Project title:
Feasibility Study for Trans-border
Biosphere Reserve Osogovo
Ref. N: 2007CB16IPO007-2012-3-047

Final Report - Annexes

FLORA

Feasibility Study for Trans-border Biosphere Reserve Osogovo

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May 2015

This project is co financed by European Union through

- IPA CROSS- BORDER PROGRAMME
CCI Number 2007CB161P0007

ANNEXES

2 ALGAE

The water bodies are important habitats for development and life of many different groups of organisms. The existence of different type of water habitats is important factor for biodiversity. More recently the awareness of protection and conservation of water bodies and the present species is increased, resulting with enhance of basic biological research. Therefore, the number of investigated habitats and species is dramatically increased. The result of such investigations is description of many new taxa (species, genera, families ...). However, the degradation of particular habitats could cause decreasing of species populations and finally loss of biodiversity. The degradation of natural habitats and consequent impoverishment of their biota is proceeding globally at a faster rate than ever before, and some have even called the present trend as the sixth mass extinction on the earth (Eldredge, 1998). Mass extinction or not, a considerable proportion of biological diversity is being lost before we even knew what was lost, where it was located, or how the loss could have been prevented. In recent years, this crisis situation has been widely noticed by both the scientific community and the public, and considerable efforts are currently being devoted to revealing the patterns of biodiversity and identifying the imminent threats to its existence (Purvis & Hector, 2000; Sala et al., 2000). Running waters are amongst the most threatened ecosystems (Allan & Flecker, 1993; Ricciardi & Rasmussen, 1999). They are threatened by climate change, landscape alteration, degradation of in-stream habitat and water quality, and introduction of alien organisms (Sala et al., 2000). Much of the biodiversity and ecosystem functioning in running waters are accounted for by benthic macroinvertebrates and algae. Algae are most important primary producers in the running waters. In many cases their production and biomass exceed the production of macrophytes. Partially and completely submersed photosynthetic biota are important components of every river ecosystem. Studying their occurrence, distribution and abundance in the ecosystem has shown their dependence of water quality in general and resulted in developing numerous and diverse applicable methods for water quality monitoring. Algae, bryophytes and aquatic higher plants have been the at the focus of research and application in the last decades of the 20th and the beginning of the 21st century. The advantages of biological methods in assessment of ecological status of river ecosystems have been stressed in numerous occasions, given the fact that the biota exhibit integrated responses to a variety of ecological factors comprising the spatial and temporal occurrence of pollution. The complexity of their responses to pollution as well as the differences in sensitivity towards various pollutants makes interpretation of the pollution

effects (through organism responses) somewhat difficult and complex. Round (1991a) points the diatoms as most reliable bioindicators in this assessment of ecological status and pollution level in river ecosystems due to several reasons: Ubiquitous presence in all river ecosystems; Fast and simple field sampling; Diatom taxa are extremely sensitive to water quality (chemism), eutrophication and pollution: The life cycle is fast and rapid and the reaction to changes in the environment is intensive (Oemke & Burton, 1986); The number of cells on the substrate is enormous providing a statistical significance in the case of random selection of a field of view when counting; The ecological preferences of diatoms are by far better known compared to other groups of organisms in the river ecosystem; The diatoms slides prepared for identification are permanent and can be used by other authors and can be compared over time; A large amount of data around the world is already compiled and the cosmopolitism (to some extent) of certain diatom taxa enables a world wide usage; Identification and counting could be done by workers that are not specialists in diatom taxonomy, of course with the support of illustrated material. Diatoms as an algal group, exhibit ubiquistic distribution that enables comparison of a wide range of habitats. Their identification is based mainly on the structure/ultrastructure of the silica cell wall, and observations are made on permanent slides prepared from cleaned diatom material (all of the organic components of the diatom cell are previously dissolved/oxidized by acid digestion). This procedure is widely accepted considering precise diatom taxonomy is impossible when the cells are living and containing chloroplasts which mask the fine detail of the silica wall structure. On the other hand, when using this procedure the researcher has no way to distinguish between cells that were alive at the time of collecting the material and dead ones so, some accumulated dead diatom frustules are undoubtedly being counted in the process. In the last two decades, the number of described diatom species is dramatically increased (see Krammer 2000, 2002, 2003, Lange-Bertalot 2001, Metzeltin & Lange-Bertalot 1995, 1998, 2009). Such situation is due to the changes in the species concepts (Mann 1999; Kociolek & Spaulding 2000), more precise delimitation of the species based on their ultrastructural features (Levkov 2009) and investigations of specific habitats (e.g. thermo-mineral springs, peatbogs, marshes, wet rocks etc). This resulted with changes in distributional data and general biogeography of diatom species. The number of species with limited distribution (endemics) is significantly increased. On other hand the number of not identified species is much larger and it is estimated to be around 25% (Williams and Reid 2009; Kociolek and Thomas 2010). Some of them are considered as potentially new species and are or will be described in near future. Similar findings were obtained in several investigations of water bodies in Republic of Macedonia.

The highest diversity of diatoms was observed in ancient lakes (Ohrid and Prespa) as well as in mountain habitats (peat-bogs, bogs, springs, lakes, ponds). The number of registered species varies from 150 to 450 on different mountains, which depends on number of samples, differences in habitat diversity and number investigated of water bodies. The highest diversity was observed on Shara Mountain (Levkov et al. 2005), while the lowest on Ograzhden (Spasovska et al. 2003). Before the projects, so far there was no available data for diatom composition on Osogovo Mountain.

Diatoms are one of the most diverse groups of algae in the freshwater ecosystems, occurring in different type of habitats. Since there are not typical postglacial lakes on Osogovo Mountain, the high-mountain habitats are represented mainly by the peat-bogs or rheophytic mosses. Special attention in this research was paid on diatom assemblages from sphagnum bogs, which are not frequent in Macedonia. In lower parts of the mountain, the number of substrata is higher and is represented by epilithon, epipelon, epiphyton, giving higher opportunity for development of diverse diatom flora. A total of 253 diatom taxa were observed and photographed. The lowest number of diatom taxa (10) was observed on wet rock near the road. Such number was expected, since only few diatom species are adapted to inhabit aerophytic habitats. However, this assemblage was found as important, because three Luticola taxa (Luticola spec. aff. heufleriana, Luticola spec. aff. charlatii and Luticola spec. aff. nivalis) were observed. These taxa are observed for the first time in Macedonia, and both posses slightly different morphological features than already established species (as presented in Hustedt 1961-1966 or Krammer & Lange-Bertalot 1986). However, Luticola nivalis was observed on several other localities in Macedonia, but always has smaller valve size and less pronounced undulations. Additionally, Achnanthes coarctata var. constricta Krasske is another taxon dominant in this assemblage, which was not so far observed in Macedonia. Its taxonomic position and ultrastructure was so far not well known. Most diverse samples originated from the peat bogs. The number of the species usually was larger than 40 (with maximum 59 taxa). One taxon named as Encyonema cf. mesianum was previously observed on mountain Nidze, is very frequent in several samples. The taxonomy of Neidium dubium and N. ampliatum species complexes is not yet resolved. Preliminary observations show that at least 14 different orphodemes of N. ampliatum can be found on Macedonian mountains (Levkov et al. unpublished). On other side N. dubium complex is less diverse in mountains, but some of them were recorded on Osogovo, but identified as members of the species complex during this study. Two other species of this genus, Neidium tenuissimum and N. alpinum are found as endangered in flora of Central Europe (Lange-Bertalot & Steindorf

