region	Total number of threatened plant species	Number of Threatened water-plants
Yerevan	144	23
Meghri	114	7
Vaik	98	5
Zangezour	93	3
Ijevan	71	2
Sevan	48	6
Lori	47	11
Shirak	39	2
Aparan	26	1
Upper Akhourian	25	1
Aragats	19	-
Geghama	14	1

- The drainage of Lake Gilly, and decline in water levels in Lake Sevan, severely affected populations of around 60 species of water plants (including *Peucedanum zedelmejeri, Eleocharis transcaucasica, Astragalus goktschaicus* and *Puccinellia grossehimii*), and a number of species disappeared completely following these activities.
- Medicinal plants, such as sweet flag (*Acorus calamus*), which has traditionally been used to treat gastro-intestinal problems, have suffered over-collection.

3.1.4 Red-listed plant species

The Armenian Red Data Book (RDB) for plants was published in 1990, having been under preparation for 15 years (including 5 years in press). Publication of these works involved substantial review of the species concerned and the selection criteria used. However, more recently socio-political change has led to revision of priorities for conservation, and the need for quantitative indicators and impartial criteria has been recognised. The current listings include many rare species which are not threatened, but exclude a number of species undergoing population declines. New criteria based on quantitative indicators were proposed by the World Conservation Union - IUCN (Mace & Lande 1991) have been used in the most recent IUCN Red Lists, but further research will be needed to apply them to both the flora and fauna of Armenia.

At present Armenian biodiversity faces serious threats, and as many as half of all plants in the country may require some conservation action. This is not reflected in the Red Data Book which represents only the most highly threatened species and lists only 387 species (12% of the flora). The distribution of threatened species in relation to region is shown in Table 3.5.

Table 3.5 Number of species of different conservation status (Red Data Book category) in different floristic regions, and the number of these listed in the Red Data Book of the Former Soviet Union (FSU). Status categories include extinct (EX), endangered (EN), rare (R), declining (D) and indeterminate (IN).

Floristic region	**Total**	**Status according to the Red Data Book**				
		Ex	**En**	**R**	**D**	**IN**
Upper Akchurian	24	2	3	11	8	-
Shirak	44	-	9	15	20	-
Aragats	28	1	1	11	15	-
Lori	48	4	5	17	21	1
Ijevan	75	7	15	24	26	3
Aparan	34	2	7	8	17	-
Sevan	55	5	8	15	26	1
Geghami	24	-	4	7	13	-
Yerevan	140	12	56	39	32	1
Daralagyaz	93	5	26	37	25	-
Zangezour	94	-	20	46	25	3
Meghri	110	2	30	48	29	1
TOTAL	**387**	**36**	**130**	**154**	**59**	**8**
No. of these in the FSU RDB	62	5	28	23	6	-

At present, fungi (including mushrooms) have not been included in the Armenian Red Data Book. A number of species of fungi appear to be declining as a result of direct and indirect human impacts. Some cap mushrooms are considered to be on the verge of extinction and should be listed in the Armenian RDB. Overall, 15 species of fungi are considered to be critically endangered.

3.2 Fauna

3.2.1 Endemic animal species

Of the 17,500 vertebrate and invertebrate species recorded in the country, 329 are endemic to Armenia. These include a wide range of invertebrates (including *Phytodrymadusa armeniaca, Nocarodes armenus, Olophrum aragatzense, Amphycoma eichleri, Cantharis araxicola, Tomomyza araxana, Bombilius schelkovnikovi, Shadinia akramowskii,* and *Gabbiella araxenai*), as well as a number of vertebrate species and sub-species.

Nine species and sub-species of fish are endemic to Armenia. These include the endemic species of Sevan trout *(Salmo isshkhan*), and its four races or sub-species (winter bakhtak *S. ishkhan*; gegharkuni *S. ishkhan gegarkuni;* bojak *S. ishkhan danilewskii*; and summer bakhtak *S. ishkhan aestivalis*), which occur in Lake Sevan and surrounding rivers. In addition, the following sub-species of fish are also endemic to Armenia, a roach (Armenian karmrakn, *Rutilus rutilus schelkovnikovi*); a schneider species (Armenian tarekhik, *Alburnoides bipunctatus armeniensis*); Sevan koghak *(Varicorhinus capoeta sevangi)*; a barbel (Sevan beghlou *Barbus lacerta goktschaicus*); and a white bream species (Armenian goustera *(Blicca bjoerkna derjavini*).

Populations of trout (*Salmo trutta),* which until recently was found in all rivers in Armenia and Wels catfish (*Silurus glanis*) have reduced significantly as a direct result of human activities such as intensive poaching, reservoir pollution unlimited water use and uncontrolled fishing.

Of the 53 reptile species found in Armenia, over 13% are endemic. These include several species of rock lizards including *Lacerta unisexualis* (white-bellied lizard, found in the Sevan basin, and surrounding areas), *L. armeniaca* (the Armenian lizard, found in the north of the country), and *L. nairensis* (found around Hrazdan river and Lake Sevan). Other endemic species and sub-species include *Eremias arguta transcaucasika* (the racerunner, from Lake Sevan basin), *Vipera darevskii* (Darevsky's viper, from Djavakhk mountain range at 2000-53000 m), and *V. raddei boettger* (endemic sub-species of Russian viper, from Armenian Plateau and Minor Caucasus). Regional endemics (restricted to the Armenian plateau) include several rock lizards (*Lacerta dahli, L. rostombekovi* and *L. valentini).* In addition, one amphibian, the Syrian spadefoot toad (*Pelobates syriacus*), is endemic to the country.

No true endemic bird species are found in Armenia, although the Armenian gull (*Larus argentatus armeniacus*) is considered to be an endemic sub-species, and has been recorded in the Lake Sevan basin, along the Arax, Hrazdan, and Akhurian rivers, and in recent years in the Ararat valley. In addition, the Caucasian grouse (*Tetrao mlekosiewiczi),* which is endemic to the Caucasus, is common in Armenia.

Among 83 mammals recorded in Armenia, six endemic species or sub-species are recorded - the northern mole vole (*Ellobius lutescens*), Vingradov's jird (*Meriones vinogradovi*), a jeroboa

(*Allactaga williamsi*), the Caucasian birch mouse (*Sicista caucasica*), the Armenian mouflon (*Ovis orientalis gmelinii*), and a sub-species of Natterer's bat (*Myotis nattereri araxen*). Of particular note is the Armenian mouflon which is now restricted to areas in southern Armenia.

3.2 Relict animal species

Few relict animal species have been recorded from Armenia. One sub-species of fish, a roach ('Armenian karmrakn', *Rutilus rutilus schelkovnikovi*) appears to be a relict of Tertiary origin, which has been preserved within the Metasmor basin. Two birds, the white - winged scoter (*Melanitta fusca)* and the boreal owl (*Aegolius funereus*), are also considered to be relict species.

3.2.3 Rare and declining animal species

A number of invertebrate and vertebrate species are listed in the Red Data Book for Armenia, and many more are now considered to be undergoing decline. Studies of around 316 endemic species and sub-species, have revealed that around 100 of these are rare or declining.

Among the vertebrates species of key concern include a number of sub-species of fish, which have been threatened by declines in the water level of Lake Sevan and by over-fishing. For example, 'winter bakhtak' (*Salmo ishkhan)*, which previously made up 30% of Sevan trout stocks, has now practically disappeared, while 'bojak' *(S. ishkhan danilewskii*) is also rarely found now. Spawning of 'summer bakhtak' (*S. ishkhan aestivalis*) has been disrupted by both the decline in the level of Lake Sevan, and the damming of rivers, leading to declines in this sub-species, while populations of 'gegharkuni' *(S. ishkhan gegarkuni)* are currently maintained through artificial breeding. 'Sevan beghlou' *(Barbus lacerta goktschaicus)* declined following the changes in Lake Sevan (leading to habitat loss) and this species is now listed in the Red Data Book of Armenia.

In addition to the fish species, many Armenian reptiles are threatened (including a number of endemics and regional endemics). Threatened species include the Caucasian rat snake (*Elaphe hohenackeri*), Russian viper (*Vipera raddei),* and a skink (*Ablepharus chernovi*) among others. The population of the racerunner (*Eremias arguta transcaucasikan*) numbering 100 individuals, in the Sevan basin, is the only one in the Caucasus. A number of semi-desert and alpine bird species are considered threatened, vulnerable or extinct, while status of others has not yet been determined. Research many of these species is limited, but such birds appear to be under increasing threat. Among mammals, the distribution and population of Armenian mouflon (*Ovis orientalis gmelinii*) have declined as a result of habitat loss and poaching. This species has undergone a significant range reduction during the last 20 years, when it has disappeared from the Ararat Valley, and is now restricted to sites in southern Armenia (Khosrov Reserve and adjacent areas).

3.2.4 Red-listed animal species

A national Red Data Book for Animals has also been published, and the Armenian Red Data Book for invertebrates is in preparation. From around 17,500 species of invertebrate and vertebrates recorded in Armenia, approximately 300 are considered to be rare or declining. Preparation of the Red Data Book for invertebrates indicates that over a hundred species will be listed, and 48 species occurring in Armenia are also listed in the RDB of the Former Soviet Union. A total of 97 vertebrates are currently listed in the Armenian RDB, of which 39 are also listed in the RDB of the Former Soviet Union, and a number are considered internationally threatened (according to the IUCN Red List of Threatened Animals; Table 3.6). However, updating the Armenian RDB would be likely to lead to the inclusion of many more species (perhaps doubling the existing list). The status, distribution, and even scientific names, of many species have changed sine the Armenian RDB was last published. A number of species occurring in isolated populations were not included in the book. Furthermore, the recent economic crisis and natural disasters have severely impacted many species, and legislation has not been effective in protecting wildlife resources. A number of species are now thought to be on the verge of extinction in Armenia.

Table 3.6 Number of species found in Armenia listed in the International Red List of Threatened Animals (IUCN, 1996), including threatened species, and those of lower risk or where insufficient data is available.

Group	Number of internationally threatened species	Number of lower risk or data deficient species
Invertebrates	6	7
Fish	1	4
Reptiles	4	4
Birds	7	5
Mammals	6	10
TOTAL	**24**	**30**

Among the species listed in the Armenian RDB are 15 species of amphibians and reptiles and 18 mammal species or sub-species (Table 3.7). The distribution of a number of threatened reptile species is shown in Map 9. The following mammals appear most at risk (Map 10): Mehely's horseshoe bat (*Rhinolophus mehelyi)*, European free-tailed bat *(Tadarida teniotis)*, long-eared hedgehog (*Hemiechinus auritus)*, marbled polecat (*Vormela peregusna)*, European otter (*Lutra lutra)*, brown bear *(Ursus arctos)*, manul (*Felis manul)*, the Asian wild sheep *(Ovis ammon)*, and wild goat (*Capra aegagrus)*. In addition, the striped hyaena *(Hyaena hyaena)*, and the Caucasian birch mouse *(Sicista caucasica)* are more or less extinct in Armenia.

Table 3.7 Species of amphibians, reptiles and mammals recorded in the Red Data Books (RDB) of Armenia and the Former Soviet Union (FSU), and also in the International Red List of Threatened Animals (RL).

Species / sub-species	English name	Armenian RDB	FSU RDB	International RL
Amphibians				
Pelobates syriacus	Syrian spadefoot toad	+	+	-
Reptiles				
Testudo graeca	Mediterranean spur-thighed tortoise	+	+	+
Phrynocephalus persicus	Toadhead agama	+	+	-
Eremias arguta	Racerunner	+	-	-
Eumeces schnederi	Skink	+	-	-
Mabuya aurata	Golden grass mabuya	+	-	-
Ablepharus chernovi	Skink	+	+	-
Lacerta parva	Dwarf lizard	+	+	-
Elaphe hohenackeri	Transcaucasian rat snake	+	+	-
Rhynchocalamus melanocephalus	Palestine kukri snake	+	-	-
Telescopus fallax	European tiger snake	+	-	-
Vipera raddei	Russian viper	+	+	-
Mammals				
Hemiechinus auritus	Long-eared hedgehog	+	-	-
Rhinolophus euryale	Mediterranean horseshoe bat	+	+	-
Rhinolophus mehelyi	Mehely's horseshoe bat	+	-	+
Myotis nattereri	Natterer's bat	+	-	-
Barbastella leucomelas	Eastern barbastelle	+	-	-
Miniopterus schreibersi	Schreiber's long-fingered bat	+	+	-
Tadarida teniotis	European free-tailed bat	+	+	-
Hyaena hyaena	Striped hyaena	+	-	-
Sicista caucasica	Caucasian birch mouse	+	-	-
Meriones meridianus	Mid-day gerbil	+	-	-
Ursus arctos syriacus	Brown bear	+	+	-
Vormela peregusna	Marbled polecat	+	+	-
Lutra lutra meridionalis	European otter	+	+	-
Felis silvestris caucasica	Wild cat	+	-	-
Panthera pardus tullianus	Leopard	+	+	-
Felis manul	Manul	+	+	-
Capra aegagrus aegagrus	Wild goat	+	+	+
Ovis orientalis gmelinii	Armenian mouflon	+	+	+

Chapter 4. Agrobiodiversity and Species of Economic Importance

Farming has a long history in Armenia, dating back two millennia. Since that time it has continued to be an important factor acting on natural ecosystems, and on the genetic diversity of the country, both through the use of land and through man's effects on the genetic composition of species through selective breeding.

4.1 The origins of cultivated crops and domestic livestock

Armenia is considered to be one of the centres of origin for wild ancestors of crops and livestock, and for the artificial selection of new varieties and breeds.

4.1.1 Crops

The Armenian plateau is recognised an important centre of origin for cultivated plants. This is based upon both the number of extant wild relatives of crop plants (criterion used by Humbolt & Brown in the19th century), and upon the number of varieties of different species occurring in the country (criterion used by Vavilov). Historical evidence has revealed ethno-botanical use dating from the 8th century BC, with excavations showing evidence of crop growing as early as the 5th century BC. This discovery of early ethno-botanical use is supported by evidence from ancient Assyrian cuneiforms (9th-8th centuries BC) which suggest widespread cultivation of wheat across the Armenian plateau. Further evidence comes from Armenian chronicles, which mention the use of a range of fruit species, including Armenian varieties (e.g. fig, apple, pear, and peach) while wheat, vegetables and forest plants are mentioned by Barsegh Kesaratsi (329-279 BC).

Archeological and ethno-botanical studies also indicate long-term cultivation of grains (wheat, barley, rye, millet, oats), pulses (peas, lentils, chick peas, broad beans), fruit (water-melon, grapes, apricot, quince, plum, cherry, pomegranate, peach, apple), as well as nuts and wild grasses on the Armenian plateau. This extent of cultivation and variety of crops indicates that Armenia is an important site of origin for crop cultivars.

4.1.2 Wild relatives and crops in Armenia

The following varieties and wild relatives of crops occur in Armenia (see also Map 11).

- ***Cereals***. A total of 13 species and approximately 360 varieties of wheat are found in Armenia. Three species of world importance grow in Armenia (*Triticum boeoticum, T. urartu* and *T. araraticum*), and the latter two species appear to have originated in the vicinity of Armenia. A further nine species of wheat (genus *Aegilops*) are recorded in Aremnia, including some wild varieties. A number of species of rye occur in Armenia (sub-species of *Secale cereale,* and wild relatives *S. vavilovii* and *S. montanum*, including 36 varieties). Barley cultivars (*Hordeum distichon, H. intermedium* and *H. vulgare*) are planted and a further eight wild species (with high intra-specfic diversity) occur naturally (including *H. sponteanum* and *H. bulbosum*).

- ***Pulses*** Native cultivars of runner beans (*Phaseolus*), lentils (*Lens*), garden pea (*Pisum*), and

broad bean (*Vicia*) are found in Armenia. In addition, wild relatives of lentils (2 species), chickpeas (*Cicer arietinum*; 2 varieties), and garden peas (3 species) are found.