1996) and are rare in the flora of Macedonia (Krstic et al. 2006). Other genus that shows great morphological diversity is Gomphonema. On other hand, undescribed taxon named as Gomphonema kozufense was observed in several peat-bogs. This taxon, was so far known only from the type locality on Mountain Kozhuf (South Macedonia). Another interesting species is Gomphosphenia tackei. This species was so far not observed in Macedonia, but probably it was neglected due to the small valve size, during previous investigations on similar habitats (e.g. Levkov et al. 2002, 2005). The genus Eunotia show great diversity in mountain and slightly acidic habitats. The revision of this genus is ongoing. However, the preliminary observations of this genus in Macedonia, show that there more then 40 different species. Some of them were identified as new species and will be described in forthcoming monograph on this genus. One of those species is Eunotia macedonica Lange-Bertalot, Pavlov & Levkov which was observed in several samples. Species Eunotia steineckeii, Eunotia cantonatii, Eunotia pseudogroendlandica. Eunotia subarcuatoides, are considered as rare in the flora of Macedonia, since they are observed only on one or very few localities on Shara or Baba Mountain. However, the full diversity of Eunotia needs to be reexamined in close future after publishing of monograph (in series Diatoms of Europe). Several small sized diatom species were also recorded during this study like Navicula tridentula, Adlafia suchlandtii, Chamaepinnularia soehrensis var. hassiaca etc.) which are not frequently recorded. Those taxa are also considered as rare or endangered in red list of diatoms in Central Europe. Although pennate diatoms are more diverse in benthic assemblages, several cyclic diatoms were observed in the ponds and peat-bogs. One of the Cyclotella cf. krammeri, so far observed in Lake Karanikolichko on Shara Mountain (as epiphytic) was recorded living on mosses in the small pond near spring region of river Toranica. This taxon need to be verified by the additional observation, because it shares similar morphology with type of C. krammeri, but it has significantly lower valve size.

There is a large difference between diatom compositions in rivers on different altitude. The spring region is mainly inhabited by typical oligotrophic taxa e.g. Diatoma mesodon, D. hyemalis, Hannea arcus, Meridion circulare, M. circulare var. subconstricta. In this region also large populations of Vaucheria sp., Lemanea fluviatilis and Nostoc sp. can be observed. The filaments of L. fluviatilis are usually inhabited by colonies of Chamaesiphon sp, which is characteristic element for highly oxygenated, oligotrophic fast-flowing waters. The lower parts of the rivers are mainly inhabited by species which are tolerant or indifferent to eutrophication as Navicula cryptotenella, N. lanceolata, N. gregaria, N. reichardtiana, Nitzschia dissipata Nitzchia sigmoidea, Cocconeis placentula var. euglypta, Sellaphora

pupula. Such diatom composition is typical for many lowland rivers in Macedonia, where moderate natural and anthropogenic eutrophication is present. In the investigated area, the eutrophication is mainly caused by erosion (visible with presence of organic sediments and detritus in the parts with slower water flow), communal waste waters (from settlements and stock farms) and fishery ponds. The typical symptoms of eutrophication are occurrence of large populations of Cladophora glomerata and intensive development of epilithic diatom communities. The diatom composition of streams is very diverse, depending on physical and chemical parameters. The streams in forests are significantly shaded and the diatom assemblages are consisted by several taxa (mostly representatives of genera Navicula. Cocconeis, Achanthidium and Planothidium). On other side, the open areas of the stream have more diverse substratum for development of diatoms (mosses, macrophytes, stones, pebbles, sand, mud), what enables higher diatom diversity. Some characteristic species observed in these habitats are Diploneis krammeri, Gomphonema tergestinum, Frustulia vulgaris, Placoneis hambergii, Pinnularia subcapitata, Rhopalodia gibba etc.. The most frequent diatom taxa which have occurred in the peat bogs are Diadesmis perpusilla, Diatomella baulforiana, Diploneis oblongella, Karayevia oblongella, Encyonema spp. (E. minutum, E. norvegicum, E. neogracile, E. silesiacum), Eunotia spp. (E. macedonica, E. incisa, E. paludosa, E. minor, E. steineckeii etc), Planothidium spp. (P. lanceolatum, P. frequentissimum, P. rostratum) and Pinnularia spp. Such diatom composition is typical for mountain moss habitats with slightly lower pH.

2.1 Valorisation

The diatoms are not listed in any EU directive or convention. However, there is attempt to classify the diatoms according to their distributions and degree of threat of the habitat (locality) where they occur. Such red list of diatoms from Central and Eastern Europe was published by Lange-Bertalot & Steindorf (1996). One decade later, Krstic et al. (2006) based on this list and modifications based on own observations have published the first red list of diatoms from Macedonia. The level of endangerment for most of the species in the latter list were the same (or similar), with exception for species considered as endemic for lakes Ohrid and Prespa. This list was applicative mainly for the species found in mountain regions in Macedonia. According to both red lists (Krstic et al. 2006 and Lange- Bertalot 1996) several taxa observed in the investigation area are pointed as rare or endangered.

Table 1 List of important diatom species recorded on Osogovo Mt.

Species	*Category*

Diatoma anceps	*2*
Diatomella baulforiana	*2*
Encyonopsis caesatii	2
Eunotia steineckeii	2
Eunotia tetraodon	2
Navicula lapidosa	2
Neidium alpinum	2
Pinnularia acrosphaeria	2
Sellaphora pseudopupula	2
Achnanthidium cf. distincta	3
Amphora inariensis	3
Cymbopleura anglica	3
Decusata hexagona	3
Diploneis oculata	3
Diploneis ovalis	3
Diploneis petersenii	3
Encyonema neogracile	3
Encyonema norvegicum	3
Eunotia bilunaris var. mucophila	3
Eunotia flexuosa	3
Eunotia macedonica	3
Gomphonema gracile	3
Gomphonema hebridense	3
Halamphora montana	3
Navicula subtilissima	3
Nitzschia alpina	3
Nitzschia brunoi	3
Placoneis hambergii	3
Placoneis ignorata	3
Sellaphora variostriata	3
Achnanthes inflata	R
Caloneis lauta	R
Cavinula cocconeiformis	R
Encyonema cf. mesianum	R
Gomphonema calcifugum	R
Gomphonema kozufensis	R
Navicula trdentula	R
Neidium hercynicum	R
Neidium longiceps	R
Neidium tenuissimum	R
Placoneis undulata	R
Chamaepinnularia soehrensis var. hassiaca	FR
Fallacia insociabilis var. dissipatoides	FR
Pinnularia stomatophora var. irregularis	FR
Surirella laponica	FR
Luticola spec. aff. heufleriana	FR

Luticola spec. aff. charlatii	FR
Luticola aff. nivalis	FR

2- endangered species

3 - Low endangered species

R. Extremely rare species

FR - first record for flora of Macedonia

When the number of rare (11) and endangered (30) taxa observed on Osogovo Mt. is compared with the other mountains, it can be seen that diatom assemblages on the mountain are mainly composed by widely distributed ("cosmopolitan") taxa. The highest number of important diatom species was determined in peat-bogs and specific habitats (as wet rocks).

2.2 Important areas for protection of diatoms

On the basis of species diversity (conservation status, rarity, endemism, etc.) some localities and habitats can be pointed out as very important for the conservation of diatoms. The characterization of particular water bodies or habitats was performed based on presence of rare, endangered and potentially new species as well as the number of identified species present in the sampling site. The water habitats received score 1 is considered as "*highly endangered, rare and diversity rich*" when the habitat is rare in R. Macedonia, is under threat (climate changes, human impacts, deterioration etc) and there is a high possibility to be modified or extinct; and has high diversity of diatoms and macroinvertebrates (especially species present on the international list and EU conventions); The water habitats received score 2 when it is considered as " *Endangered and diversity rich*". Such habitats are more frequently present in the investigated area and Macedonia in general, but are under threat of modification and extinction. These habitats are also biologically rich and provide living space for many species of diatoms and macroinvertebrates. The habitat or water body receive score 3 and is considered as "*Vulnerable and diversity rich*" when it is under human pressure (as water extraction, eutrophication, modification etc), and it possess rich flora and fauna.

Table 2. List of important water bodies and habitats present in the investigation Area

Location or River Name	**Score**	**Status**
Slana Bara	1	Highly endangered, rare and diversity rich
Krkljanska river, spring	2	Endangered and diversity

region		rich habitats
Vlaski Kolibi	2	Endangered and diversity rich habitats
Crna River mouth	3	Vulnerable and diversity rich habitats
Bela River mouth	3	Vulnerable and diversity rich habitats
Toranichka River, spring region	3	Vulnerable and diversity rich habitats
Kamenicka River, spring region	3	Vulnerable and diversity rich habitats
Kriva River, spring region (main brook)	2	Endangered and diversity rich habitats
Tributary of Stanechka River; flowing water	2	Endangered and diversity rich habitats
Stanecka River, spring region (main brook)	3	Vulnerable and diversity rich habitats
Esterac River	2	Endangered and diversity rich habitats
Zelengradska River	2	Endangered and diversity rich habitats
Jamiska River, flowing water	3	Vulnerable and diversity rich habitats
Emiracka River	3	Vulnerable and diversity rich habitats
Bela River-Kostin Dol	3	Vulnerable and diversity rich habitats

2.3 Threats

Desiccation of water bodies due to the climate changes. The decreasing of wet precipitation in last decades significantly influenced the aquatic biota. Wetland biocenoses became seriously endangered, fragmented or threatened with extinction.

- Modification of water regime (from flowing to stagnant water body). On such way a total loss of habitats happened and the species connected with particular habitats can extinct. For example: the construction of dam on river Zletovica.
- Water extraction and capturing of springs and streams. For example water extraction from spring region of Stanechka river for water supply of Kriva Palanka. The spring region of Stanechka river are forming large wetland areas, a habitat which is rare in Macedonia, while on Osogovo these wetlands are the largest sphagnum peat-bogs in

Macedonia. Such human activities can lead to disappearance of specific habitats and species connected with peat-bogs.

- Erosion and deforestation can cause changes in water regime and quality which will lead to changes in species composition. Additionally, the typology of the river bad can be modified with increase of organic and inorganic sediments and loss of particular habitats (macrophytes, stones, pebbles etc). The number of sensitive taxa will decrease, and tolerant and eurivalent species can occur with higher abundances.
- Eutrophication of water bodies due to the fishery ponds and inappropriate management of fisheries. In many cases water from the ponds with high content of nutrients is discharged directly to river ecosystem without any treatment. In several cases it was observed significant changes in algal communities and bottom fauna below outflow from pond.
- Pollution of water bodies with heavy metals from mining activities. Heavily polluted water from flotation is usually discharged without any treatment. Such water is characterized with low pH and contains a high amount of toxic heavy metals and which caused intensive changes in species composition and abundances, and in some cases total species loss.
- Pollution from settlements. Although in higher parts of Osogovo there aren't large villages, however, the pollution is significant due to the small size of the river stretch. The significant changes in biocenoses were observed due to the impact of communal waste water. In some cases (especially in lower part of the rivers) there is significant quantity of solid waste which can cause changes in water flow and also changes in water quality.
- Pollution and eutrophication from stock farms. In many cases, the untreated waste waters from the farms are discharged directly.
- Pollution from agriculture. There is no data about the quantity and quality of agrochemicals (pesticides, herbicides etc) which are used in food production. These organic substances can cause changes in species composition due to their toxicity to many species.

2.4 Conclusions

A total of 253 diatom taxa were recorded on Osogovo Mt. From them, more than 40 taxa were not properly identified and cannot be fitted into a know species due to the differences in valve morphology and size compared with already described taxa. Additional SEM investigations are necessary for adequate treatment of these taxa. Two taxa from genus Luticola have specific characters which are dissimilar with known species and probably belong to undescribed (new) species. The diatom assemblages in peat-bogs are very diverse and contain several rare species (e.g. Gomphosphaenia tackei; Adalafia suchlandtii, Chamaepinnularia soehrensis var. hassiaca etc) which were for first time recorded in R. Macedonia. The upper parts of rivers Kriva, Stanechka, Zletovska, Kamenicka, are inhabited by a typical oligotrophic diatom flora. These communities are in general, represented by cosmopolitan species which distribution is reducing due to the human impact (eutrophication). Therefore, some of them are considered as vulnerable or endangered. During these observations a total of 11 rare, 30 endangered and 3 probably new diatom species were observed. Additionally more than 40 taxa were not completely identified and further investigations are necessary for establishing the proper identity of those taxa.

Further, long-time investigation on water bodies on Osogovo Mountain will enlarge the check-list with more species belonging to other ecological groups. The preliminary investigations of water bodies on Osogovo Mt. show that there are at least 15 sites (water bodies, habitats) important for protection. The highest protection was suggested for wetlands on Slana Bara and nearby spring areas of Stanechka river, as well as rivers Esterac and Zelengradska.

2.5 Recommendation for future monitoring

According to the preliminary investigations of water bodies on Osogovo Mt, several recomendation can be proposed:

- More detailed study of the aquatic flora and fauna in the region in longterm period. One year study is not sufficient for determination of biodiversity of diatoms
- Monitoring of water quality of the river ecosystems, based on diatoms
- Monitoring water quantity, with special emphasis on mountain wetlands (peat-bogs) and springs. Springs sources shouldn't be dredged or impounded. This alternation will cause functionally changes in biological processes.