- ***Fodder plants***. A range of fodder plants occur, mainly from two families – Fabaceae (among others *Medicago* (10 species / varieties), *Trifolium* (30), *Onobrychis* (6) and *Vicia* (36) and Poaceae (including species and varieties of *Agropyron, Arrhanuterum, Dactylis, Festuca, Lolium, Pleum,* and *Bromas*).

- ***Fruits and berries.*** Fruiting plants have been grown since ancient times, and a wide range of cultivated, wild and semi-wild forms are found today. These include apples (4 varieties), pears (17), whitebeam (10), hawthorns (11), plums (4), and almond trees (4). Species and varieties of peach, quince, walnut, pomegranate, melon and fig, are cultivated as well as varieties and species of the genera *Ribes* (includes blackcurrant), *Dospyros, Cerassus, Pistacia* (includes pistachio and turpentine), *Elaeagnus* (includes silverberry and oleaster) *Fragaria,* and *Rubus.*

- ***Vegetables and salad crops.*** As well as cultivated species, a number of wild crop species occur, including beetroot, spinach, carrots, coriander, mint, asparagus, and leek.

- ***Oil bearing plants.*** As well as cultivated crops the following wild species grow: flax hemp, camiline (false flax) mustard (several species), safflower, and poppies.

- ***Wild edible plants***. A wide range of plants have been collected from the wild since historical times, and some of these have since been brought into cultivation.

The conservation of the natural diversity found within wild populations and relatives of crops is an important issue. This is most likely to succeed in protected areas (reserves and reservations). In addition, ex-situ conservation takes place in nurseries, seedbanks, research laboratories and herbaria. Special collections and nurseries might also be established to help protect endemic varieties of cultivated plants.

4.1.3 Native breeds of livestock

Armenia appears to have been the source for a number of wild relatives of domestic livestock, including sheep. Recent studies suggest that the endemic Armenian mouflon (*Ovis orientalis gmelinii*) may be the ancestor of domestic sheep. In addition, the Kharabaghian race of horse appears to have derived from native wild horses of the Armenian Plateau. Armenia also appears to have been a centre for goat breeding, and endemic varieties of goat (such as Kilikian semifine-wool goat) have been described.

There is a long history of animal breeding in Armenia, with archeological studies showing the keeping of livestock since Neolithic times (including horses, cows, sheep and pigs). Cuneiform records from Urartu also indicate that all the main agricultural species in Armenia were also bred at that time. Further evidence for the history of livestock breeding comes from ancient Armenian chroniclers (3rd - 4th centuries AD). Since that period there is extensive evidence for artificial selection and the development of distinctive animal breeds in Armenia.

- The Causcasian breed of cow was derived from the crossing of native Caucasian, Lebedinian and Castroma varieties.

- Native varieties of domestic sheep derive from the Armenian mouflon, while the Armenian semicoarse-wool sheep derives from selective breeding of Balbas-American and Ramboulije-British Lincoln breeds. A range of sheep bearing semi-fine wool have also been developed through mixed breeding.
- The 'Armenian manufacturing pig' was developed from crosses of big white pigs, and Landras, Wales and Djurok breeds.
- 'Yerevan' chickens were developed from crossing Rhode Island, Austalorp and New Hampshire breeds.
- A native breed of rabbits ('Armenian marder') were bred from blue-coated rabbits crossed with Himalayan and chinchilla breeds.
- Buffaloes bred in Armenia were originally derived from the Asian water buffalo.
- In addition, coypu (originating in South America) have been bred in Armenia since 1940.

4.2 Current focuses for crop cultivation

A wide range of crops are grown today in Armenia, and given the importance of agriculture in the country, these species represent an important reserve of biological diversity, as well as sources of genetic resources for further artificial selection. Around 600,000 ha (20% of the overall land) has been cultivated - including 500,000 ha of arable lands and nearly 100,000 ha of perennial seed-plots. In 1996 approximately 335,000 ha of agricultural lands were under cultivation.

Cultivated plants include crops, fruit, vines etc. Crop plants are summarised in Table 4.1. In particular, arable land is an important component of land cover in Armenia, and grains grow at altitude between 375 and 2000m, and on slopes up to 16^0. Thus the overall area potentially available for arable production is 1.2 million ha (40% of the total land).

- **Vegetables and salad crops.** Armenia's climate is well suited to growing vegetables and salad crops. Those currently grown include: onion, cucumber, radish, garlic, cabbage, spinach, tomato, pepper, egg-plant, cauliflower, turnip, cress, parsley, dill, coriander, basil, mint, okra, marrow, pumpkin, and horseradish.

- **Fruit cultivation.** Apples and pears are generally grown at higher altitudes, while apricots and peaches are grown in the valleys; over 35% of the country's fruit orchards are concentrated in the Ararat valley.

- **Viniculture.** Vines cover around 3% of all agricultural lands, and are generally found in the valleys and foothills, where suitable soils are present. Land privatization has severely affected viniculture in Armenia, and some grape varieties may be lost as a result.

Table 4.1. Common crops in Armenia and their current distributions

Crop type	Examples	Distribution
Cereals	Wheat, barley, maze	Mainly in Shirak, Sevan basin, Zangezour, the Ararat valley
Pulses	Runner and broad bean, lentil, pea	Mainly on slopes (700-2000m); including slopes of Ararat valley, Vaijk, Shirak, and Sevan basin,.
Oil-yielding plants	Flax, geranium and sunflower	Mainly in Shirak, Zangezour, Armevir, and Echmiadzin.
Root crops	Sugar beet, fodder beet	Akhurian, Artic, Spitak and Amasia (sugar beet); coutrywide (fodder beet),
Tuber crops	Potatoes, (Jerusalem artichoke for fodder)	Country-wide
Alkaloid-bearing plants	Tobacco	North-east of Sevan basin, (areas reduced following land privatization)
Fodder grassplants	Alfalfa, clover, vetch etc.	Cover most of the agricultural (and pasture) lands

Armenia's independence following the break up of the former Soviet Union, led to changes in the distribution and ownership of land, with up to 99% of agricultural lands now being privatized, along with 79% of lands growing perennial crops and 63% of hayfields. A total of 88% of agricultural land is now in private ownership. Land privatization and economic changes have had important impacts on both the crops cultivated, the area of land cultivated and the productivity of land (as a result of changes in demand, pesticide use etc.). This is illustrated in Table 4.2.

4.3 Current focuses for livestock and animal breeding

Livestock breeding is widespread throughout Armenia, and hayfields and pastures represent almost 60% of all agricultural lands. Pastures of sub-alpine and steppe habitats are particularly important for cattle breeding, and thousands of hectares of high mountain pastures are used during summer. A wide range of animals are raised in Armenia, and these are listed below. However, there has been a general reduction in livestock numbers since the collapse of the Soviet Union and land privatization (Table 4.3).

- ***Cattle*** represent the most important type of livestock (over 50%), much of which represents dairy production, although cattle are also reared for meat (providing 37% of meat in the country); by-products include leather and manure. Cattle farming occurs throughout the country, but cattle populations have declined dramatically (> 40%) since 1986 (Table 4.3).

Table 4.2 Crop production in pre-privatization (1985) and post-privatization (1990, 1995) periods

Crop	1985		1990		1995	
	area (ha)	productivity (c/h)	Area (ha)	productivity (c/h)	area (ha)	productivity (c/h)
Cereals	135523	20.9	138164	19.6	205974	15.3
Maize	19000	215.4	2100	134.4	1552	131.6
Geranium	1018	224.5	576	111.9	87	45.7
Beet	5600	228.6	2600	203.0	490	203.4
Potato	19963	153.0	22413	95.0	38105	134.4
Tobacco	4768	28.3	739	22.4	677	24.2
Forage	257600	64.9	251200	54.1	126588	-
Fruit	53500	26.0	50000	42.8	29029	16.8
Grapes	32900	95.8	29100	58.3	24800	54.4
Vegetables	17968	339.0	17909	211.0	19170	213.7

- ***Sheep and goats*** are raised for wool, milk and meat across Armenia, and are often kept in mixed herds. However, numbers of both sheep and goats in the country have halved since 1986.

- ***Pigs*** have been raised in Armenia since 1965, and pig farming reached a peak in 1986 when populations totaled 344,000 head. Since then pig numbers have declined dramatically; pigs are now bred by both private and state farms.

- ***Poultry*** raised in Armenia include chickens, geese, ducks and turkeys, of which chickens are far the most popular, and are used as a source of eggs, meat and feathers. In addition, a number of farms breed quail for their meat and eggs. Poultry numbers have also declined dramatically, from 12 million in 1986 to 2 million in 1996.

- ***Horses*** were once an important livestock item, with approximately 42,000 horses being bred annually up to the 1940s. However, agricultural intensification and transport improvement reduced reliance on horses, and relatively few are now bred (c. 7,500).

- ***Rabbits*** are used as a source of food to supplement meat from other livestock. Rabbit numbers have also declined dramatically since 1986.

- ***Bees*** have been kept in Armenia since ancient times, for the production of honey and beeswax, and around 130,000 bee-hives were recorded in 1994.

- ***Wild animal farming*** has developed relatively recently, mainly for fur production. Species involved include: silver fox, marten, rabbit and coypu.

Livestock production was severely affected by the economic crisis and transition to a market economy in the years following the breakup of the Soviet Union. Previously, the agricultural sector supported around 75% of the total workforce, with over 80% of agricultural lands being in livestock production. This sector has now declined dramatically, and has been substantially restructured (Tables 4.3 and 4.4). Key reasons for post-privatization decline in this industry include low stocks of animal fodder and low prices for animal products.

Table 4.3 Changes in livestock numbers in Armenia (1985-1995)

Type of livestock	Numbers of livestock (thousands)			
	1986	1988	1990	1995
Cattle	861	834	690	500
Pigs	344	344	329	160
Sheep	1,872	1,703	1,277	1,060
Goats	30	27	15	19
Horses	7.7	7.5	6.3	9.0
Poultry	12,131	113,950	11,714	2,000
Rabbits	22	24	15	5
Bee-hives	100	141	136	130

Table 4.4 Post-privatization structural impacts on animal production (1993-94)

Category	Numbers of livestock (in thousands)				
	private farms	cooperative farms	collective / state farms	private plots	**TOTAL**
Cattle	166.7	177.8	15.3	139.1	498.9
Sheep and goats	460.3	202.7	22.4	187.7	873.1
Pigs	18.1	22.9	39.2	4.1	84.3

4.4 Wild species of economic importance

4.4.1 Use of wild plants

A wide range of wild plants are collected and used in Armenia, including:

- Over 200 wild plants are used for **food** in Armenia, and different species are eaten either fresh, cooked, pickled or dried. However, of around 300 edible mushroom species only 10 are regularly used by local people. Over-collection of some species (such as hornbeam, and foxtail lilies, *Eremurus* spp.) has resulted in population declines, and some species of edible plant are now relatively rare. Many other species (around 2000) are used as **fodder** plants for livestock (for example clover, alfalfa, and meadow foxtail).

- A number of **timber** species are used for fuel, construction, and carpentry. Key species include oak, beech, and hornbeam. A significant amount of wood was also used in the tin mining and smelting industry.

- Around 10% of plants in Armenia are thought to have some **medicinal value**, and have been used for traditional medicine for many years. Key medicinal plants include species of hawthorn (*Crataegus*), blackthorn (*Rhamnus*), juniper (*Juniperus*), barberries (*Berberis*), roses (*Rosa*), and St. John's wort (*Hypericum*). A further 120 species are known as a source for essential oils (such as *Thymus* spp., *Helichrysum* spp., and *Artemisia* spp.), and 130 for their high vitamin content.

- Around 300 plants are used for their **decorative value**, as a source of horticultural plants.

- Plants are also used in a range of other ways: for dyeing (120 species, including *Euphorbia, Rhamnus, Sambucus,* and *Rubia*); for tannin production (60 species); and for resin (around 60 species, including *Astragalus*).

4.4.2 Use of wild animals

The wildlife of Armenia is affected by a number of forms of use of wild animals, particularly hunting and fishing.

4.4.2.1 Hunting

Sport hunting is widely practised in Armenia, although there is little commercial hunting. In order to limit the impact on the environment, hunting is regulated through the use of a licensing system. At present, around 20,000 hunters are registered, and the Armenian Hunters Association ('Hayhuntunion') regulates hunting in compliance with the various rules and limits set by the Ministry of Nature Protection (Table 4.5). However, limited resources restrict the support that can be given to maintaining populations of game species. Although the Armenian Hunters Association still issues licences, its other activities (such as anti-poaching work and supplementary feeding of game species) have declined.

4.4.2.2 Fishing

Fishing in Armenia has long been of importance for both sport and commerce, and is allowed anywhere apart from protected areas. Lake Sevan supports extensive commercial fishing, representing 90% of fisheries. Following the decrease in the level of the lake, the key fish species caught have changed from Sevan trout and 'koghak' to whitefish and goldfish (see Table 4.6). Since 1996, commercial fishing in Lake Sevan has been based on licences and contracts issued through the Ministry of Nature Protection.

Table 4.5 Number of licences issued and used for different game species between 1994 and 1996

Species	1994		1995		1996	
	Licences granted	Licences realized	Licences granted	Licences realized	Licences granted	Licences realized
Snipe	120	112	180	137	297	199
female quail	942	521	-	-	3625	3060
Duck	723	449	-	-	2866	2210
quail and duck	-	-	1780	1611	-	-
Pigeon	-	-	80	27	509	509
Partridge	-	-	300	24	200	0
Hare	-	-	-	-	200	84

Table 4.6 Catches of commercial fish species in Lake Sevan (in tonnes, totaled over five-year periods)

Years	Whitefish (sig)	Sevan trout (ishkhan)	Koghak	Goldfish (tsatsan)	Barbel (beghlou)
1966-1970	2692	895	-	21.9	-
1971-1975	3840	317	796	-	7.8
1976-1980	4825	244	1375	-	0.04
1981-1985	6158	2.6	1273	-	-
1986-1990	8673	-	927	10	-
1991-1995	4529	-	148	386	-

4.4.2.3 Collection of animals for medicinal use

Snake vemon is used in traditional medicine to treat conditions such as epilepsy, haemophilia, cancer, and asthma. Snakes including the bluntnose viper (*Vipera lebetina)* and the Russian viper (*V. raddei)* are therefore collected for their venom, resulting in substantial declines in populations of these species (particularly *V. lebetina*).

Chapter 5. Landscapes and Ecosystems of Armenia

The variety in landscapes and altitudes within the country (Chapter 1) is an important determinant of biodiversity and its distribution in Armenia. As previously described altitudes in the country range up to 3000m, and six key landscape types have been identified (deserts, semi-deserts, steppes, forests, alpine and sub-alpine meadows). These landscapes are generally associated with particular altitude zones (Section 1.6). In addition, a series of azonal habitats (such as wetlands) are described. Each landscape represents a different ecosystem, with a distinctive group of associated plants and animals (Map 12). However, there are also some species that are found in different ecosystems. For example plants such as fescue (*Festuca sulcata*) are common in both steppe and meadow systems. Also, many animal species seasonally migrate between different habitats. For example, the greater horseshoe bat *Rhinolophus ferrumequinum* is found in steppes in summer, semi-deserts in autumn and forests during winter; Armenian mouflon traditionally moved from winter feeding grounds on the steppes up to sub-alpine meadows in summer. Brown bears are found in forest, steppes and meadows depending on the time of year.

The plants and animals associated with each main landscape type or ecosystem are described in more detail below. The distribution of different animal groups and species in relation to different landscape types is presented in the Annex (Annexes 4-9).

5.1 Deserts

True deserts only cover a small area of Armenia, and are mainly situated below 900m altitude in the Ararat Valley. The best studied desert system is that close to the town of Gorovan. The typical flora and fauna of these ecosystems are shown in Table 5.1. Deserts represent threatened habitats, and a number of endemic species would disappear if these habitats continue to decline.