- Construction of waste water treatment plant for waters discharged from mining Toranica. Further investigations on water chemistry and impact of mining activities on the river Toranica are warranted. No data are available on accumulation rates of heavy metals in fish organs and tissues and macroinvertebrates. The results of this study show that there is significant disturbance in structure of communities (composition and abundance of species).
- Measurements for erosion prevention and deforestation must be undertaken in the area with higher degree of forest degradation.
- Proper management of fisheries and ponds, with special attention to the discharge of waste waters.
- Building of waste water treatment plants for communal waste waters.
- Education of local inhabitants for importance of water ecosystems and biota.

3 VASCULAR FLORA

Floristic richness of Osogovo Mt. is predetermined from actual ecological conditions, as well as from geological and climate changes on which the flora was exposed in the past. It is a consequence of the geographical distinction of the mountain – geographical position, altitude, relief, geological structure and geological past.

First floristic data for this mountain dates from the 19th century from Grisebach (1844) and Degen (1893). Between the two world wars, Osogovo has been visited by Jurisic (1923), Урумов (1923, 1935), Stojanoff (1928), Maly (1928), Stefanov and Georgiev (1931), Stojanov and Ahtarov (1935) and Soška (1940). For the period after the WW II, data for some species from Osogovo Mt. can be found by Kitanov (1948), Lakusic and Gajic (1971), Jovanovic at all, (1975), Micevski (1969, 1990, 1993), Matevski (1986-87) etc. Particularly rich sources of data are phytocenological investigations of Micevski (1978), Djekov and Rizovski (1978) and Matvejeva (1982).

This silicate mountain of the Rhodopi massif is 2252 m.a.s.l. high. The highest peak is Ruen. The lower parts are covered with mixed oak forests, whereas the higher parts are covered with beech forests. Both types of forests are under strong anthropogenic pressure. Intensity of farming (sheep breeding) activity significantly decreased the timberline. The lower parts of this mountain (600-1000 m), particularly from the south and the west sides, belong to the continental-submediteranean region. In this belt, the climate-zonal forest community Querco-carpinetum orientalis is distributed, which is rich of thermo- and xerophylous plant species (*Quercus pubescens, Carpinus orientalis, Fraxinus ornus, Cornus mas, Ranunculus psilostachys* etc). In the higher parts of the mountain continues the Quercetum frainetto-cerris community, with its characteristic species: *Q. frainetto*, *Q. cerris*, *Sorbus domestica*, *Lychnis coronaria*, *Helleborus odorus* and others. Above the belt with *Q. frainetto* and *Q. cerris* is the continental region, in which the community Orno-Quercetum petraeae is the main one - the highest oak forest belt. Besides *Quercus petrea* and *Fraxinus ornus*, this forest is characterized by *Corylus avellana*, *Festuca heterophylla*, *Luzula forsteri*, *Brachypodium sylvaticum* and others. The belt of the beech forest occupies approximately 1100-1800 m elevation belt. It is separated in three regions: piedmont-continental-mountain region, mountain continental region and subalpine mountain region. All of these regions are characterized with a different climate community, such as Festuco heterophyllae-Fagetum for piedmont-continental-mountain region, Calamintho grandiflorae-Fagetum for mountain continental region, and Fagetum subalpinum for subalpine mountain region. Floristic

composition in the first association contains mesophylous beech forest elements, but also thermophylous species from oak forests. In the higher forest communities only mesophylous species are found, which are adapted on conditions in dense beech forests. Key species are *Actaea spicata, Calamintha grandiflora, Dentaria bulbifera, Circea lutetiana, Luzula sylvatica*. Because of the strong human influence, the timberline in Osogovo Mt. is significantly unequal. Maximum altitude in some places is about 1800 m, but in other areas it is descending lower. All areas above the forests, up to the highest parts of the mountain are covered with vegetation of dwarf shrub with *Vaccinium myrtilus*, *V. ulliginosum* and *Bruckenthalia spiculifolia*, as well as different grassland communities from Seslerietalia comosae.

Table 3 List of vascular flora on Osogovo. The total of registered species is 1045 divided in 86 families:

	MARCHANTIOPHYTA	
	MARCHANTIACEAE	*Marchantia polymorpha*
	LYCOPODIOPHYTA	
	LYCOPODIACEAE	*Huperzia selago* (L.) Drnh. ex Schrank et Mart.
		Lycopodium clavatum
	SELAGINELLACEAE	*Selaginella helvetica* (L.) Spring
	EQUISETOPHYTA	
	EQUISETACEAE	*Equisetum arvense* L.
		Equisetum hiemale L.
		Equisetum palustre
		Equisetum telmateia
	POLYPODIOPHYTA	
	ASPIDIACEAE	*Dryopteris filix-mas* (L.) Schott
		Dryopteris borreri
		Dryopteris carthusiana
	ASPLENIACEAE	*Asplenium septentrionale* (L.) Hoffm.
		Asplenium trichomanes L.
		Polystichum setiferum
	ATHYRIACEAE	*Athyrium filix - femina* (L.) Roth.
		Cystopteris fragilis (L.) Bernh.
	HYPOLEPIDACEAE	*Pteridium aquilinum* (L.) Kuhn.
	BLECHNACEAE	*Blechnum spicant*
	OPHIOGLOSSACEAE	*Botrychium lunaria* (L.) Swartz.
	POLYPODIACEAE	*Polypodium vulgare* L.
	THELYPTERIDIACEAE	*Thelypteris phegopteris* (L.) Slosson
	PINOPHYTA	
	CUPRESSACEAE	*Juniperus communis* L.
		Juniperus oxycedrus
		Juniperus sibirica Burgsd.
	PINACEAE	*Abies alba* Mill.
		Picea abies (L.) Krast.
		Pinus nigra L.

		Pinus sylvestris L.
	TAXACEAE	*Taxus baccata* L.
	MAGNOLIOPHYTA	
	MAGNOLIOPSIDA	
	ACERACEAE	*Acer campestre* L.
		Acer heldreichi Orph. ex Boiss.
		Acer hyrcanum Fiesch. et C. A. Mey
		Acer pseudoplatanus L.
	ADOXACEAE	*Adoxa moschatelliana* L.
	AMARANTHACEAE	*Amaranthus defexus*
		Amaranthus lividus
		Atriplex rosea
	ANACARDIACEAE	*Cotinus coggygria*
		Pistacia terebinthus
	APIACEAE	*Aegopodium podagraria* L.
		Aethusa cynapium L.
		Angelica pancici Vand.
		Angelica sylvestris L.
		Anthriscus nitida (Wahlenb.) Garcke
		Anthriscus sylvestris (L.) Hoffm.
		Astrantia major L.
		Bupleurum commutatum
		Bupleurum falcatum L.
		Carum carvi L.
		Chaerophyllum aureum L.var. *balcanicum* (Vel.) Stoj. et Stef.
		Chaerophyllum hirsutum L.
		Cnigium silaifolium (Jacq) Simonk.
		Eryngium campestre L.
		Ferulago silvatica (Bess.) Reichenb.
		Heracleum sibiricum L.
		Heracleum verticillatum Panc.
		Laser trilobum (L.) Borkh.
		Laserpitium latifolium L.
		Ligusticum mutellina (L.) Crantz
		Myrrhoides nodosa (L.) Cann.
		Oenanthe banatica Heuff.
		Oenanthe millefolia Janka.
		Oenanthe stenoloba
		Pastinaca hirsuta Panc.
		Peucedanum aegopodioides (Boiss.) Vand.
		Peucedanum austriacum
		Peucedanum carvifolium Vill.
		Peucedanum cervaria (L.) Lapeyr.
		Peucedanum oligophyllum (Grsb.) Vand. ssp. *aequiradiatum* (Vel.) Acht.
		Physospermum cornubiensis (L.) DC.
		Pimpinella saxifraga
		Sanicula europaea L.