Table 5.1 Description of fauna and flora associated with desert ecosystems, with some examples of typical or distinctive species

Group	Comments	Examples of distinctive species
Fungi		*Agaricus, Montagnea, Tulostoma, Disciseda.*
Higher plants	Most plants are specific to deserts and relatively rare throughout Armenia. Distinctive vegetation structure and composition is associated with saline and chalk substrates in the Ararat Valley	*Calligonum polygonoides, Achillea tenuifolia, Seidlitzia florida, Rhinopetalum fibbosum, Ceratocarpus arenrius, Salsola spp., Kalidium caspicum, Halostachys caspica, Halocnemum strobilaceum, Gypsophila spp., Halanthium rarifolium*
Invertebrates	Distinctive invertebrate fauna, including several endemic species (particularly at Gorovan)	*Pharaonus caucasicus, Cardiophorus araxicola, Sphenoptera khnzoriani, S. vediensis*

5.2 Semi-deserts

Semi-deserts (800-1200m) commonly support wormwoods such as *Artemisia fragrans* and *A. araxina*, and other associated plants and animals are shown in Table 5.2.

Table 5.2 Description of fauna and flora associated with semi-desert ecosystems, with some examples of typical or distinctive species

Group	Comments	Examples of distinctive species
Higher plants	Semi-deserts often covered by ephemeral plants in spring; xerophytes occur in these habitats (both plants and bushes); flowering vegetation occurs in some lowland sites	*Artemisia fraganas, A. araxina, Ceratocephala falcata, Anisantha tectorum, Capparis spinoza Zygophyllum fabago, Rhamnus catharticus*
Invertebrates	Many endemic invertebrate species. Invertebrates from different regions occur (including species of Mediterranean, Iranian, Caucasian and Crimean origin). Some of the same species occur in steppe habitats.	*Phytodrymadusa armeniaca, Nocarodes armenus, Dictyla subdola, Geotomus punctulatus, Amphicoma eichleri, Cantharis araxicola, Tomomyza araxana, Bombilius schelkovnikovi, Shadinia akramowskii, Gabbiella araxena, Pupilla bipapulata, Zodarion petrobium*
Amphibians		*Bufo viridis, Hyla arborea*
Reptiles	Some reptiles are specifically associated with small patches of desert habitat with xerophyte vegetation.	*Lacerta raddei, L.strigata, Ophisops elegans, Testudo graeca, Eumeces schneideri, Mabuya aurata, Elaphe hohenackeri. Telescopus fallax, Eryx jaculus, Vipera lebetina, Malpolon monspessulanus, , T.vermicularis, Eirenis quatorlineata, E. collaris, E. punctatolineatus, Phrynocephalus persicus, Eremias pleski, E. strauchii*
Birds	Over 50 species recorded in total	pheasant (*Phasianus colchicus*), black francolin (*Francolinus francolinus*), rufus wheatear (*Oenanthe xanthoprymna*)
Mammals	Desert and semi-desert mammals are found mainly in the south of the country	common vole, beech marten, fox, long-eared hedgehog, noctule bat, grey long-eared bat

5.3 Steppes

Mountain steppes represent the dominant ecosystem of Armenia, and occur throughout the country at altitudes between 1200 and 2000m (sometimes as high as 2500m). Vegetation cover is varied, but particularly important plants include fescue (*Festuca sulcata*) and feather grass (*Stipa* spp.). The flora and fauna of this ecosystem are described in Table 5.3.

Table 5.3 Description of fauna and flora associated with steppe ecosystems, with some examples of typical or distinctive species

Group	Comments	Examples of distinctive species
Fungi		*Pleurotus eryngii, Agaricus, Macrolepiota, Coprinus*
Higher plants		*Stipa lessingiana, S. pulcherrima, S. capillata, Festuca sulcata, F. ovina, Bothriocloa ischaemum, Agropyrum cristatum, Astragalus microcephalus, A. largus, Onobrychis cornuta, Bromopsis variegatum, Phleum phleoides, Koeleris cristata*
Invertebrates	Invertebrate diversity is low , but several rare and threatened species occur	*Bradyporus dilatatus, Montana armeniaca, Eumerus sogdianus, Bruchidius armeniacus, Cryptocephalus moravi*
Amphibians		*Bufo viridis, Rana ridibunda, R. macrocnemics*
Reptiles		*Lacerta armeniaca, L. dahli, L. valentini, L. nairensis, L. strigata, L. agilis, L. caucasica, L. apodus, Ophisiops elegans, Vipera erivanensis, V. raddei, Coronella austriaca, Eryx jaculus, Telescopus fallax, Natrix natrix, N. tessellata*
Birds	More than 30 species recorded	Mainly passerines and falcons
Mammals		Fox, wolf, coypu, marten, greater horseshoe bat, wild goat, Armenian mouflon, brown bear

5.4 Sub-Alpine and Alpine meadows

Meadows are typically found above 2000m altitude, and support a wide floral diversity (Table 5.4). Sub-alpine meadows often support a distinct assemblage of grasses, particularly in northern regions. Alpine meadows (over 2700 m) are rich in Poaceae (such as *Poa alpina*) and the carpet vegetation of such meadows represents an unusual and interesting habitat.

5.5 Forests

Almost all forests in Armenia are state-owned and the Government is responsible for forest conservation, management and planting. In most forests timber extraction is strictly prohibited, however such rules are often broken. Forest cover is relatively low in Armenia, with less that 10% of the land being forested. Armenian forests are predominantly broad-leaved (97%), and are dominated by oak, beech and hornbeam. Other species occasionally found in forests include juniper, pine and yew.

Forest habitats are typically found on mountain slopes between 500 and 2400m altitude, although beech and oak forests are typically concentrated at moderate altitudes (1300-

Table 5.4 Description of fauna and flora associated with meadow ecosystems, with some examples of typical or distinctive species

Group	Comments	Examples of distinctive species
Fungi	Cap mushrooms well represented (discomycetes and gasteromycetes)	*Helvella, Morchella, Peziza, Calvatia, Geastreem, Bovista,*
Higher plants		*Festuca varia, Poa longifolia, P. alpina, Phleum alpinum, Trifolium, Onobrychis transcaucasica, Dactylis glomerata, Festuca gigantea, Linum hypericigolium, Sibbaldia parviflora, Myosotis alpestris, Alchemilla, Carex*
Invertebrates	Distinctive invertebrate fauna with many national and regional (Caucasian) endemics	*Carobus stjeruvalli, C.tamsi, Dorcadion* spp., *Deltomerns khnzorian, Trechus armenus, T.dzermuhensis,* as well as *Bombus* spp., *Terymus auretus, Tricbia armenica*
Amphibians		*Rana macrocnemis, R. ridibunda, Bufo viridis*
Reptiles		*Vipera erivanensis, V.darevsky, Lacerta valentini, Coronella austriaca,*
Birds	Between 10 and 15 species recorded; many Red data Book species	Caspian snowcock (*Tetraogallus caspiusi*), choughs (*Pyrrhocorax graculus, P. pyrrhocoraxi*), Lammergeier (*Gypaetus barbatus*), accentors (*Prunella ocularis, P. collaris*), wallcreeper (*Tichodroma muraria*), snowfinch (*Montifringilla nivalis*)
Mammals	A total of 17 recorded mammal species	Rodents, including mice and voles.

1600m). A range of animals are associated with these forests, including brown bears and wild boar (Table 5.5). Four major forest types, and associated tree species, are described below:

- **Oak forests,** represent about a third of forest cover (c. 90,000 ha) and are widely distributed across the country. Of four oak species (*Quercus* spp.) found in Armenia, two (broad-leaved and Georgian oak) are typical of forests. Of these broad-leaved oak is the more frost tolerant species and is found throughout the country at altitudes as high as 2600m. In contrast, Georgian oak is typically restricted to altitudes between 500 and 1400m, and is typically found in the north and in Zangezour region. Other species which typically grow in oak forests are ash (*Fraxinus excelsior*), hornbeam (*Carpinus betulus*) Georgian maple (*Acer* sp.), cork elm (*Ulmus* sp.), and field maple (*Acer campestre*). A third oak species (Arax oak) is now declining as a result of climatic warming and human impacts.

- **Beech forests,** dominated by Oriental beech (*Fagus orientalis*), represent about a third of forest cover. The are widespread in northern Armenia, particularly on north-facing slopes at altitudes of 1000-2100m. Other species found in beech forests include Caucasian lime (*Tilia euchlora*), Litvinov beech (*Fagus* sp.) and spindle-tree (*Euonymus europaeus*), and substantial grass cover is supported in these forests.

- **Hornbeam forests** are less common than those of beech and oak, and occur at altitudes of 800-1800m. Other trees found in these forests include oak, field maple, common ash, Caucasian pear (*Pyrus* sp.), and Oriental apple (*Malus* sp.).

- **Dry scrub forests** are found in both north and south of the country occurring at altitudes of 900-1000m in the north, but at much higher altitude in the south (1800-2000m). These forests support around 80 species of xeric trees and shrubs, all of which are drought tolerant and light-loving. As well as thorn forests, dominated by juniper (*Juniperus* spp.), broad-leaved forests also occur (characterised by species such as pistachio (*Pistacia vera*), Georgian maple, and almond (*Prunus dulcis*), among others). A range of shrubs is also found in these forests, including buckthorn (*Rhamnus catharticus*), cherry (*Prunus* spp.), and jasmine (*Jasminium*).

Table 5.5 Description of fauna and flora associated with forest ecosystems, with some examples of typical or distinctive species

Group	Comments	Examples of distinctive species
Fungi	Many fungi supported in such habitats, including 757 species of cap mushrooms; 314 species are found in mixed deciduous forests and 266 have been identified in thorn forests	
Invertebrates	High diversity of invertebrates, including a quarter of beetle species recorded in the country; invertebrates of northern forests typically resemble those of Caucasian and European regions, whilst those of the south resemble Mediterranean and Iranian faunas.	*Ciddaria firmata, Bupalus piniarus, Ancylochira araratica, Salpingus castaneus, Hypoplhlocus pini*.
Mammals		Wild goat, wild boar, Persian squirrel, European mole, wood mouse, forest dormouse

5.6 Azonal

The main azonal ecosystems in Armenia are wetlands, with rich floristic diversity (see chapter 2). In addition to aquatic systems and marshlands, the vegetation of open rocks is also azonal, and different species are supported depending on the type of rock substrate. Species associated with wetlands include higher plants (*Astragalus, Acantholimon*, *Lonicera iberica, Rhamnus pallasii*, *Cerasus incana, Spirae hypericifolia*), invertebrates (*Lestes sponsa*, *Puella lunulata, Orthetrum cancellatum,Enochrus melanocephalus, Lymnaca stragnalis, Planorbis planorbis*), amphibians and reptiles (for example, the grass snake *Natrix natrix*) and mammals such as coypu, and water rat.

Chapter 6. Threats to, and Impacts on, Biodiversity in Armenia

While the importance of the biological resources of Armenia is clearly recognised, equally obvious are the threats to these resources. A variety of anthropogenic effects now threaten the plants, animals and ecosystems of Armenia, and increased population pressure is further increasing these impacts on biodiversity. Historically, low human population densities and regulated use of natural resources protected the balance of ecosystems. However, over the last 1000 years human impacts on the land have increased, mainly through deforestation and increased use of pastures. Such problems have intensified over recent years with unprecedented population growth and urbanization since 1920 (Table 6.1, 6.2). The rate of habitat modernization parallels those in Western countries, and exceeds those in the neighbouring countries (Turkey, Iran, Georgia and Azerbaijan). Even the important mountain areas of Armenia are suffering increased anthropogenic pressures.

Table 6.1 Increases in population and human impacts between 1920 and 1990.

Parameter	Factor of increase
Population	5-fold
Urban population	26-fold
Urban spread	14-fold
Industrial districts and centres	30-fold
Irrigated land area	3-fold
Cultivated land area	1.5-fold
Areas under construction (buildings, roads, streets, etc)	20-fold

Table 6.2. Some parameters of current population and human pressures in Armenia

Parameter	Total	Density (average)
Population	3.8 million	232 persons / km^2
Populated areas	980 settlements	6 settlements / $10km^2$
Road (rail and car) network	14 thousand km	0.85km / km^2

The biological resources of Armenia have undergone permanent change as a result of both internal and external factors. The most important threats to Armenian biodiversity include habitat loss and direct destruction of species, which have resulted in population declines in a number of plants and animals.

6.1 Habitat loss and modification

Anthropogenic impacts have affected a large proportion of Armenia, and have led to damage and destruction to natural habitats. Agricultural intensification has resulted in the loss of natural grasslands, and particularly of wetlands; over the last 50 years around 20,000 ha of marsh and wetland has been drained and converted to agricultural use. The effects of habitat loss or modification are also evident at a local scale, and a number of species (including plants and animals) have been affected by activities such as local deforestation, construction and road building. For example a small area of high floristic diversity close to Zvartnots temple has been destroyed following construction and industrial use close to the site, while around 180 species of desert plants that once occurred at a site near Goravan have now disappeared.

Habitat loss poses a particular threat to restricted range species, and those of semi-desert and mountain steppe habitat, many of which occur at the edge of their geographical range in Armenia. Changes in community composition, including decreasing species richness, are recorded in these habitats. The conversion of steppes and semi-deserts for agriculture over the last 50 years have also had important impacts on bird communities, with the disappearance of their natural habitats. Many bird species associated with such habitats are now listed as threatened in Armenia. There are also recorded population declines in reptiles from semi-desert areas, including the spur-thighed tortoise (*Testudo graeca*), toadhead agama (*Phrynocephalis persicus*), golden grass mabuya (*Mabuya aurata*), Caucasian sand boa (*Eryx jaculusi*), Montpellier snake (*Malpolon monspessulanus*), racerunners (*Eremias pleski* and *Eremias strauchii*), and the snake-eyed lizard (*Ophisops elegans*) from the Arax Valley. In addition, an important population of the regionally endemic sub-species of racerunner (*Eremias arguta transcaucasika*) has nearly disappeared from the Sevan basin as a result of agricultural land use, and only 100 individuals now remain within a single site. Similar declines are noted in the dwarf lizard *Lacerta parva*, another endemic which is now restricted to an area of 5km^2 near Spitak.

The decline in the level of Lake Sevan had significant impacts on a number of wetland habitats in the vicinity, which dried out. As a result a number of marshland species (including lizards, waders and mammals) have disappeared from that area. Other water bodies have also suffered anthopogenic impacts. The diversion of water from the Noravank gorge to provide a water supply to a nearby village resulted in the loss of habitat and eventual disappearance of the wildlife of the gorge, including invertebrates, amphibians, reptiles, and mammals, as well as the destruction of an area of natural beauty.

6.1.1 Forest loss in Armenia

Forests, like other habitats, represent a dynamic system, and forest cover in Armenia has undergone significant changes since ancient times, in both species composition and structure. However, the impact of man of the forests of the country is obvious. Archaeological data indicates that around 40% of the land was originally covered in trees, at altitude zones of 500-2000m (Map 13). Since then forest cover has been affected by both changes in climate and by anthropogenic impacts. Increased temperatures resulted in a shift in the altitude zones at which forests were found, with the upper tree line increasing as far as 2200m altitude in the north and 2600m in the south. However, anthropogenic impacts have had more extreme effects on forest habitats, which now represent only 10% of the land

surface (a quarter of the previous forest cover; Map 13), and are concentrated in the north-east of the country. A number of regions in Armenia are today totally deforested (Shirak, Armavir and Ararat), while others show very restricted tree cover (<1%; Vaik, Kotaik, and Gegharcunik).

A range of factors have increased pressures on forest resources, including a series of conflicts in the region which resulted in mass migrations of rural populations, and increased pressure on land for grazing and agriculture. Two major periods of timber extraction have occurred during this century. Between the 1930s and 1950s, around 450,000m^3 of wood was extracted annually from Armenian forests for industrial use. Although this extraction was supposed to occur through selective logging of post-mature and damaged trees, forest resources were decimated at this time, and most of the mature trees were removed (which accounts for the current lack of mature and post-mature forests stands in Armenia).