		Seseli libanotis (L.) Koch
		Seseli pallasii Bess.
		Seseli peucedanoides (Bieb.) Kozo-Pol.
		Seseli rigidum W. et K.
		Smyrnium perfoliatum L.
		Torilis arvensis ssp. *neglecta* (Schult.) Thell.
		Torilis japonica (Houtt) DC.
		Torilis nodosa (L.) Gaertn.
		Trinia glauca (L.) Dum.
	ARACEAE	*Arum maculatum* L.
	ARALIACEAE	*Hedera helix* L.
	ARISTOLOCHIACEAE	*Asarum europaeum* L.
	ASTERACEAE	*Achillea chrysocoma* Friv.
		Achillea clusiana Tausch.
		Achillea clypeolata
		Achillea coarctata Poir.
		Achillea collina
		Achillea distans W. et K. ex Willd. ssp. *tanacetifolia* Janch.
		Achillea grandifolia Friv.
		Achillea lingulata W. et K.
		Achillea millefolium L.
		Achillea setacea W. et K.
		Antennaria dioica (L.) Gaertn.
		Anthemis arvensis L.
		Anthemis austriaca
		Anthemis carpatica Willd.
		Anthemis cretica L.
		Anthemis macrantha Heuff.
		Anthemis tinctoria
		Anthemis truimfetti (L.) DC.
		Artemisia vulgaris L.
		Aster alpinus L.
		Aster amellus L.
		Bellis annua L.ssp. *vandasii* (Vel.) D. Webb.
		Bellis perenis L.
		Bellis sylvestris Cyr.
		Carduus carduelis (L.) Gren. ssp. *austro-orientalis* Franco
		Carduus nutans L.
		Carduus personata (L.) Jack.
		Carduus tmoleus
		Carlina acanthifolia All.
		Carlina acaulis
		Carlina corymbosa
		Carlina vulgaris L.
		Centaurea cyanus L.
		Centaurea deusta
		Centaurea jacea

		Centaurea napulifera Roch. ssp *orbelica* (Vel.) Koz. et Andr.
		Centaurea napulifera Roch. ssp *pseudoaxillaris* (Stef.) et T. Georg.) Dost.
		Centaurea nigrescens Willd.
		Centaurea orbelica
		Centaurea rhenana Boreau. ssp. *tartarea* (Vel.) Dost.
		Centaurea rutifolia S. et S.
		Centaurea triumfetti All. ssp. *cana* (S. et S.) Dost
		Centaurea unuflora Turra ssp. *nervosa* (Willd.) Bonn. et Layens
		Chondrilla juncea
		Cicerbita alpina (L.) Wallr.
		Cichorium intybus L.
		Cirsium appendiculatum Grsb.
		Cirsium candelabrum Grsb.
		Cirsium canum
		Cirsium erysithales
		Cirsium heterotrichum Panc.
		Cirsium ligulare Boiss.
		Crepis biennis L.
		Crepis conyzifolia (Gouan) A. Kern.
		Crepis foetida subsp. rheadifolia
		Crepis sancta (L.) Babck.
		Crepis setosa Hall.
		Crepis viscidula Froel.
		Doronicum austriacum ssp. *giganteum* (Grsb.) Cav.
		Doronicum columnae Ten.
		Doronicum hungaricum Rchb.
		Echinops sphaerocephalus
		Erigeron acer L.
		Erigeron annuus
		Eupatorium cannabinum L.
		Filago arvensis
		Filago minima
		Hieracium bifidum Kit.
		Hieracium bauhini
		Hieracium djimilense group Boiss.
		Hieracium gentle
		Hieracium hoppeanum Schult.
		Hieracium lachenalii Gmel.
		Hieracium leithneri (Heldr. et Sart. ex Boiss.) Zahn.
		Hieracium marotii Georg. et Zahm.
		Hieracium murorum
		Hieracium pilosella L.
		Hieracium pilosissisimum Friv.
		Hieracium praealtum
		Hieracium pseuderiopus Zahn.
		Hieracium sparsum Friv. var. *secundum*

		Homogyne alpina
		Hypochaeris maculata L.
		Hypochaeris glabra
		Hypochaeris radicata L.
		Inula bifrons L.
		Inula helenium L.
		Inula salicina L.
		Lactuca quercina L.
		Lapsana communis L.
		Leontodon autumnalis L.
		Leontodon hispidus
		Leucanthemum vulgare Lam.
		Matricaria caucasica (Willd.) Poir.
		Matricaria tryhophylla (Boiss.) Boiss.
		Mycelis muralis (L.) Dum.
		Omalotheca supina (L.) DC.
		Omalotheca sylvatica (L.) Schultz-Bip et F. Schultz
		Petasites albus (L.) Gaertn.
		Petasites hybridus (L.) Gaertn. B.Mey. et Scherb. ssp *ochoroleucus* (Boiss et Huet) Sourek.
		Prenanthes purpurea L.
		Pulicaria dysenterica (L.) Bernh.
		Senecio abrotanifolius L. ssp. *carpathicus* (Herb.) Nym.
		Senecio jacobaea L.
		Senecio nemorensis L. ssp *bulgaricus* (Vel.) Koz. et Andr.
		Senecio pancicii Deg. ssp *arnautorum* (Vel.) Stoj. et Stef.
		Senecio papposus (Reichb.) Less.
		Senecio rupestris W.et K.
		Senecio subalpinus Koch
		Senecio sylvaticus L.
		Senecio vernalis W. et K.
		Senecio viscosus L.
		Solidago virga-aurea L.
		Sonchus asper (L.) Hill.
		Sonchus oleraceus L.
		Tanacetum corymbosum (L.) Schultz-Bip
		Tanacetum macrophyllum (W. et K.) Schultz-Bip.
		Tanacetum partehenium (L.) Schultz-Bip.
		Tanacetum vulgare L.
		Taraxacum officinale Web. ssp *alpinum* (Hoppe.) Chenevard
		Telekia speciosa (Schreb.) Baumg
		Tragopogon balcanicum Vel.
		Tragopogon majus
		Tussilago farfara L.
	ASCLEPIADACEAE	*Vincetoxicum hirundinaria*
	BALSAMINACEAE	*Impatiens noli - tangere* L.
	BETULACEAE	*Alnus glutinosa* (L.) Gaertn.