Extensive deforestation also took place between 1992-1995, during the period of economic blockade and energy crisis. A combination of poor forest management and illegal felling resulting in damage to around 27,000 ha of forest (more than 8% of the total forest area), and, of this area, around 7000 ha was totally cleared. The effects of the damage to forests are clear in changes in species composition and in the loss of forests on lower slopes. The effects of the energy crisis on forests were particularly severe in the vicinity of urban areas (such as the hills around Yerevan) where pressure for fuelwood resulted in clearance of such woodland, resulting both habitat loss, and increased erosion of soils on hillsides.

Extensive grazing of cattle and pigs in forest habitats in recent years has further contributed to degradation of forests, particularly through its effects on regeneration and understory vegetation.

6.2 Over-use of biological resources

In Armenia, both habitats and species have suffered from unregulated use. Although few figures are available, concern is expressed about the impacts of over-collection of wild plants and poaching of animals (see Chapter 4). Among species most at risk are plants of edible, medicinal or decorative use, and over-collection of such species has affected the semi-deserts, steppes and meadows in which they occur. Among animals, snakes have suffered over-collection for their venom, while the Armenian mouflon has suffered from poaching in the past. Habitats, particularly pasturelands, have also suffered degradation through over-use.

6.2.1 Overgrazing of grasslands and pastures

Anthropogenic factors have severely affected the pasturelands of Armenia, and a large proportion of grasslands have deteriorated in quality. Management of these lands has been poor to date, leading to substantial declines in areas suitable for grazing. Over-grazing has resulted in land erosion, formation of boggy areas and reduction in plant diversity. The area of natural pasture land has declined from 1.4 million ha in 1940 to 808,000 ha today, and remaining areas have been degraded and have become dominated by rocks (87%), scrub (25%), and inedible (74%) or poisonous plants (47%), while diversity has declined. For example, while between 100 and 700 plant species are normally supported by steppe systems, the number of species found after intensive over-grazing drops to around 15.

Similar declines in richness are reported in meadow systems (from 125 to around 25 after over-grazing). Over-grazing has also resulted in changes in species composition, with declines in populations of valuable fodder plants and increases in weeds and poisonous species (such as crowfoot, thistle, creeping thistle, as well as *Euphorbia sequieriana*, and *Astragalus* spp.). In addition the over-collection of particular species for human consumption from natural pastures has pushed these species to the edge of extinction.

Changes in grazing regimes post-privatization have led to decreases in floristic diversity in some areas where grazing has declined, but more importantly increased habitat degradation in over-grazed areas. Privatization led to complex problems of access to, and use of, common grazing lands, and consequently the use of natural pastures and hay meadows has declined substantially since then. Over 60% of hay meadows have now been privatized, while pastures are used on a lease basis. Despite the declines in livestock populations since privatization, over use of remaining pastures is still an important problem. Although grazing has been reduced in the highlands (alpine and upper sub-alpine meadows), a two- to three-fold increase in grazing pressure has been recorded in lowland sub-alpine meadows and steppes. The likely intensification of livestock grazing with economic recovery, coupled with the current lack of regulation, means that the issue of over-use of pastures is likely to grow in importance over the coming years. Regulation will be essential to ensure that natural grasslands remain areas where traditional grazing practices can coexist with the protection of natural communities and their inherent genetic diversity.

6.3 Pollution

Pollution is a major issue in Armenia, involving not just current emissions, but the legacy from pollution during the Soviet era. Sources of pollution include industrial centres, mining enterprises, chemical and power plants, and vehicle emissions.

Prior to economic crisis substantial pollution was produced by the country's industrial centres, totaling around 245,000 tonnes annually (54,400 tonnes of solid particles and 190,900 tonnes of liquid or gaseous emissions). This included around 50 different pollutants, including sulphate anhydride (58%), nitric oxides (15%) and oxides of carbon (14%). At present only a small proportion of industries remain operational (10-30%), and emissions of pollutants have dropped dramatically to 15,000-20,000 tonnes per year. However, pollution continues to have negative impacts on both natural ecosystems and agricultural lands in the country. Nitrogen-containing compounds (ammonia, nitric oxides) released from the Vanadzor chemical plant have affected up to 22% of surrounding forests (703.7 ha within a 5km radius). The emission of flourides and chlorides from the 'Narit' Reseach Association has resulted in direct damage to crops within a 2km radius and reductions in productivity and quality.

Of great concern is the continued release of toxic waste, including heavy metals (annual outputs in 1980 were equivalent to 18,000 tonnes), and the effects of this pollution are still evident. For example, heavy metal levels in crops around the Alaverdi metallurgical plant are between 20 and 40 times above the maximum allowable level.

Substantial amounts of accumulated industrial waste exist in the country, mainly as a result of mining (estimated as hundreds of millions of cubic metres of waste). Even during the current period of reduced industrial outputs, almost 300,000m^3 of industrial waste (including slag) was produced by mining operations in 1996 alone. A number of tailings from extractive and processing operations remain in the country, totaling around 220 million m^3 (including 30 million m^3 from Zangezour copper-molybdenum plant, 12 million m^3 from Ararat gold refinery, and 3 million m^3 from the now closed Dastakert copper-molybdenum plant). There is a particular risk of pollutants from these tailings leaching into water systems.

Industrial and mining operations have had a significant impact on water systems of the country. The release of polluted water and industrial effluent directly into some rivers has resulted in widespread loss of natural vegetation and animal life (for example, the lower stream of the River Debed, and the basin of the River Voghji have been affected in this way). Natural ecosystems are affected by both chemical and thermal pollution from industrial plants, and polluted water is also finding its way into irrigation systems, thus affecting agriculture and threatening human health.

Vehicle emissions are a major contributor to pollution in Armenia, representing 94% of total emissions (an increase from 67% of emissions in 1987). In particular, exhaust fumes contain oxides of nitrogen and carbon (Table 6.3), which contribute both to local pollution of natural ecosystems, and to global warming. At present laws regulate several pollutants in vehicle emissions, however overall assessments of pollution from road transport are difficult to quantify accurately from the data available. However, it is clear that pollution level dropped significantly during the energy crisis in the early 1990s, but have now risen dramatically again (Table 6.3).

Table 6.3 Vehicle emissions of various pollutants, 1987-1995

Pollutant	**Emission levels (thousand tonnes)**								
	1987	1988	1989	1990	1991	1992	1993	1994	1995
Nitrogen oxide	23.3	23.8	24.9	23.5	20.9	11.7	8.8	7.9	9.5
Carbon oxide	389.3	392.6	381.3	287.5	349.4	187.8	142.2	126.4	171.9
Hydrocarbons	76.6	75.7	74.0	72.4	62.4	29.6	19.4	16.9	23.1
Total	**486.2**	**492.1**	**480.2**	**383.5**	**432.7**	**229.0**	**170.5**	**151.1**	**204.5**

6.4 Introduced and invasive species

A range of species have been introduced to Armenia. Many of these are of commercial value and are maintained within controlled conditions. However, other species, with high ecological adaptiveness, have expanded their ranges to the detriment of native species. The impacts of such species, and their success in entering new ecosystems, is dependent on their morphology, ecology and behaviour.

Most introductions were non-accidental, and include species with economic (agricultural, fisheries, hunting, medical, or technical) or aesthetic value. For instance, American and Canadian poplars have been imported to grow on saline lands, pink geranium is grown for its essential oil, and sweet flag (*Acorus*) from India and China, has been grown since Medieval times. However, a number of species appear to have been introduced accidentally, and many of these prove damaging to both natural ecosystems and agricultural lands (such as Colorado beetles, and Asian grasshopper). Among the most aggressive invasive plant species are *Xanthium, Cirsium,* and *Galinsoga parviflora*, while wormwood ambrosia (*Ambrosia artemisiefolia*) has expanded its distribution by over 200km^2 within the last decade.

Armenia's fisheries have been supported by the introduction of a range of fish species since the 1920s (see Section 2.5.2), and such species now represent the most productive fish in Lake Sevan. However, their interaction with native fish is not well understood. However, the introduction of goldfish (*Carassius auratus*) to the lake resulted in increasing populations, and high levels of competition with native fish species. River crayfish have also spread dramatically in Lake Sevan since their introduction in the 1980s.

Other species that have become naturalised to Armenia include pheasant (*Phasianus colchicus*) which is bred in Khosrov reserve and coypu (*Myocastor coypus*) which have expanded their distribution since 1940, and are now found in most marshlands of the Kur and Arax rivers.

6.5 Climate change

It is predicted that, as a result of global warming, the average temperature in Armenia will rise by 2-3ºC, and rainfall will decrease by 10-15%, within the next 50-100 years. This further aridization of the climate is likely to affect vegetation, particularly those species least tolerant to drought. In addition, the area covered by alpine and sub-alpine meadows is likely to decline. In contrast, an expansion of semi-desert habitats is predicted, along with a new zone of true desert in the Ararat Valley, and a number of rare plants and animals associated with this habitat will become threatened. Wetland systems will be particularly affected, and many saline marshes are likely to disappear, along with their associated species. Therefore predicted global warming, based on current levels of greenhouse gas emissions, would have dramatic and long-term effects on the biodiversity of Armenia, and is likely to lead to the loss of a number of rare and endemic species.

6.6 Sectors affecting biodiversity

A wide range of sectors in Armenia either use or affect biodiversity, directly or indirectly. These include the agriculture, forestry, industry, energy, transport, and tourism sectors, and the way in which each impacts biological resources is explained below.

6.6.1 Agriculture

Agriculture remains the largest sector in Armenia. More than half the total land is devoted to agricultural or forestry use, and agricultural use in lowland areas is as high as 80-90% of the land. Agriculture impacts biodiversity in a number of ways:

- habitat change and destruction of natural ecosystems;
- over-grazing (affecting vegetation composition of pastures);
- land degradation (including compaction of soils and increased salinity) and reduction in productivity;
- pesticide use and soil pollution;
- soil erosion (and increased risks of landslides);
- pollution of water sources;
- increased spread of disease through livestock populations.

The effects of over-grazing have been discussed above (Section 6.2.1), along with its impacts on alpine and sub-alpine meadows, forests, and steppes. Another impact of such grazing has been increased erosion and soil compaction, and increased loss of organic compounds from soils, particularly on mountain slopes. In addition, major centralised livestock breeding centres also affect biodiversity through the effects of their construction, and through impacts on water resources through over-use by livestock. The concentration of livestock at limited watering sites, not only results in competition for water with wildlife, but also increases the risks of disease transmission, among livestock, wildlife and humans.

Although privatization of agricultural land in Armenia represents an important change for farmers, it may have significant adverse impacts on natural resources. Prior to 1992 over 75% of agricultural land was used by state or collective farms, however post-privatization the land has been divided between 130,000 farms, as well as a number of non-agricultural organisations. Privatization and land ownership has resulted in new legal and social conditions relating to land use, and in the absence of effective state regulation this may result in increased degradation of newly privatized lands, along with further reductions in productivity given the lack of environmental guidance in sustainable land use. Poor land management is likely to affect not just natural ecosystems but also the productivity of the land and the levels of pollution from chemical applications. In some areas unregulated land use may greatly increase the risk of desertification.

6.6.2 Forestry

The extent of forest use and deforestation in Armenia, as a result of timber extraction, grazing, industrial use, and fuel requirements during the energy crisis, have already been described (Section 6.1.1). Loss of forests has a number of effects on biodiversity and natural ecosystems:

- loss and change of forest habitats;
- increased erosion with loss of tree cover;
- increased silting and eutrophication of water bodies;
- collapse of natural hydrological systems associated with forests;
- gradual forest succession as a result of changed water balance (from primary forest, to secondary growth, to scrubland and eventually to desert).

Evidence of the degradation of forest habitats, and further knock-on effects, are relatively widespread in Armenia. Such processes are clearly demonstrated in the Lake Sevan basin, where forest degradation has resulted in increased soil erosion, which has in turn contributed to siltation and euthrophication of the lake and surrounding rivers.

6.6.3 Industry

Extensive industrial growth took place in Armenia between the 1920s and the 1980s, with the development of more than 200 industrial sites, including a number of gigantic industrial plants, at altitudes up to 2000m. Industrial growth relied on extensive use of the natural resources of the country, with little environmental regulation. Industrial development therefore had significant effects on the ecosystems and biodiversity of the country, including:

- habitat loss as a result of construction;
- degradation of natural habitats;
- pollution of soils, water and air.

Within Armenia, metallurgical and chemical industries were particularly important, but represented major polluters of the environment, releasing dangerous substances into the air and into water systems. Despite industrial decline, pollution continues from four remaining plants, and from stored industrial waste and tailings. In addition, cement works pose a danger to the environment, through the widespread emission of dust, which affects natural habitats. The cement works are not currently operational, however economic revival may lead to the recovery of this industry and thus increased pollution from this source.

Figures in 1997 indicated that over 130 mining enterprises existed in Armenia, of which all but four involved open-cast mining. Mining operations affect an area of 9,700 ha, including 8,275 ha which have undergone direct disturbance, and 1,400 ha covered by tailings or slag. Many mines are situated at relatively high altitudes (including copper and gold mines at between 2000 and 2500m), and thus represent a direct threat to fragile mountain ecosystems, and also affect lowland habitats downstream from such mines.

Mining affects the biodiversity of the country as a result of:

- large scale habitat destruction through open-cast mining;
- impacts of tailings and other deposits on ecosystems;
- pollution of rivers and groundwater.

6.6.4 Construction

Construction work has increased dramatically in Armenia over the last half century, in line with industrial development and human population growth. Around 90 000 ha, or 3% of the total land is now covered by urban or industrial construction. Such areas support few species and construction affects biodiversity directly, through the complete destruction of natural habitats. In addition, areas in the vicinity of construction work are affected by habitat degradation and by long-term damage with construction wastes that are not properly removed.

6.6.5 Energy

A total of 19 major power plants have been constructed in Armenia, including four hydroelectric power stations and one nuclear power station. In total the power plants cover around 250,000 ha, but hydro-electric plants are also supported by a network of channels, tunnels and reservoirs. In addition, high voltage power lines are widespread throughout the country, totaling 2980km in length, and are found in many natural landscape types (including forests, steppes, and meadows).

The impacts of the energy sector on biodiversity have become clear since the 1950s. At that time the development of hydroelectric power plants on the River Hrazdan, and increases to the depth of that river, led to increasing outflow from Lake Sevan, and consequent declines in its level by 18-19 m. The declines had substantial effects on the lake and its biodiversity, including changes in chemical balance, loss of species and eutrophication (Section 1.4.1). Hydro-electric plants also affect biodiversity locally, within the rivers on which they were built. Effects include changes in biodiversity both in feeder channels and downstream of outlets, and in artificial reservoirs designed to regulate flow. Changes in water flow have also resulted in aridization of some areas where water has been channeled off for use by the power plant.

In general, all forms of power station (hydro-electric, thermal and nuclear) affect biodiversity in some way, as does the electrical transmission network across the whole country:

- thermal pollution (including of water used as a coolant) and air pollution (particulate and gaseous);
- effects of construction of power plants on the site;
- local changes in vegetation in the vicinity of power plants;
- local habitat disruption through the erection of high voltage power lines (particularly on mountain steppes where vast areas of forest have been felled to erect such lines);
- there is some indication that the electromagnetic field from power lines may lead to changes in the vegetational and faunal composition in the direct vicinity.

6.6.6 Transport

The transport system in Armenia is extensive, covering 800km of rail track and 13,000km of roads (of which 12,000km is tarmac road). Transport systems affect biodiversity in a number of ways:

- destruction of natural habitats during construction;
- degradation of surrounding habitats;
- pollution (local and air pollution);
- barrier to dispersal resulting in fragmentation of populations;
- direct mortality of wildlife.

The direct degradation of habitats on the verges of roads is a major problem, since efforts have been made to mitigate impacts through habitat enhancement (tree planting, etc.). A greater issue has been the destruction caused by off-road vehicles (four-wheel drives and caterpillar trucks), particularly in alpine and sub-alpine meadows. There is increasing vehicle use and road development in these fragile environments, resulting in destruction of vegetation and soil, and increased erosion and water run-off.