		Alnus incana (L.) Moench.
		Alnus viridis (Chaix.) DC.
		Betula pendula Roth.
		Carpinus betulus L.
		Carpinus orientalis Mill.
		Corylus avellana L.
		Corylus colurna L.
		Ostrya carpinifolia Scop.
	BORAGINACEAE	*Anchusa officinalis* L. ssp. *officinalis*
		Anchusa procera Bess.
		Cerinthe glabra Mill.
		Cerinthe minor L.
		Cynoglossum creticum Mill.
		Cynoglossum hungaricum Sink.
		Cynoglossum officinale L.
		Myosotis alpestris F.W. Schmidt
		Myosotis laxa Lehm. ssp. *caespitosa* (C.F. Schultz) Hyl. ex Nordh
		Myosotis ramosissima Roch.
		Myosotis scorpioides L.
		Myosotis sylvatica Ehrh. ex Hoffm.
		Onosma heterophylla
		Pulmonaria mollis Wulf. ex Horn.
		Pulmonaria obscura Dumort.
		Pulmonaria officinalis L.
		Pulmonaria rubra Schott
		Symphytum tuberosum L.
	BRASSICACEAE	*Alliaria petiolata* (Bieb.) Cavara. et Grande
		Alyssum repens Baung
		Alyssum saxatile
		Alyssum hirsutum
		Alyssum pichleri
		Arabis glabra (L.) Bernh.
		Arabis hirsuta (L.) Scop.
		Arabis nova Vill.
		Arabis procumbens
		Arabis procurrens W. et K.
		Arabis sagittata (Bertol.)DC.
		Arabis turrita L.
		Barbarea balcana Panc.
		Berteroa incana (L.) DC.
		Capsella bursa-pastoris (L.) Medic.
		Cardamine amara L.
		Cardamine acris
		Cardamine barbaraeoides Hal.
		Cardamine bulbifera (L.) Crantz
		Cardamine glauca Spreng
		Cardamine graeca L.
		Cardamine hirsuta L.

		Cardamine impatiens L.
		Cardamine matthiolii Mored.
		Cardamine pectinata Pall. ex DC.
		Cardamine pratensis L.
		Cardamine raphanifolia Pourr. ssp. *acris* (Grsb.) O.E. Schultz
		Cardaminopsis arenosa (L.) Hay.
		Coronopus squamatus
		Diplotaxis muralis (L.) DC.
		Draba lasiocarpa Roch.
		Draba muralis L.
		Erysimum canescens
		Erysimum cuspidatum
		Erysimum diffusum Ehrh.
		Erysimum drenovskyi Deg.
		Hesperis matronalis L.
		Lunaria annua L.
		Lunaria redivia L.
		Lepidium ruderale
		Rorippa pyrenaica (L.) Rchb.
		Rorippa sylvestris (L.) Bess.
		Raphanus raphanistrum subsp. landra
		Sisymbrium officinale (L.) Scop.
		Thlaspi goesingense Hal.
		Thlaspi kovatsii Heuff.
		Thlaspi ochroleucum Boiss. et Heldr
		Thlaspi perfoliatum L.
		Thlaspi praecox Wulf.
	CAMPANULACEAE	*Campanula alpina* Jack.
		Campanula glomerata
		Campanula epigaeae
		Campanula hemschinica Koch.
		Campanula latifolia L.
		Campanula lingulata
		Campanula moesiaca Vel.
		Campanula patula L. ssp.*patula*
		Campanula persicifolia L.
		Campanula phrygia
		Campanula rapunculus L.
		Campanula rotundifolia L.
		Campanula scheuchzeri Vill.
		Campanula sparsa Friv. ssp. *sphaerothrix* (Grsb.) Hay.
		Campanula spathulata
		Campanula spathulata subsp. sibthorpiana
		Campanula trachelium
		Campanula trojanensis Kovanda. et Ancev
		Campanula velebitica Borb.
		Edraianthus serbicus (Kern.) Petr.
		Jasione bulgarica Stoj. et Stef.

		Jasione dentata
		Jasione heldreichii Boiss. et Orph.
		Jasione montana
		Jasione orbiculata
		Jasione laevis Lam.ssp. *orbiculata* (Grsb. ex Vel.) Tutin
	CAPRIFOLIACEAE	*Lonicera xyiosteum* L.
		Sambucus ebulus L.
		Sambucus nigra L.
		Sambucus racemosa L.
		Viburnum opulus L.
		Valerianella eriocarpa
		Valerianella microcarpa
	CARYOPHYLLACEAE	*Arenaria biflora* L.
		Arenaria rotundifolia M. B.
		Cerastium alpinum L.
		Cerastium arvense L.
		Cerastium brachypetalum
		Cerastium banaticum (Roch.) Heuff. ssp. *alpinum* (Boiss.) Buschm.
		Cerastium decalvans Schloss. et Vuk.
		Cerastium dubium
		Cerastium fontanum
		Cerastium rectum Friv.
		Cucubalus baccifer
		Dianthus armeria
		Dianthus barbatus L.
		Dianthus capitatus Balt. ex DC ssp. *andrezejowskianus* Zapal
		Dianthus cruentus Grsb.
		Dianthus deltoides L.
		Dianthus giganteus
		Dianthus microlepis Boiss.
		Dianthus pinifolius
		Dianthus tristis Vel.
		Herniaria incana Lam.
		Herniaria glabra
		Lychnis flos-cuculi L.
		Lychnis coronaria
		Minuartia hirsuta (N.B.) Hand.Mazz. var. falcata
		Minuartia recurva (All.) Schinz et Thell. ssp. *orbelica* (Vel.)Koz.et Kuzm.
		Minuartia verna (L.) Hiern.
		Minuartia viscosa
		Moehringia mucosa L.
		Moehringia pendula (W. et K.) Fenzl.
		Moehringia trinervia (L.)Clairv.
		Moenchia graeca
		Moenchia mantica
		Petrorhagia illyrica Ball. et Heyw. ssp. *haynaldiana*

		(Janca)Ball. et Heyw.
		Petrorhagia saxifraga(L.) Link.
		Petrorhagia prolifera
		Sagina procumbens L.
		Sagina saginoides
		Saponaria officinalis L.
		Scleranthus neglectus Roch. ex Baung.
		Scleranthus perennis
		Silene armeria L.
		Silene asterias Grsb.
		Silene lerchenfeldiana Baung.
		Silene italica
		Silene otites
		Silene roemeri Friv.
		Silene sendtneri Boiss.
		Silene skorpilii
		Silene subconica
		Silene viridiflora L.
		Silene vulgaris
		Silene waldsteinii Grsb.
		Spergula arvensis L.
		Spergularia rubra (L.) J. et C. Presl.
		Stellaria alsine Grimm.
		Stellaria graminea L.
		Stellaria holostea L.
		Stellaria nemorum L.
		Viscaria vulgaris ssp. *atropurpurea* (Grsb.) Stoj.
	CELASTRACEAE	*Euonymus europaeus* L.
		Euonymus latifolius (L.) Mill.
		Euonymus verrucosus Scop.
	CHENOPODIACEAE	*Beta trigyna* W. et K.
		Chenopodium bonus - henricus L.
		Chenopodium glaucum L.
		Chenopodium opulifolium
		Chenopodium polyspermum
		Rodax canus
		Polycnemum majus
	CISTACEAE	*Helianthemum nummularium* (L.) Mill.
		Helianthemum salicifolium
		Tuberaria guttata
	CONVOLVULACEAE	*Convolvulus arvensis*
		Convolvulus canthabrica
	CORNACEAE	*Cornus mas* L.
		Cornus sanguinea L.
	CRASSLUACEAE	*Jovibarba heuffelii* (Schott.) A. et D.Love
		Rhodiola rosea L.
		Sedum acre L.
		Sedum album L.
		Sedum alpestre Vill.