6.6.7 Tourism and recreation

The landscapes and biodiversity of Armenia have been a focus for tourism and recreation use over a number of decades, but this has intensified significantly over the last few years. By the end of the 1980s over 110 sanatoria and guest houses were operating, supporting more that 600,000 customers. In addition 200 summer camps for children existed, and 30 tourist centres, with 6000 places, were operational, along with around 10 tour routes. In the last few years recreational activities have increased dramatically, however many are improperly managed and result in damage to biodiversity and to natural sites. Up to 100,000 visitors a year have been reported at some sites. Damage includes:

- direct destruction of vegetation;
- trampling;
- littering.

There is a need to regulate tourism and ensure it develops in a controlled manner in order to minimise damage to the environment. Key to this will be effective public awareness and education programmes aimed at the population (particularly young people), and eventually at foreign visitors, to ensure increased awareness of, and responsibility towards, the environment.

Chapter 7. Existing measures for biodiversity conservation

7.1 Protected areas

A network of specially protected areas was first established in Armenia in 1958 to protect ecosystems, habitats and rare, endemic and threatened species. There are currently five State Reserves, 22 State Reservations and one national park registered, which together cover around 311,000 ha, or 10% of the surface of the country. Around 60% of Armenian species are represented within the protected area network, however there is a bias towards forest habitats, and a need to expand the system to include better representation of other ecosystems.

7.1.1 Reserves

State Reserves are established to provide high levels of protection for important habitats and species, and human use within reserves is restricted to scientific research. State Reserves therefore represent strict nature reserves, with respect to IUCN criteria. The Ministry of Nature Protection has overall responsibility for State Reserves, and manages two reserves (Erebuni and Sev Lich). Three more reserves (Dilijan, Shikahogh and Khosrov) are managed by 'Hayantar' State Enterprise (under the authority of the Ministry of Nature Protection). An outline of the five reserves, and their focal habitats and species is shown in Table 7.1.

A number of problems linked to design and effectiveness of protection affect the State Reserves.

- **Use by local people**. Despite their designation as strictly protected areas, local communities have become established in a number of reserves (including Khosrov, Dilijan, and Shikahogh). Activities such as tree-cutting, poaching, grazing and plant collection by surrounding communities affect most reserves (including Khosrov, and Dilijan). A law developed in 1985 to exclude communities from the reserve and reclaim the appropriated lands has not been enforced to date. The effects of the energy crisis in the early 1990s led to increased pressure on forested areas in reserves – for example, 4000 ha within Dilijan reserve was felled, mainly around settlements within the reserve. Erebuni also suffers from being close to urban areas. The lack of effective buffer zones for reserves is an important issue when considering the needs for multiple land use in these areas.

- **Lack of resources.** The lack of equipment and financial resources substantially affect the effectiveness of protection activities, particularly through the inability to regularly patrol the reserve and regulate poaching and other illegal activities. Reduced staffing and low wages for park staff are also major constraints to effective protection, particularly in Dilijan reserve. Shikahogh reserve urgently requires staff training, as well as financial and technical assistance.

Table 7.1. State reserves of Armenia, showing key statistics and details of habitats and species protected by each area

Reservation	Established	Area (ha)	Location	Altitude	Focal species and habitats
Khosrov Reserve	1958	29,196	South-facing slopes of Geghama mountains, the north-west ranges of Urts and Yeranos mountains, the basins of Azat and Khosrov rivers	1400-2250m	Dry scrub forests and semi-desert habitats; relict species of flora and fauna of Central Armenia; juniper, oak and scrub forests represented; 1800 plant species recorded (representing more than 50% of the Armenian flora) and including 146 RDB species; plants include wild relatives of crops, fruit trees and cereals; many arthropods (scorpions and mites) and crustaceans (*Daphnia, Cyclops)* recorded; 142 bird species (including 66 RDB species) and 55 mammal species (including brown bear, wild boar, wild cat, Armenian mouflon, lynx, wild goat, wolf, fox, and leopard) have been recorded.
Dilijan Reserve	1958	29,000	Northern Armenia; slopes of Pambak, Aregouni, Miapor, and Gougarats ranges, basins of Aghstev and Getik rivers	1000-2300m	Forest habitats, including beech, oak and yew; rare forest animals; natural monuments of historical and architectural importance; 900 plant species recorded (35 RDB species) including orchids, iris, fritillaries, peat moss, Cornelian cherry, barberry, tulips, *Dactylorhiza iberica, Epipactis, Epipogium aphyllum, Lilium armenum, L. szovitsianum,* and *Gladiolus;* fauna includes fish (trout, bsrbel and whitefish), four amphibian species, 13 reptiles, 147 birds (including two threatened species - Caucasian grouse and Caspian snowcock) and 43 mammal species (including Caucasian mole, badger, weasel, beech marten, lynx, wild cat, squirrel, wild boar, roe deer, and otter).
Shikahogh Reserve	1958	10,000	Southern Armenia, the basin of the rivers Tsav and Shikahogh	700-2400m	Forest habitats including oak, hornbeam, yew, oriental beech, and walnut groves; about 70 RDB plant species; relict plants include *Ophioalossum vulgatum, Pteridium creticum, Coronaria coriacea, Galanthus transcaucasicus;* orchids, iris, poppy, meadow-saffron; endemics include zangezour pear, wild strawberry, tulips, Saint-John's wort, and *Astragalus zangezouri*; fauna include: reptiles (yellow-bellied snake, grass-snake); birds (turtle-dove, hoopoe, bluethroat, Scops owl, long-eared owl, grouse, griffon vulture and black vulture); mammals include badger, hare, coypu, wild cat, chamois, wolf, fox, hedgehog, greater horseshoe bat, wild boar, brown bear, lynx, leopard, wild goat and moufflon.

Reservation	Established	Area (ha)	Location	Altitude	Focal species and habitats
Erebuni Reserve	1981	89	Slopes above River Arax, in the vicinity of Yerevan		Dry mountain steppes and semi-deserts; mountain xerophyte habitats; 293 plant species represented including wild relatives of cereal crops (*Aegilops cylindrica*, *Secale vavilovii*, *Triticum araraticum*, *T. boeoticum*, and *T. urartu*); rare and endangered plants (*Iris reticulata*, *Rhizocephalus orientalis*, *Hohenackeria excapa* and *Cundelia tournefortii*); fauna include amphibians (*Rana ridibunda*, *Bufo viridis*, *Hyla savigni*), 17 reptile species (*Vipera lebetina*, *Malpolon monspesscullanus*, *Mabuya aurata*, and *Eumeces schneideri*), 50 species of birds (including quail, partridge, turtle dove, falcons, harriers, and little owl); mammals include fox, weasel, marten, wolf and badger.
Sev Lich Reserve	1987	240	Foothills of Mets Ishkhanasar (volcanic highlands of Sjunik); borders Azerbaijan	2666 m	Lake basin of volcanic origin and adjacent natural habitats; poor vegetation cover as includes large water surface; many rare and endemic species grow close to its edges; meadow vegetation including 102 plant species; Sevan trout has been introduced to the lake

- **Lack of complete gazettement**. Until recently Shikahogh Reserve had not been formally gazetted or managed, and the park existed only on paper, without formal legal status. No staff were in place for management, research or support activities. A management unit was established in 1998, but this still lacks financial resources and suffers from a weak technical base, and the reserve has not yet been fully demarcated.

- **Poor reserve design**. Although Khosrov reserve is among the best protected, it suffers from being divided into eight separate sections, the borders of which do not take account of local topography and landscapes. The migration routes of many species have not been taken into account in the design of the reserve (including routes for mouflon, leopard and wild goats), and the location of water resources has not been considered in relation to the position of the reserve. A number of key habitats close to the reserve are not included within its boundaries. Shikahogh reserve does not incorporate the important Tsav plane grove, which needs special protection.

- **Lack of knowledge.** Financial restrictions have limited the amount of research and inventory work done in reserves, which in turn has affected the efficiency of management and the monitoring of biodiversity. Khosrov reserve has been relatively well studied, but financial cuts have restricted scientific work in recent years. No survey work has been conducted in Dilijan for several years, and little research has been conducted at either Shikahogh or Sev Lich reserves.

7.1.2 Reservations

State Reservations were established to protect a range of rare and important habitats and species in Armenia, and to improve the balance between economic use and nature protection in the country. In reservations, some economic activities are allowed, although these are expected to be regulated to prevent ecological damage. Most reservations are managed by 'Hayantar' State Enterprise, but some are under the jurisdiction of the Ministry of Nature Protection and Ministry of Agriculture, and one is managed by the National Academy of Science. Details of the 22 reservations in Armenia are shown in Table 7.2.

Reservations suffer many of the same problems as reserves, particularly in relation to over-use of biological resources.

- **Tree-cutting.** Removal of trees is a clear problem in a number of reservations including those designed to protect Tsav plane grove, Juniper scrub forests, (where forest has become thinned and regeneration is limited), Gjulakari grove, Pine Banksi, Ijevan, Gandzakar - Verin Aghda and rosebay scrub forests.

- **Overgrazing.** Illegal use of pasture land within reservations has affected a number of areas including those designed to protect Aragats alpine forests, rosebay scrub forests and Vordan karmir.

- **Other activities.** Some areas have also been affected by other activities, including sand extraction (Goravan sandlands) and road construction (Gandzakar - Verin Aghdan).

Table 7.2. State reservations of Armenia, showing key statistics and details of habitats and species protected by each area

Reservation	Established	Area (ha)	Location	Altitude	Focal species and habitats
Akhnabad Yew Grove	1958	2500	North-east Armenia (Miapor range, basin of River Getik)	1400-1800m	Relict and unique yew (*Taxus baccata*) grove (280-450 years old)
Tsav Plane Grove	1958	60	Southern Armenia, between rivers of Tsav and Shikahogh (grove extends into Azerbaijan)	700-800m	Natural grove of plane (*Platanus orientalis*); other plants (*Juglans regia, Periploca graeca, Hedera helix*)
Hazel	1958	4000	Northern Armenia; basin of River Khachaghbur (Ijevan range), Tavush region	700-800m	Hazel (*Corylus colur*) and yew groves; oriental beech; rare fern species
Juniper thin forests	1958	3310	Southern slopes of Areguni and Sevan ranges		Relict juniper scrub forests, including *Juniperus polycarpos, J. foetidissima, J. sabina*, and *J. oblonga.*
Rose bay forests	1959	1000	Northern Armenia, slopes of Pambak, Tsaghkuniats, Areguni and Sevan ranges	1900-2200m	Relict shrub species such as *Rhodendron caucasicum;* rare plants (family Ericaceae).
Aragats alpine forests	1959	300	The highest parts of Mount Aragats	3200-3500m	A glacial lake (Kare), and adjacent meadows; rare and relict plant species (*Ranunculus aragatsii, Galium sosnovskyu, Delphinium foetidum* and others).
Meadows and valleys	1959	5000	Northern Armenia, north-facing slopes of basin of Pambak river	1900-2200m	Fauna: roe deer, brown bear, and Caucasian grouse

Reservation	Established	Area (ha)	Location	Altitude	Focal species and habitats
Gjulakari grove	1958	2590	Valley of Karhank-djur river (Bazoum range)	1300-1850m	Relict pine forests (130-150 years old); other trees including hornbeam, maple, Eastern oak and beech are found. Rare plants including *Platanthera chlorantha*, and others are recorded from this site.
Goravan sandlands	1958	200	Ararat basin, by River Verdi, on the edge of Urts range, (close to Khosrov Reserve)	1100-1200m	Sandy desert habitat and associated vegetation, including some threatened species (*Astragalus paradoxus, Calligoium polygonoides, Rhinopetalum gibbosum*, and *Leontice armena*)
Pine Banksi	1958	400	North facing slopes of River Marmarik basin (Tsaghkuniats range)	1800-2000m	Pine (*Pinus banksiana*) grove
Herher	1958	6140	The basin of the River Herher	1600-1800m	Xerophyte vegetation; Juniper scrub forests.
Jermouk mineral waters	1958	3865	River Arpa, Vaik region	2000-2500m	Oak forests; containing *Quercus macranthera*, and a number of endemic and rare tree species; animals including Armenian mouflon, wild goat, leopard and boar.
Jermouk	1983	7000	River Arpa, Vaik region		Source basins of warm mineral waters
Arzakan and Meghradzor	1971	14500	Basin of Daralik and Maralik rivers, Kotayk region;	1600-2100m	Forest and gorge; animals including roe deer, brown bear; *Lururus mlokosiewicsi*; rare and threatened species (*Ophioglossum vulgatum, Nectaroscordum tripedale*).

Reservation	Established	Area (ha)	Location	Altitude	Focal species and habitats
Ijevan	1971	7800	Northern Armenia, basin of River Aghstev (Ijevan range)	900-2100m	Forest animals.
Gandzakar /Verin aghdan	1971	6800	Northern Armenia; Rivers Paitadjour and Aghstev		Forest animals
Getik	1971	6000	North-eastern Armenia; basin of River Getik	1500-2700	Forest animals.
Yeghegnadzor	1971	4200	Northern Armenia, Vajk region; rivers Yeghegis and Arpa	1200-2800m	Local fauna; flora including rare and endemic species (*Smyrniopsis armena, Centaurea arpensis, C. phaeopappoides,* and *Arrhenatherum kotschyi*)
Hanakavan	1981	3400	Upper stream of River Marmarik (Tsaghkunjats range)		Source for mineral waters.
Vordan karmir	1987	200	In the Ararat valley, between the villages of Argavand, Arazap and Sovetakan		Saline desert habitat supporting plants such as *Nitraria schoberi, Kalidium caspicum, Halostachys caspica,* and *Tamarix smyrnesis*; a cereal plant (*Aeluropus littralis*) supports an endemic insect (*Porphyrophora hamelii*) which is the source of a red pigment (karmin).
Boghakari.	1989	2790	Zangezour mountain range; Syunik region	1400-2100m	Sparse oak forests; a number of rare and endemic plants *Tulipa sosnovskyi, Fritillaria kurdica, Quercus araxina, Allium paradoxum, Gagea lutea* and orchid species. Local endemics include *Scrophularia takhtajianii.*
Goris		1900	Southern Armenia (Zangezour); basin of rivers Vorotan and Vararakn	1400-2800m	Habitats for a range of animals (roe deer, brown bear, wild boar); rare plant species (*Phasianus colchicus, Punica granatum, Ficus carica, Iris paradoxa, I. grossgaimi, Centaurea lenzeoides*, and *Allium* spp.).

- **Design of reservations**. For some reservations area designation appears to have proceeded without full scientific consideration, and does not take account of either topographical or ecological factors.

7.1.3 National Parks

The only National Park in Armenia was established in 1978 to protect Lake Sevan and the surrounding areas. Overall, including buffer zones, 150,100 ha are protected, including 24,800 ha of dry land. Sevan National Park falls under the jurisdiction of the Ministry of Nature Protection, and is managed as a research centre, which monitors the ecosystems, and undertakes various conservation measures (including regulation of use and tourism, and protection of historical and cultural monuments). Licensed fishing on the lake is also regulated.

Three main zoning areas exist: the core (reserve) zone, a recreation zone and a zone for economic use. The core protection zone includes the watershed for the lake, and the park also incorporates a number of smaller reserves and reservations. One of the key sites in the park is the Artanish peninsula (25,000 ha), which, being very isolated, is relatively undisturbed. Around 1000 higher plant species (including 94 trees and shrubs) are found in this area, which also supports a range of endemic and rare animal species. Three main zones are recognised within the Artanish peninsula, including the lakeshore habitats (planted forests containing pine, poplar, apricot-tree, oleaster, and sea-buckthorn), a medium altitude zone (20-100m) where species such as juniper and rose are common, and an alpine zone (> 100m) dominated by meadow habitats. However, the first two zones were severely affected by illegal felling during the energy crisis.