		Sedum annum L.
		Sedum cepaea L.
		Sedum erythraeum
		Sedum hispanicum
		Sedum ochroleucum Chaix. in Vill.
		Sedum rubens L.
		Sedum sartorianum Boiss.
		Sedum tuberiferum
		Sempervivum erythraeum Vel.
		Sempervivum leucanthum Panc. var. *ciliosum* (Panc.) Hayk.
	DIPSACACEAE	*Cephalaria flava* (S. S.) Szabo
		Dipsacus laciniatus L.
		Dipsacus pilosus L.
		Knautia arvensis (L.) Coult.
		Knautia dinarica (Murb.) Borb.
		Knautia drymeia Heuff.
		Knautia midzorensis Form.
		Knautia midzorensis Form. x *perfoliata* Vel.
		Scabiosa columbaria L.
		Scabiosa lucida Vill.
		Scabiosa ochroleuca
		Scabiosa triniifolia Friv.
		Scabiosa ucranica
		Scabiosa webbiana D. Don.
		Succisa pratensis Moench.
	ERICACEAE	*Arctostaphylos uva - ursi* (L.) Spreng.
		Bruckenthalia spiculifolia (Salisb.) Rchb.
		Vaccinium myrtillus L.
		Vaccinium uliginosum L.
		Vaccinium vitis - idaea L.
	EUPHORBIACEAE	*Euphorbia amygdaloides* L
		Euphorbia cyparissias L.
		Euphorbia esula ssp. *tommassiana*
		Euphorbia niciciana
		Euphorbia polychroma Kern.
		Euphorbia pubescens
		Euphorbia serrulata Thuill.
		Euphorbia villosa
		Mercurialis perennis L.
	FABACEAE	*Anthyllus vulneraria*
		Astrgalus glycyphyllos L.
		Astragalus odoratus
		Chamaecytisus absinthioides (Janka) Kuzm.
		Chamaecytisus glaber (L.) Rothm.
		Chamaespartium sagitale (L.) Gibbs.
		Coronilla emeroides
		Coronilla varia
		Colutea arborescens

		Commelina communis
		Dorycnium herbaceum Vill.
		Genista carinalis Grsb.
		Genista depressa Bieb. ssp. *moesiaca* Vel.
		Genista fukarekiana
		Genista januensis Viv.
		Genista ovata W. et K.
		Genista pilosa
		Genista tinctoria L. var. *virgata*
		Lathyrus aphaca
		Lathyrus hirsutus
		Lathyrus grandiflorus
		Lathyrus laxiflorus (Dest.) O. Kuntze
		Lathyrus niger (L.) Bernh.
		Lathyrus pratensis
		Lathyrus sylvestris L.
		Lathyrus vernus (L.) Bernh.
		Lotus corniculatus L.
		Medicago falcata
		Medicago minima (L.) Bart.
		Melilotus alba Medic.
		Ononis spinosa L.
		Robinia pseudoacacia L.
		Trifolium alpestre L.
		Trifolium angustifolium
		Trifolium arvense L.
		Trifolium aureum Poll.
		Trifolium badium Schreb. ssp.*pseudobadium* (Vel.) Koz.
		Trifolium campestre Schreb
		Trifolium dubium
		Trifolium cherleri
		Trifolium echinatum
		Trifolium hybridum L.
		Trifolium hirtum
		Trifolium incarnatum
		Trifolium medium L.
		Trifolium michelianum Savi.
		Trifolium montanum
		Trifolium ochroleucon Huds.
		Trifolium pannonicum
		Trifolium pignatii Fauche. et Chaub.
		Trifolium pratense
		Trifolium repens L. ssp. *orbelicum* (Vel.) Pawl.
		Trifolium resupinatum
		Trifolium smyrnaeum
		Trifolium striatum
		Trifolium trichopterum Panc.
		Trfolium tenuifolium
		Trifolium velenovskyi Vandas.

		Vicia bithynica
		Vicia cracca
		Vicia dalmatica
		Vicia grandiflora Scop.
		Vicia hirsuta
		Vicia laeta Cesati.
		Vicia lathyroides L.
		Vicia onobrychoides L.
		Vicia pisiformis L.
		Vicia sepium L. var. *sepium*
	FAGACEAE	*Fagus sylvatica* L.
		Quercus cerris L.
		Quercus dalechampii Ten.
		Quercus frainetto
		Quercus petraea (Mart.) Lieb.
		Quercus pubescens
	GENTIANACEAE	*Centhaurium erythrea*
		Centaurium pulchellum (Swartz) Druc.
		Gentiana asclepiadea L.
		Gentiana cruciata L.
		Gentiana lutescens (Vel.) Holub.
		Gentiana punctata L.
		Gentiana utriculosa L.
		Gentianella bulgarica (Vel.) Holub.
		Gentianella germanica (Willd.) Born.
	GERANIACEAE	*Erodium cicutarium* (L.) L' Her.
		Geranium divaricatum Ehrh.
		Geranium lucidum L.
		Geranium macrorrhizum L.
		Geranium pheum L.
		Geranium robertianum L.
		Geranium sanguineum
		Geranium sylvaticum L.
	JUGLANDACEAE	*Juglans regia*
	HYPERICACEAE	*Hypericum annulatum*
		Hypericum barbatum
		Hypericum hirsutum L.
		Hypericum maculatum Grantz
		Hypericum perforatum L.
		Hypericum richerii Vill. ssp. *grisebachii* (Boiss.) Nym.
		Hypericum rumeliacum
		Hypericum tetrapterum Fries.
	LAMIACEAE	*Acinos alpinus* (L.) Moench. ssp. *hungaricus* (Simonk.) Sojak.
		Acinos arvensis
		Acinos suaveolens (S. et S.) G. Donf.
		Ajuga genevensis L.
		Ajuga laxmanii (L.) Benth.
		Ajuga pyramidalis L.