Protection is aimed at the rare and endemic species of the lake and surrounding habitats. The diversity of habitats and conditions in the area support a wide range of plants and animals, including:

- Plants - including *Acantholimon gabrieljanae, Astragalus goktschaicus, Isatis sevangensis, Sorbus luristanica, S. hajastanica,* and *Adonis wolgensis*
- Fish - nine species, including whitefish, Sevan trout, barbel, 'kogak' and carp.
- amphibians - six species including the green toad (*Bufo viridis*) and a frog (*Rana ichchani*);
- Reptiles - 17 species including rock lizards (*Lacerta unisexualis, L. nairensis, L. rostombekovi, L. armeniaca*) and snakes (*Natrix natrix, Coronella austriaca, Vipera erivanensis*).
- Birds - 267 species including greylag goose (*Anser anser),* white winged scoter *(Melanitta fusca),* red-creasted pochard (*Netta rufina),* pochard (*Aythya ferina),* white headed-duck (*Oxyora leucocephala*), coot (*Fulia atra),* mallard (*Anas platyrhynchos*), whooper swan (*Cygnus cygnus*), shelduck (*Tadorna tadorna*), Armenian gull (*Larus argentatus armenicus*), greater and lesser cormorant (*Phalacrocorax carbo* and *P. pygmaeus*), glossy ibis (*Plegadis falcinellusi),* flamingo *(Phoenicopterus ruber*), and black-winged stilt (*Himantopus himantopus*).
- Mammals - 34 species; including marbled polecat, otter, manul, leopard, wild goat, wolf, fox, and beech marten.

The decline in the water level of Lake Sevan (by 19m since the 1950s) has severely affected aquatic, coastal swamp and marshland habitats of the park. In addition, a further 10,000 ha of marshland was drained for agricultural use. In particular, the birds using Lake Sevan were affected by these habitat changes, and a number of species no longer breed on the lake. Between 1922 and 1996, the areas used by nesting waterfowl on the lake nearly halved, and the number of Armenian gulls on the lake has also declined dramatically.

There is a need for further research in the Lake Sevan national park, particularly to help with reserve demarcation and to identify the best management approaches for the park and its water resources. It has also been suggested that the park be expanded to incorporate the area previously covered by Lake Gilly, before it was drained, and to undertake some form of habitat restoration of the lake area.

7.1.4 Natural Monuments

Natural monuments have been established to protect unique and typical natural sites of academic, historic or cultural importance (following a law on specially protected areas passed in 1991). Such sites are protected from disturbance, to avoid loss of small areas of high international importance or of aesthetic value. Each site is considered independently and an appropriate agency is specified for protection. Some monuments include living trees, such as the wide-leaf pines around Tsaghkavan village (Meghri region), Vardan's oak (a national hero), and a Judas tree. Other natural monuments include volcanic formations, various mountain lakes, mineral springs, and waterfalls.

However, natural monuments are not under full legal protection, and inventory and identification procedures are underdeveloped. These sites are considered to be the most threatened within the protected areas system. As a result of human impacts (including mining, tree-felling and constructions) many natural monuments are being degraded and destroyed.

7.2 Conservation outside protected areas

A number of ecosystems and species are not well represented in protected areas, and their survival will rely on conservation efforts outside the protected areas network. Environmental activities are currently only regulated by out-dated laws which relate to control of activities in river valleys, environmentally sensitive areas and collection of particular species. In addition the Ministry of Nature Protection operates three mechanisms which serve to limit damage to biodiversity: a system of hunting licences; provision of special licences for the collection of medicinal plants; and environmental impact assessment for business development.

However, given the current rate of social, economic and political change, a new series of measures is needed to address conservation and land use outside protected areas. These might include legislation, education and improved administration, supported by independent ecological assessments and monitoring of all industrial and other activities.

7.3 Ex-situ conservation

7.3.1 Botanic gardens and nurseries

The Botanic Garden of the National Academy of Science is responsible for plant collections in Armenia. The Botanic Garden was established in 1935 in the north-eastern part of Yerevan (80 ha of semi-desert habitat). Further botanic gardens and nurseries have been established in other regions (including Vanadsor, Sevan and Artsakh). The Botanic Institute also houses a collection of plant specimens in its scientific herbarium.

During last 60 years, the collection has grown to include around 1650 species, of which the majority (1070 species) is housed in Yerevan Botanic Garden. Trees represent 40% of the national collection (650 species) and shrubs represent 51% of the collection (850 species).

The Botanic Garden is currently of great interest to visiting specialists, particularly the important collection of Armenian flora (1.5 ha, with around 750 species (25% of the Armenian flora) represented). The collection includes around 200 species of endemic, rare and declining plant species, and provides a basis for the study of Armenian flora, and the ecological interactions of species, in a relatively natural environment.

7.3.2 Zoological parks

The Yerevan Zoological Garden was established as an educational, research and conservation institution. In 1997, a range of species were maintained, including 14 fish species, nine amphibian species, 40 reptile species and 47 mammal species. As well as a number of exotic species, native mammals are also kept within the zoo, including brown bear, wolf, fox, lynx, Armenian mouflon, wild goat, and striped hyaena. However, the conservation activities of the zoo are currently limited, with few plans for effective captive breeding of threatened species. Furthermore, in recent years a number of private zoos have been established, without State regulation, which tend to be inappropriately managed, with no significant impact on the survival of threatened species.

7.3.3 Genetic collections and genebanks

A collection of micro-organisms is held at the National Bacteriological Research Centre (established in 1993). Currently, some 6000 species of bacteria and fungi are housed in the collection. Many of the species have important potential for bio-technology use, and others are representatives of crop pests and pathogens.

Chapter 8. Existing capacity and programmes for conservation

8.1 Legislation for biodiversity use and conservation

Laws to protect biodiversity were first adopted in Armenia during the Soviet era. However, no comprehensive legislative base existed for natural resource protection in Armenia, and government regulation was limited to a number of sectors such as forestry, fisheries and hunting (the latter being regulated through 'Hayhuntunion', an association of State hunting organisations and NGOs). The issue of over-grazing was only addressed by guidelines for collective and state farms issued by the Ministry of Agriculture (including dates for summer grazing and limits for livestock density).

Following independence in 1991 environmental legislation was reviewed, with the aim of developing a more comprehensive State policy towards ecological protection and sustainable use. This has resulted in a series of new laws being developed, including regulations relating to protected areas, a land code (both 1991) and a forest statute (1994). A law relating to the protection of flora and fauna is currently being prepared by the Ministry of Nature Protection, and this will be reviewed by NGOs and scientific institutions. The key laws relating to biodiversity are explained in more detail below.

Key laws and regulations relating to biodiversity conservation and natural resource use in Armenia

- **Law on Principles of Environmental Protection (1991)**
- **Law on Especially Protected Areas (1991)**
- **The Land Statute (1991)**
- **The Water Statute (1992)**
- **Law on protection of the Atmosphere and Air Quality (1994)**
- **The Forest Statute (1994)**
- **Law on Environmental Impact Assessment (1995)**
- **Government decree on Fishing activities in Lake Sevan (1996)**
- **Law on Payments for Nature Protection and Use of Natural Resources (1998)**
- **Law on Flora (in draft)**
- **Law on Fauna (in draft)**

8.1.1 The Forest Statute

The Forest Statute provides for the conservation, protection and efficient management of forests taking to account their ecological, social and economic significance, and basing decisions on available scientific information. The aims of this regulation are to conserve natural forest features, increase regeneration and productivity of forest areas, enable efficient use of forest resources, protect rights of use with respect to forests, and to strengthen the legal enforcement of forest protection. However, the Forest Statute does not take account of the implications of land privatization, and still recognises all forests as absolute property of the State. This restricts local authorities and the private sector from taking over some of the responsibilities for forest protection, and increasing forest cover. At present the Ministry of

Nature Protection is involved in drafting amendments to the Forest Statute, in order to bring it up to date.

Since all forests are considered as State property, the government is responsible for overseeing the protection and management of forests, through relevant local authorities ('marz') and a special State agency ('Hayantar', under the Ministry of Nature Protection).

- The Government is responsible for: determining priorities for management, classifications of forests, procedures for conservation and management, and forest use fees; approving appropriate forestry projects; setting quotas for timber extraction; implementing research and forest management practices; monitoring of forest stocks; and collaboration with international authorities relating to forestry practices and conservation.

- Local authorities are responsible for: provision of temporary concessions and supervision of construction, industrial and mining activities in forest areas.

- The authorised State agencies ('Hayantar') are responsible for: the development and implementation of forestry projects; registry of forest stock; ensuring forest regeneration, management and sustainable use; and for addressing issues linked to mismanagement of abuse of forest resources, including illegal felling and the effects of pollutants.

A range of other provisions are made within the Forest Statute, including: age of maturity and felling; forest use; rights and obligations of forest-users; methods for timber extraction and processing; use of forests for research, hunting and recreation; measures for forestry in protected areas, and urban regions; rates of forest regeneration; charges for forestry use; supervision of forestry; measures for resolving disputes and reactions to violation of forest legislation; and development of international agreements relating to forestry.

8.1.2 The Law on Specially Protected Areas

The Law on Specially Protected Areas outlines the procedures for establishing protected areas and guides their management. The aims are as follows: to maintain the balance of natural ecosystems, to preserve natural monuments of national importance, to conserve the biodiversity of the country, to control use of natural habitats, to promote environmental education and public awareness and to ensure recognition of natural resource depletion within the legal framework. The law specifies that protected areas be established trough government decree, and that overall responsibility for their management lies with the Ministry of Nature Protection. The law also refers specifically to the development of a State listing for protected areas, mechanisms for protected area identification and gazettement, and the status and management regimes for different types of protected area. However, this law does not address a number of relevant issues, such as socio-economic benefits of biodiversity, land privatization, and the role and rights of the private sector, and might therefore be improved by revision.

8.1.3 Draft Laws on Flora and Fauna

The draft laws on Flora and Fauna set out policies for the conservation, protection, regeneration and management of natural populations of plants and animals, and regulations for human impacts on natural diversity.

The Law on Flora aims to ensure sustainable conservation of plants, their genetic diversity and natural habitats, to develop scientific assessments of levels for sustainable use of natural plant populations, to ensure a sustainable conservation of flora, and to protect the rights of those involved in plant conservation and management. The implementation of this law will be overseen by the Ministry of Nature Protection, and by local government and other agencies. The draft law provides for: inventory, study and monitoring of plant populations; development of a State listing for plants and their use; further elaboration of the Red Data Book for plants; investigation of issues relating to plant conservation; conservation of rare and threatened plant species; use of plants; rights and obligations of plant collectors; restriction or termination of rights to collect particular plants; measures for dealing with disputes over use of plants; and international agreements relating to plant conservation issues.

The Law on Fauna aims to: ensure conservation of animals and their genetic diversity, maintain the integrity of animal populations, protect animals from inappropriate disturbance, protect migration routes and regulate use of animal species. The responsibilities of different agencies (including the government, ministries and other State bodies, local authorities and local self-government institutions) are outlined. The draft law make provision for: survey, study and monitoring of animals; listings of animals and their use; elaboration of the Red Data Book for animals; setting goals for animal conservation; measures for dealing with disputes; and international agreements relating to animal conservation issues

8.2 State structures for biodiversity management

Since 1991 the Ministry of Nature Protection and Ministry of Agriculture have been responsible for the management of natural resources in Armenia.

- **The Ministry of Nature Protection** is responsible for ecological survey and inventory, monitoring and management of biodiversity (both in-situ and ex-situ), development of guidelines for sustainable use, and for reviewing the implementation of legislation relating to the environment. The Ministry has responsibility for a number of protected areas, and also oversees and supervises activities of other government agencies in relation to natural resource use. In line with current legislation, the Ministry of Nature Protection considers all applications for the development of new industrial enterprises, and a statutory environmental impact assessment enables the Ministry to offer advise, monitor and, where necessary, block such developments. The Ministry also issues licences for hunting and collection of medicinal plants, and there are plans to extend the licensing system for other forms of natural resource use, involving further regulations relating to dates, appropriate collection methods and fees.

- **The Ministry of Agriculture** is responsible for management of state agricultural lands,

and for supporting farmers of privatized land. In addition, the Ministry of Agriculture oversees management of agrobiodiversity, and manages six of the State Reservations in Armenia (Chapter 7).

- A number of other state agencies are involved in the management of agrobiodiversity, under the supervision of the Ministry of Agriculture. These include: the State Department of Geology, the State Land Inspectorate, the State Veterinary and Animal-breeding Inspectorate, the Department of Livestock Breeding, and the Department of Plant cultivation, Selection and Land management.

- Regional rural inspectorates have some devolved responsibilities for biodiversity management and supervision. These inspectorates include the State rural inspector for animal-breeding, the State rural inspector for land-use, and the State rural inspector for geology.

8.3 Scientific research

Armenia has a strong tradition of scientific research relating to biodiversity and other fields (Section 2.2), and this has been maintained despite recent economic crises. Research has focused on inventories of flora and fauna (and their genetic diversity), taxonomy, population dynamics, adaptation by exotic species, plant phenology, identification of impacts on biodiversity and studies of effective conservation measures. A range of collections provide the basis for much of this research (including collections based in herbaria, museums, botanical gardens, as well as seed-banks, and genetic databases). For example, the Institute of Botany (of the National Academy of Sciences) holds more than 265,000 plant specimens, while a further 25,000 are held in Yerevan State University. The largest collections of animals are based in the Institute of Zoology and in the Natural History Museum of Armenia, with a total of 10,000 specimens, including many rare and threatened species (such as Sevan trout, leopard, manul, wild cat, striped hyena and Armenian mouflon). A permanent research station and pilot plot (40 ha.) has been maintained at altitude of 3200m on Mount Aragats since 1962. Extensive research on alpine flora and fauna has been conducted at this site, including patterns of evolution, and assessing human impacts on alpine vegetation, with the aim of developing mechanisms for effective conservation of such habitats.

A number of institutions are involved in scientific research relating to biodiversity, including:

- the National Academy of Science (comprising the Institutes of Botany, Zoology, Bacteriology, Aquatic Ecology and Fisheries, Agro-chemistry and Hydroponics, and the Centre of Noosphere Research);
- institutes of the Ministry of Agriculture and Ministry of Industry (Institutes of Land Cultivation, Soil Science, Fruit and Grape Cultivation, and Applied Bio-technologies);
- the university sector (including the Agricultural Academy, Medical University, and Teaching Institute).

8.4 Biodiversity inventory and monitoring

Biodiversity monitoring is an important component of any national ecological monitoring programme. Systematic monitoring of biodiversity is not currently conducted in Armenia, and at present, monitoring is not even conducted in protected areas, as a result of lack of resources and of qualified staff to undertake systematic surveys.

Although inventory work on the habitats of Armenia was initiated in the 1920s, a full inventory of flora and fauna has never been conducted, and much of the current information is out of date. Between the 1950s and 1980s floral inventory work focused on the region around Yerevan. In addition, some rare species (including big mammals) and game species were periodically surveyed during this time. Inventories of vascular plants, fish, birds and mammals have been conducted in a number of protected areas (Erebuni, Dilijan, Khosrov, Sev Litch, and Lake Sevan National Park). Although in many cases these are out-dated or incomplete (see Section 7.1.1), such surveys may provide important baseline data for future monitoring programmes. Furthermore, much of the research (including phenological studies) conducted by the National Academy of Sciences and other institutions has important value for the development of appropriate monitoring methods, as well as providing valuable baseline data. For example, the information gathered on Armenian plants during collections for Yerevan Botanic Garden could also be related to distributions and trends in populations.

An improved system for monitoring biodiversity might involve a range of levels: surveys of landscapes, ecosystems and species, assessments of human impacts, and prediction of likely consequences. The development of any monitoring system should take into account existing studies of biodiversity, current protection status, and the aims and indicators of monitoring. An effective monitoring system will require country-wide co-ordination, permanent survey sites, and availability of the necessary technical abilities, staffing, equipment and communication systems.

8.5 Educational programs and training

Education and training relating to biodiversity conservation is carried out at a number of levels in Armenia. A basic introduction to biology and the diversity of plants and animals is provided in the 5th year of secondary school, and often involves a field trip to the botanic garden or zoo. A number of higher education courses also include information on biodiversity conservation, both in state institutions (Table 8.1) and private universities (Yerevan University of Ecology and Law; 'Yerevan' University; Moscow College for the Humanities and Ecology; International Independent University for Ecology and Political Science). Relevant courses offered by State institutions are listed in Table 8.1

Table 8.1 Higher education institutions and courses offered relating to biodiversity conservation and ecology

Institution	Courses
Yerevan State University Biology faculty	• ecology • environment • biogeography • environmental principles • impact of environmental factors on ecosystems
Geography faculty	• principles of sustainable development • environmental problems of Armenia • landscape science • biogeography • landscape ecology
Chemistry faculty	• principles of ecology • nature protection
Yerevan Institute of National Economy	• modern problems of ecology • economy of nature use • principles of nature protection • ecological safety • economy and ecology
Yerevan Teaching Institute	• plant ecology • animal ecology • hydro-ecology • monitoring • ecology and nature protection • populations ecology • principles of ecological education
Armenian Agricultural Academy	• environmental protection and sustainable use of natural resources • agro-ecology • plant ecology

8.6 Public Awareness

At present public awareness of environmental issues in Armenia is relatively low, particularly in relation to losses in biodiversity. Relatively little attention is given to these issues in the State press, radio and television, although a program on environmental issues is produced once every fortnight on national television. In addition, private television channels show foreign wildlife documentaries, but no programmes are broadcast about Armenian biodiversity. Until 1995, an important source of information was the monthly publication 'Armenian Nature', however this has now ceased production due to lack of funds. In 1998 the Ministry of Nature Protection began to produce a monthly environmental newspaper 'Nature', however its limited print run means it cannot be widely disseminated.

It is clear that public awareness and involvement is an important issue in achieving sustainable and equitable conservation. This was recognised in the *International Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environment Matters* (Aarhus 1998). Armenia signed this convention at the meeting in Denmark in 1998, and with eventual ratification will undertake to provide enhanced mechanisms for disseminating information, increasing awareness and encouraging public participation in biodiversity conservation and associated decision making.

8.7 The role on Non-Governmental Organizations (NGOs)

Even during the Soviet era a number of public organisations existed which took an active role in biodiversity conservation. Among these were the Geographical Society, the Biological Society and the Armenian Society for Nature Protection (with its local offices in all regions). The Armenian Society for Nature Protection mainly undertook education and awareness work, through schools and other institutions, as well as organising meetings and lectures, and producing a monthly publication called 'Armenian Nature'. The society also carried out extensive tree planting in different regions of the country. In 1989 a number of small regional public organisations were united to form the 'Greens Union' (previously the organisation 'Survival'). The goal of the union was to work towards protection of plant and animal species, to develop guidelines for sustainable use and to improve environmental legislation.

At present, more than 50 environmental and ecological NGOs are registered in Armenia. In general these organisations focus on environmental education and training, review of new initiatives and their environmental impacts, and participate in discussion and development of key national environmental projects (Annex 10). However, the effectiveness of the NGO movement in Armenia is currently constrined by a number of factors, including lack of co-ordination and co-operation with the Ministry of Nature Protection, lack of resources (inappropriate membership fees), and reliance on external sources of income (private sponsorship and grants from overseas organisations).

8.8 International agreements and conventions

Armenia has ratified a number of international agreements and conventions relating to the protection of biodiversity.

- *Convention on Wetlands of International Importance Especially as Waterfowl Habitat* (Ramsar Convention, 1971). Armenia ratified the Ramsar Convention in 1993, however despite the international importance of Lake Sevan and Lake Arpa, little has been done to implement this convention.

- *Convention on Biological Diversity* (UNCBD, Rio de Janeiro, 1992). This convention was ratified by Armenia in 1993, and the first stage of implementation is currently being undertaken including the development of a *National Biodiversity Strategy and Action Plan*, and this first National Report (incorporating a *Country Study of Biodiversity*) to meet reporting requirements to the convention.

- *Convention concerning the Protection of the World Cultural and Natural Heritage* (World Heritage Convention, Paris, 1972). This convention was ratified in 1993, however there is little available information on implementation.

- *Convention to Combat Desertification* (UNCCD, Paris, 1994). The UNCCD was ratified by Armenia in 1997. A project is currently being developed to meet obligations under this convention.

- *Framework Convention on Climate Change* (UNFCCC, Rio de Janeiro, 1992). The UNFCCC was ratified by Armenia in 1993, and production of a *Country Study on Climate Change* is underway.

Three further international conventions relate to biodiversity conservation, and Armenia has not yet acceded to these.

- *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES, Washington 1973).

- *Convention on the Conservation of Migratory species of Wild Animals* (Bonn Convention, 1979).

- *Convention on the Conservation of European Wildlife and Natural Habitats* (Bern Convention, 1979).

8.9 Existing projects and programmes for biodiversity conservation

As well as the numerous projects and programmes conducted by government agencies (including the Ministry of Nature Protection), NGOs and other organisations and individuals, several large scale internationally supported programmes currently address biodiversity conservation in Armenia, and involve the production of detailed plans for the future management of biodiversity.

- The ***Lake Sevan Action Plan*** (financed by the World Bank) involved a review of the current situation in the lake and the surrounding watershed, and the development of an action plan to improve the status of the lake and use of its water resources. The goal of the plan is to improve landscape and biodiversity conservation across the whole area, improve opportunities for sustainable use of natural and biological resources in the area, and increase the effectiveness of protection offered by Lake Sevan National Park, through a review of its management and functioning.

- The ***National Environmental Action Plan*** reviewed current issues for biodiversity conservation in Armenia and identified priority areas for action, including improved legislation, inventory and monitoring, improved management in-situ (including protected areas), improved ex-situ conservation, sustainable use of biological resources, and development of educational and scientific programmes on biodiversity. These priorities have been developed into a detailed action plan.

- The ***Country Study on Climate Change in Armenia*** (financed by GEF, via UNDP) is

currently being produced, with assessments of likely impacts of climate change on natural ecosystems, species, agricultural land, water resources, and human health in the country. The project will also address necessary actions to mitigate the likely effects of climate change.

- The ***National Biodiversity Strategy and Action Plan*** (BSAP, financed by GEF, via UNDP) is currently under development, as a first obligation under the Convention on Biological Diversity, and as an enabling activity for GEF, to allow further funding to be released to finance biodiversity projects in-country. The first stage of the *Biodiversity Strategy and Action Plan* comprises a review of biodiversity and existing measures for protection (the *Country Study on Biodiversity*), which is represented by this first National Report. The BSAP has been developed involving participants from a range of sectors to identify specific activities needed to achieve priorities in biodiversity conservation, and is currently in draft.

Chapter 9. Biodiversity Strategy for the Republic of Armenia

As part of the production of a *Biodiversity Strategy and Action Plan* (BSAP) for the Republic of Armenia, experts from a wide variety of sectors have worked to outline the aim and priorities for biodiversity conservation. Included here is an outline of the Biodiversity Strategy for Armenia, including an overall aim, objectives and strategic approaches to dealing with the threats to biodiversity in the country. This constitutes a key part of the *Biodiversity Strategy and Action Plan*, along with a brief contextual overview, a problem analysis and a detailed plan of prioritised actions and activities to meet the stated objectives, supported by specific budgets and timescales.

9.1 Overall Aim

The overall aim of the Biodiversity Strategy is:

To ensure the conservation, sustainable use and regeneration of landscape and biological diversity of the Republic of Armenia, for sustainable human development

9.2 Objectives

The objectives for the biodiversity strategy are listed below. The order of the objectives does not indicate any prioritization. The process of target setting is still underway, and the gaps will be completed in the final BSAP.

- *To develop mechanisms which act to mitigate economic activities that negatively affect biodiversity, while ensuring that a more realistic market value is placed on biological resources by 2001.*

- *To increase internal and external investments in order to conserve and regenerate landscapes and biodiversity by 30% by 2004.*

- *To conserve, regenerate and sustainably use forest resources, with a resulting increase in healthy forested areas of 3000 ha by 2004.*

- *To support and extend the capacity to use science as a vital tool in guiding conservation management (including both research and monitoring), through increased investment of 15% in both relevant scientific programmes and professional training by 2004.*

- *To improve management systems relating to biodiversity conservation (including protected areas management) with the result of increased effectiveness by 2000.*

- *To improve legislation and economic mechanisms for the conservation and sustainable use of biological and landscape diversity, in line with the other objectives.*

- *To improve and strengthen the ecological education and training system, along with increasing public awareness of biodiversity, so that knowledge improves by 30% by 2004.*

- *To ensure the use of appropriate ecologically-friendly technologies in support of biodiversity conservation, through increased investment in this field of 10% by 2004.*

- *To ensure the participation of NGOs and other relevant stakeholders in all stages of project development and implementation, and improve their opportunities to take a direct role in conservation management, with an increased involvement of 20% by 2004.*

- *To conserve and regenerate species, ecosystems and landscapes, so that a further 3% is in a natural condition by 2004.*

- *To extend the network of specially protected areas, and to improve the effectiveness of the system by 5% by 2004, in an appropriate manner which takes into account the size and terrain of the country.*

- *To ensure the sustainable use and further regeneration of biological resources, including agrobiodiversity, to maintain 90% of genetic resources by 2004.*

- *To support and contribute to the sustainable development, including the further integration of biological resource management into the development of rural communities, to help to reduce the levels of poverty by 30% by 2004.*

9.3 Strategic approaches

A number of different tools for addressing biodiversity conservation have been adopted as a means to reach the objectives listed in Section 9.2. These are listed in below, but their order does not imply any priority for different approaches.

Strategic approaches to biodiversity conservation in Armenia

- *In-situ conservation.*
- *Ex-situ conservation.*
- *Sustainable use of biological and landscape diversity.*
- *Development of institutional potential and training.*
- *Ecological education and public participation.*
- *Identification and monitoring.*
- *Research.*
- *Information exchange and accessibility.*
- *Co-operation (technical, scientific, inter-state, technology transfer).*
- *Impact assessment.*
- *Legislation.*
- *Incentive measures.*
- *Financial resources.*
- *Co-ordination of the Biodiversity Strategy and Action Plan (BSAP).*

Annex 1 Characteristics of reservoirs and rivers in Armenia

Characteristics of different reservoirs in Armenia

Name	Capacity (million m^3)	Maximal depth (m)	Area (ha)
Akhuryan	525	55	4180
Azat	70	2.5	260
Arpalitch	105	2.5	2000
Aparan	91	40	750
Spandaryan	277	76	1425
Toloris	96.8	33	650
Djoghaz	45	55	210
Kechut	25	20	145
Shamb	13.6	12	104
Mantash	8.2	26	70
Hrazdan	5.6	6	170

Characteristics of different rivers in Armenia

Name	Flow rate (m^3/sec)	Annual runoff (million m^3)	Length (km)
Azat	6.4	202	40
Akhurian	31.8	847.4	205
Arax	86.2	272.4	158
Argichi	4.64	147	51
Arpa	21.5	679	90
Gavaraget	3.82	121	47
Karchakhbiur	1.19	38	25
Hrazdan	22.6	714	141
Marmarik	5.2	164	35
Metsamor	33.1	1046	45
Meghri	3.23	102	36
Vokhchi	9.6	303	56
Vorotan	21.5	679	119
Vardenik	1.77	56	28
Vedi	2.02	64	58
Kasakh	6.75	213	89
Agstev	2.18	290	99
Debet	37.0	1169	152
Dzoraget	16.6	531	71
Pambak	8.96	283	86

Annex 2 Diversity of benthic invertebrates in water basins

The number of species of different groups of benthic invertebrates found in the water basins of Armenia

Group	Class	Order	Number of species
Porifera			1
Cnidaria			2
Nemathelmintes			74
	Turbelaria		3
Nematoda			23
	Oligochaeta		36
	Hirudinea		12
Sardigrada			1
Mollusca			46
	Gastropoda		32
	Bivalvia		14
Arthropoda			192
	Hydracarina		15
	Crustacea		29
	Insecta		148
		Odonata	7
		Ephemeroptera	2
		Plecoptera	1
		Heteroptera	8
		Tricoptera	33
		Coleoptera	34
		Diptera	63
TOTAL			**316**

Annex 3 Invertebrate diversity in different landscapes

Numbers of species in different invertebrate groups associated with different landscape types in Armenia (only includes data from groups where sufficient data is available)

Group	No. of families studied	Total number of species studied	No. endemic species	Number of species				
				Semi-desert	Desert	Mountain steppe	Mountain meadow	Forest
Molluscs								
Gastropods	31	141	6	52	26	79	48	104
Bivalves	2	14	0	7	7	9	6	7
Arachnids	30	302	?	66	26	132	13	87
Insects								
Orthoptera	3	146	13	76	4	98	4	43
Homoptera	1	82	1	24	6	40	4	7
Hymenoptera	5	481	0	258	197	233	81	133
Coleoptera	8	1205	267	279	18	365	86	386
Lepidotera	1	321	19	69	69	26	0	228
Diptera	1	49	10	9	29	19	9	18

? – data not available

Annex 4 Distribution of fish species in Armenia

Occurrence of different fish species in water bodies and rivers in Armenia

Species	Lakes					Reservoirs										Rivers					
	Sevan	Sev	Kari	Akna	Small lakes	Spandaryan	Arpi	Hrazdan	Djokhaz	Mantash	Aparan	Kechut	Tolors	Shamb	Armanis	Marmarik	Vorotan	Debed	Arpa	Metsamor kasakh	Akhuryan
Salmoniformes																					
Salmo trutta m.fario							+									+	+	+	+		+
Salmo caspius																	+	+	+	+	
Salmo ischchan	+	+	+	+						+	+										
Salmo gairdneri irideus					+																
Coregonus lavaretus sevanicus	+											+									
Cypriniformes																					
Rutilus rutilus schelkovnikovi																				+	
Leuciscus cephalus orientalis						+	+	+	+		+		+	+	+						
Chondrostoma cyri leptosoma							+									+		+		+	+
Barbus lacerta cyri				+		+	+	+	+		+	+	+	+	+	+		+		+	+
Barbus goktschaicus	+																				
Barbus capito							+	+												+	+
Alburnoides bipunctatus armeniensis							+	+	+				+	+	+		+		+	+	+
Ctenopharingodon idella					+																
Varicorhinus capoeta capoeta						+	+	+	+				+	+	+		+	+	+		

Varicorhinus capoeta sevangi	+																			
Carassius auratus																				
Hypophthalmichthys molitrix					+															
Cyprinus carpio	+				+	+	+		+										+	+
Aspius aspius taeniatus							+									+		+	+	+
Gobio persa							+												+	+
Barbus mursa mursoides							+									+		+	+	+
Alburnus filippi Kessler						+	+				+				+	+	+	+	+	+
Acantalburnus microlepis											+					+		+		
Blicca bjoerkna derjavini																			+	
Nemachilus brandti															+	+	+	+	+	+
Nemachilus angorae															+	+	+	+	+	+
Cobitius aurata															+	+	+	+	+	+
Siluriformes																				
Silurus glanis																+		+	+	+
Cyprinodontiformes																				
Gambusia affinis affinis					+															
Gambusia affinis holbrooki					+															

Annex 5 Distribution of herpetofauna in relation to landscape

Occurrence of amphibian and reptile species in different landscapes in Armenia

Class/order	Species	Occurrence in landscapes			
		Semi-desert	Mountain steppe	Forest	Mountain meadow
Amphibia					
	Triturus vulgaris	-	-	+	-
	Triturus vittatus	-	-	+	-
	Pelobates syriacus	+	+	-	-
	Bufo viridis	+	+	+	+
	Hyla savignyi	+	-	-	-
	Hyla arborea schelkovnikovi	+	-	+	-
	Rana ridibunda	+	+	+	+
	Rana macrocnemis	-	+	+	+
Reptilia					
Cheloni a					
	Mauremys caspica	+	-	-	-
	Emys orbicularis	+	+	-	-
	Testudo graeca	+	+?	-	-
Sauria					
	Cyrtopodion caspius	+	-	-	-
	Laudacia caucasica	+	+	+	-
	Phrynocephalus helioscopus	+	-	-	-
	Pseudopus apodus	+	+	+	-
	Anguis fragilis	-	-	+	-
	Mabuya aurata	+	+	-	-
	Eumeces schneideri	+	+	-	-
	Ablepharus bivittatus	+	+	-	-
	Ablepharus chernovi	-	+	-	-
	Eremias arguta	-	+	-	-
	Eremias strauchii	+	-	-	-
	Eremias pleskei	+	-	-	-
	Lacerta strigata	+	+	-	-
	Lacerta media	-	+	+	-
	Lacerta agilis	-	+	+	-
	Lacerta parva	-	+	-	-
	Lacerta praticola	-	-	+	-
	Lacerta raddei	+	+	+	-
	Lacerta portschinskii	-	-	+	-
	Lacerta nairensis	-	+	-	-
	Lacerta valentini	-	-	-	+

Class and order	Species	Occurrence in landscapes			
		Semi-desert	Mountain steppe	Forest	Mountain meadow
	Lacerta armeniaca	-	+	+	+
	Lacerta dahli	-	+	+	-
	Lacerta unisexualis	-	+	+	-
	Lacerta rostombekovi	-	+	+	-
	Ophisops elegans	-	+	+	-
Reptilia					
Serpentes					
	Typlops vtrmicularis	+	-	-	-
	Eryx jaculus	+	+	+	-
	Natrix natrix	+	+	+	+
	Natrix tesselata	+	+	+	+
	Natrix persa	-	-	+	+
	Coluber najadum	+	-	+	-
	Coluber schmidti	+	-	-	-
	Coluber ravergieri	+	+	+	+
	Coluber nummifer	+	-	+	-
	Elaphe hohenackeri	+	+	+	+
	Elaphe quatuorlineata	+	+	+	+
	Eirenis collaris	+	+	-	-
	Eirenis punctatolineatus	+	+	-	-
	Eirenis modestus	+	+	-	-
	Pseudocyclophis persicus	+	-	-	-
	Rhinchocalamus melanocephalus	+	-	-	-
	Coronella austriaca	-	+	+	-
	Telescopus fallax	+	+	-	-
	Malpolon monspessculla-nus	+	-	-	-
	*Psammophis lineolatum**	+	-	-	-
	Vipera eriwanensis	-	+	-	-
	Vipera darevskii	-	-	-	+
	Vipera raddei	-	+	+	-
	Vipera lebetina	+	-	+	-

* Possibly occurs in this landscape
? Further information needed

Annex 6 Amphibian and reptile diversity in different landscapes

Numbers of threatened (T) and non-threatened (NT) amphibians and reptiles associated with different landscape types in Armenia*

Orders	Total number of species	Number of species							
		Semi-desert		Mountain steppe		Forest		Mountain meadow	
		NT	T	NT	T	NT	T	NT	T
Amphibia									
Salamandridae	2	-	-	-	-	-	2	-	-
Bufonidae	1	1	-	1	-	1	-	1	-
Pelobatidae	1	-	1	-	1	-	-	-	-
Hylidae	2	1	-	-	-	1	-	-	-
Ranidae	2	1	-	2	-	2	-	2	-
Reptilia									
Emididae	2	1	-	-	1	-	-	-	-
Testudinidae	1	-	1	-	1	-	-	-	-
Gekkonidae	1	-	1	-	-	-	-	-	-
Agamidae	2	1	1	1	-	1	-	-	-
Anguidae	2	1	-	1	1	2	-	-	-
Scincidae	4	-	3	-	4	-	-	-	-
Lacertidae	17	1	3	10	1	10	-	2	-
Typhlopidae	1	1	-	-	-	-	-	-	-
Boidae	1	-	1	-	1	-	1	-	-
Colubridae	18	6	8	6	3	6	3	4	2
Viperidae	4	-	1	-	2	-	2	-	2
TOTAL	61	14	20	21	15	23	8	9	4

* Threatened includes vulnerable, endangered and indeterminate status species

Annex 7 Bird diversity in different landscapes

Numbers of endangered (T) and non-threatened (NT) birds associated with different landscape types in Armenia*

Class	Total no. of species	Number of species									
		Desert, semi-desert		Mountain steppe		Forest		Mountain meadow		Azonal	
		NT	T	NT	T	NT	T	NT	T	NT	T
Gaviiformes	2	-	-	-	-	-	-	-	-	1	1
Podicipediformes	5	-	-	-	-	-	-	-	-	4	1
Pelecaniformes	4	-	-	-	-	-	-	-	-	-	4
Ciconiformes	13	-	-	-	-	-	-	-	-	8	5
Phoenicopteriformes	1	-	-	-	-	-	-	-	-	-	1
Falconiformes	35	-	-	5	5	7	5	-	-	4	9
Anseriformes	28	-	-	-	-	-	-	-	-	16	12
Galiformes	7	-	1	2	-	-	-	-	2	1	1
Gruiformes	13	-	3	-	2	-	-	-	-	3	5
Charadriiformes	62	-	-	-	-	-	-	-	-	42	20
Columbiformes	8	1	1	-	-	3	-	-	-	3	-
Cuculiformes	2	-	-	-	-	-	-	-	-	1	1
Strigiformes	7	-	-	-	-	3	1	-		2	1
Caprimulgiformes	1	-	-	-	-	1	-		-	-	-
Apodiformes	2	-	-	-	-	-	-	-	-	2	-
Coraciiformes	5	2	1	-	-	-	1	-	-	1	-
Piciformes	8	-	-	-	-	2	4	-	-	2	-
Passeriformes	146	18	5	17	2	40	2	6	4	40	12

* Endangered includes vulnerable, endangered and indeterminate status species

Annex 8 Distribution of mammals in relation to landscape

Occurrence of mammal species in different landscapes in Armenia

Order and species	Occurrence in landscapes			
	Semi-desert	Mountain steppe	Forest	Mountain meadow
Insectivores				
Erinaceus europaeus	+	+	+	-
Hemiechinus auritus	+	+	-	-
Talpa orientalis	-	+	+	+
Sorex minutus	-	+	+	+
Sorex araneus	-	+	+	-
Neomys fodiens	+	+	+	+
Crocidura suaveolens	-	+	+	-
Crocidura leucodon	-	+	+	-
Crocidura russula	+	+	+	+
Crocidura zarudnyi	-	-	-	+
Bats				
Rhinolophus hipposideros	+	+	-	-
Rhinolophus ferrumequinum	+	+	-	-
Rhinolophus euryale	+	+	-	-
Rhinolophus mehelyi	+	-	+	-
Rhinolophus blasii	+	-	-	-
Myotis blythi	+	+	-	-
Myotis nattereri	+	+	-	-
Myotis emarginatus	+	+	-	-
Myotis mystacinus	+	+	-	-
Miniopterus schreibersii	+	+	+	-
Plecotus auritus	-	+	+	+
Plecotus austriacus	+	+	-	-
Barbastella darjeliengensis	+	+	-	-
Barbastella barbastella	+	+	+	-
Nyctalus noctula	+	-	-	-
Nyctalus leisleri	+	+	+	-
Pipistrellus kuhlii	+	+	-	-
Pipistrellus pipistrellus	+	+	+	-
Pipistrellus nathusii	+	-	+	-
Pipistrellus savii	+	+	+	-
Vespertilio murinus	+	+	+	-
Vespertilio ognevi	+	+	-	-
Eptesicus serotinus	+	+	+	-
Tadarida teniotis	-	-	+	-

Lagomorphs				
Lepus europeus	+	+	+	+

Order and species	Occurrence in landscapes			
	Semi-desert	Mountain steppe	Forest	Mountain meadow
Rodents				
Sciurus persicus	-	-	+	-
Citellus citellus	+	+	-	-
Hystrix hirsutirostris	+	+	+	-
Glis glis	-	-	+	-
Dyomys nitedula	-	+	+	-
Sicista caucasica	-	+	+	-
Allactaga elater	+	+	-	-
Allactaga williamsi	+	+	-	-
Rattus norvegicus	+	+	+	-
Rattus rattus	-	+	+	-
Mus musculus	+	+	+	+
Apodemus sylvaticus	+	+	+	+
Cricetulus migratorius	+	+	-	+
Cricetus auratus	-	+	+	+
Meriones persicus	+	+	-	-
Meriones blackleri	+	+	-	-
Meriones vinogradovi	+	+	-	-
Arvicola terrestris	+	+	+	+
Microtus arvalis	-	+	+	+
Microtus socialis	+	+	+	-
Microtus guentheri	+	+	-	-
Microtus majori	-	+	+	-
Microtus daghestanicus	-	+	-	+
Microtus nivalis	+	+	-	+
Ellodius lutesens	+	+	-	+
Splax leucodon	-	+	+	+
Myocastor coypus	+	-	-	-
Carnivores				
Martes foina	-	+	+	-
Vormela peregusna	+	+	-	-
Mustela nivalis	+	+	+	+
Meles meles	+	+	+	-
Lutra lutra	+	+	+	-
Ursus arctos	-	+	+	+
Canis lupus	+	+	+	+
Canis aureus	+	-	+	-
Vulpes vulpes	+	+	+	+
Hyaena hyaena	*	*	*	-
Panthera pardus	+	+	+	-
Felis silvestris	+	+	+	-

Felis ocreata	+	+	-	-
Felis chaus	+	+	-	-
Felis lynx	+	+	+	-

Order and species	**Occurrence in landscapes**			
	Semi-desert	Mountain steppe	Forest	Mountain meadow
Felis manul	+	+	-	-
Ungulates				
Sus scrofa	+	+	+	-
Capreolus capreolus	+	+	+	+
Cervus elaphus	-	-	+	-
Capra aegagrus	+	+	+	+
Ovis orientalis	+	+	-	+

* - Possibly occurs in this landscape

Annex 9 Diversity of mammals in different landscapes

Numbers of endangered (T) and non-threatened (NT) mammals associated with different landscape types in Armenia*

Family	Total no. of species	Number of species									
		Semi-desert		Mountain steppe		Forest		Mountain meadow		Azonal	
		NT	T	NT	T	NT	T	NT	T	NT	T
Erinaceidae	2	-	2	-	1	1	-	-	-	-	1
Talpidae	1	-	-	-	1	1	-	-	1	-	-
Soricidae	7	-	4	-	2	1	-	-	2	-	1
Rhinolophidae	5	-	2	1	-	1	-	-	-	-	5
Vespertilionidae	17	-	10	-	3	-	1	-	-	-	14
Mollossidae	1	-	-	-	-	-	1	-	-	-	1
Leporidae	1	-	1	1	-	1	-	-	1	-	-
Hystricidae	1	-	1	-	1	-	1	-	-	-	-
Capomyidae	1	-	1	-	-	-	-	-	-	1	-
Scinridae	2	-	1	-	1	-	1	-	1	-	-
Muscardinidae	2	-	-	-	-	-	2	-	-	-	1
Dipodidae	2	-	2	-	2	-	-	-	-	-	-
Zapodidae	1	-	-	-	1	-	-	-	-	-	-
Muridae	17	5	3	11	2	3	1	2	2	4	-
Spalacidae	1	-	1	-	1	-	-	-	1	-	-
Mustelidae	5	1	4	1	4	3	1	1	-	-	1
Ursidae	2	-	-	-	-	2	1	1	-	1	-
Hyaenidae	1	-	1	-	1	-	-	-	-	-	-
Canidae	3	1	-	1	2	2	1	1	1	-	1
Felidae	6	2	1	1	2	1	3	-	1	-	-
Suidae	1	1	-	-	1	-	1	-	-	-	-
Cervidae	2	-	-	-	-	-	2	-	1	-	-
Bovidae	2	-	-	-	2	-	1	-	1	-	-
Total	**83**	**10**	**34**	**16**	**27**	**16**	**17**	**5**	**12**	**5**	**25**

* Endangered includes vulnerable, endangered and indeterminate status species

Annex 10 Key environmental NGOs in Armenia

The most active environmental and ecological NGOs in Armenia

Name	Address	Objectives and activities
ALTAIR (Humanitarian Centre)	Nalbandyan 29/8 tel: 523210	To promote human development, improve living standards, strengthen culture and education, and provide environmental guidance
Armenian Botanic Union	Avan 63 tel: 621781	Growth of plant species characteristic to Armenia, protection of important plants and vegetation cover
Armenian Ecological Association of Women	Abovyan 68 tel:268004	Public awareness of environmental issues; environmental research; implement environmental projects; deal with environmental health issues of female workers; protection of human rights
Armenian Ecologists Union	Bagramian ave. 24d/11,12 tel: 273428	Involved in tackling the ecological problems of Armenia, assessment of environmental projects, participation in environmental education and scientific research
Association Towards Sustainable Human Development	Khandjan 33/18 522327	Promote and develop the concept of sustainable human development in Armenia
AVISH (Benevolent Community of Nature's Friends)	Nalbandyan 49/4 tel:521846, 528740	Environmental education, tree planting activities, involvement of public and state organizations in tackling environmental issues
BYURAKN	Nalbandyan 19/34 tel: 524484	Ecological education of all sections of society, particularly children; ecological research; dissemination of environmental information
Ecological and Biological Security Academy –Armenian Branch	Tigran Mets ave. 40/6 tel:558635	Development of environmentally friendly technologies; conduct environmental research at the request of state and public organizations; environmental education; provide specialist inputs
Ecological Fund of Armenia	Komitas 49/302-304	Assessment of environmental situation in Armenia, based on up-to-date research
Ecological Survival	Bagramian ave. 24d tel:279268	Involved in drafting of environmental laws, public environmental education, and biodiversity conservation issues
ECOTEAM	Abovyan 22a/53 tel: 529277, 530331	Projects relating to alternative energy sources and energy efficiency
Ecotourism Association	Abovyan 44/2 tel:397552, 562590	Promotion of ecotourism in Armenia as a means of education and protection of the environment, and development of harmony between human and nature
Environmental Protection Advocacy Centre	Koryun 8/8 tel:561386	Explain environmental rights of citizens and public organizations to students, practicing lawyers, state officials and

(EPAC)		the general public; promotion of environmental legislation; drafting of laws; discussions of draft laws

Name	Address	Objectives and activities
FAUNA Club	Tumanian 33. tel: 538538	Animal rights issues; work on the relationships between humans and animals in cities
FLORA	Gyumri, Krytyan 12, tel: 39436, 33586	Establishment of an environmental advocacy centre; organization of tree planting; renewal of sewerage network; protection of historic monuments
Greens Union of Armenia	Mamikoniants 47/13 tel:257634, 281411	Environmental protection activities; promotion of environmental legislation; development of alternative and safe sources of energy
Nature Protectors Union of Armenia	Charets 8, Yerevan State University, tel. 556778, 633189	Campaign against illegal hunting and tree felling; work for the protection of natural areas
Socio-Ecological Association	Chaikovski 30/1 tel:422637	Work towards harmonization of nature protection and social development, by making economic development one of the incentives for nature protection
Sustainable Development	Rubiniants 1a/45 tel: 247391	Increase of public awareness in safe environment and issue related to nature protection, drafting the environmental laws and projects as well as educational programs.
TAPAN Ecoclub	SW district B2 21/23 tel:733322	Protection of the natural environment; protection and rehabilitation of cultural and historical monuments
Union of Armenian Ecological Organizations	Abovyan 63 te:551361	Overseeing co-operation and co-ordination between ecological organizations in Armenia
Union of Armenian Women - Ecological Branch	Pushkin 38, tel:557630, 281652	Focus attention of public and government on environmental issues.
Union of Fauna Protection	Khachatryan 26/1 tel: 265370 272233	Protection of endangered animal species; establishment of dog and cat homes
Youth Ecological Group	Abovyan 68 tel: 562245 562322	Increase awareness among young people regarding environmental problems, activities to clean up environmental pollution