		Ajuga reptans
		Ballota nigra L. ssp. *nigra*
		Calamintha grandiflora (L.) Moench.
		Calamintha nepeta
		Calamintha sylvatica
		Clinopodium vulgare L.
		Galeopsis speciosa Mill.
		Galeopsis tetrahit L.
		Lamiastrum galeobdolon (L.)Ehrend. et Polatschek
		Lamium amplexicaule L.
		Lamium garganicum L.
		Lamium maculatum
		Lamium purpureum L.
		Mentha aquatica
		Mentha longifolia (L.) Huds.
		Mentha pulegium
		Mentha spicata
		Micromeria cristata (Hampe.) Grsb.
		Nepeta cataria L.
		Nepeta nuda
		Nepeta canonica
		Origanum vulgare L.
		Prunella grandiflora (L.) Schol.
		Prunella laciniata
		Prunella vulgaris L.
		Salvia glutinosa L.
		Salvia verticillata
		Scutellaria altissima
		Scutellaria galericulata
		Stachys alpina L.
		Stachys angustifolia
		Stachys plumosa Grsb.
		Stachys scardica (Grsb.) Hay.
		Stachys sylvatica L.
		Teucrium chamaedrys
		Teucrium polium
		Thymus albanus H.Braun
		Thymus balcanus
		Thymus jankae Celak.
		Thymus longicaulis
		Thymus macedonicus
		Thymus tosevii
		Thymus vandasii Vel.
	LENTIBULARIACEAE	*Pinguicula balcanica* Casper
	LINACEAE	*Linum austriacum*
		Linum biene
		Linum capitatum Kit. ex Schult.
		Linum catharticum L.
		Linum hologynum Rchb.

	LYTHRACEAE	*Lythrum salicaria* L.
	MALVACEAE	*Althea officinalis* L.
		Hibiscus tronium
		Abutilon theophrasti
	OLEACEAE	*Fraxinus exelsior* L.
		Fraxinus ornus L.
	ONAGRACEAE	*Circaea luteciana* L
		Epilobium adnatum
		Epilobium alsinifolium Vill. ssp. *parviflorum* I. Ganc
		Epilobium anagalidifolium Lam.
		Epilobium angustifolium L.
		Epilobium collinum C. C. Gmel.
		Epilobium hirsutum L.
		Epilobium montanum L.
		Epilobium nutans F. Schm.
		Epilobium obscurum Schreb.
		Epilobium palustre L.
	OROBANCHACEAE	*Parentucellia latifolia*
	OXALIDACEAE	*Oxalis acetosella* L.
	PAPAVERACEAE	*Chelidonium majus* L.
		Corydalis bulbosa (L.) DC.
		Corydalis solida (L.) Swartz
		Papaver agremone
		Fumaria rostellata Knaf.
		Glaucium corniculatum
	PLANTAGINACEAE	*Plantago atrata* Hoppe.
		Plantago holosteum
		Plantago lanceolata L.
		Plantago carinata
		Plantago major L.
		Plantago media L.
		Plantago subulata L.
	PLUMBAGINACEAE	*Armeria rumelica* Boiss.
		Armeria rumelica var. rhodopaea
	POLYGALACEAE	*Polygala comosa* Schkuhr.
		Polygala major Jacq.
		Polygala oxyptera Rchb.
	POLYGONACEAE	*Bistorta major* S. Gray
		Bistorta vivipara (L.) S. Gray
		Persicaria mitis (Schrank) Opiz.
		Pleuropteropyrum undulatum (A. Murr.) A. et D. Love
		Polygonum alpinum
		Rumex acetosa
		Rumex acetosella L.
		Rumex alpinus L.
		Rumex angiocarpus
		Rumex pulcher
	PORTULACACEAE	*Montia fontana* L.
	PRIMULACEAE	*Lysimachia vulgaris* L.

		Primula veris L.
		Pulsatilla montana subsp. slavjankae
		Soldanella chrysostricta Kress.
	PYROLACEAE	*Moneses uniflora* (L.) A. Gray
		Orthilia secunda (L.) House.
		Pyrola chlorantha Swartz
		Pyrola media Swartz
		Pyrola rotundifolia L.
	RANUNCULACEAE	*Actaea spicata* L.
		Anemone narcissiflora L.
		Anemone nemorosa L.
		Anemone ranunculoides L.
		Anemone sylvestris L.
		Aquilegia nigricans Baung.
		Aquilegia aurea
		Caltha alpestris Schott, Nym. et Kostschy
		Caltha laeta Schott, Nym. et Kostschy
		Caltha palustris
		Clematis vitalba L.
		Clematis flamula
		Consolida regalis
		Helleborus odorus
		Hepatica nobilis
		Isopyrum thalictroides
		Nigella arvensis
		Ranunculus acris L.
		Ranunculus auricomus L.
		Ranunculus bulbosus
		Ranunculus ficaria L.
		Ranunculus illyricus L.
		Ranunculus montanus Willd.
		Ranunculus nemorosus DC.
		Ranunculus oreophylus
		Ranunculus platanifolius L.
		Ranunculus polyanthemos L.
		Ranunculus pedatus
		Ranunculus pseudomontanus
		Ranunculus psilostachys
		Ranunculus repens L.
		Ranunculus serbicus Vis.
		Thalictrum aquilegiifolium L.
		Thalictrum minus L.
		Trollius europaeus L.
	ROSACEAE	*Agrimonia eupatoria* L.
		Agrimonia procera Wallr.
		Alchemilla cinerea Buser.
		Alchemilla crinita
		Alchemilla erythropoda Juz.
		Alchemilla glabra

		Alchemilla glaucescens Wallr.
		Alchemilla gracilis Opiz.
		Alchemilla monticola Opiz.
		Alchemilla xanthochlora Rothm.
		Alchemilla flabellata
		Amelanchier ovalis Medic.
		Aphanes arvensis
		Aremonia agrimonoides (L.) DC.
		Cotoneaster integerrimus Medic.
		Crataegus monogyna Jacq.
		Filipendula ulmaria (L.) Maxim
		Filipendula vulgaris
		Fragaria moschata Duchesue
		Fragaria vesca L.
		Fragaria viridis
		Geum coccineum S. et S.
		Geum molle Vis. et Panc.
		Geum montanum L.
		Geum reptans L.
		Geum rhodopaeum Stoj. et Stef.
		Geum rivale L.
		Geum urbanum L.
		Potentilla argentea L.
		Potentilla aurea
		Potentilla erecta (L.) Rausch.
		Potentilla haynaldiana Janka
		Potentilla inclinata
		Potentilla laciniosa
		Potentilla micrantha Ramond ex DC.
		Potentilla neglecta Baumg.
		Potentilla reptans
		Potentilla sulphurea Lam.
		Potentilla ternata C. Koch
		Prunus avium L.
		Prunus cerasifera Ehrh.
		Prunus mahaleb
		Prunus spinosa L.
		Pyrus eleagnifolia
		Pyrus sylvestris
		Pyrus piraster
		Rosa canina L.
		Rosa pendulina
		Rubus idaeus L.
		Rubus hirtus
		Rubus saxatilis L.
		Rubus canescens
		Rubus discolor
		Rubus sanguineus
		Sanguisorba minor

		Sanguisorba officinalis L.
		Sibbaldia parviflora Willd.
		Sorbus aria (L.) Krantz
		Sorbus aucuparia L.
		Sorbus domestica
		Sorbus umbellata (Desf.) Fritsch ssp. *meridionalis* (Guss.) Valev
		Spiraea chamaedryfolia L.
		Waldsteinia geoides Willd.
	RUBIACEAE	*Asperula aristata* L. ssp.*scabra* (J. et C. Persl.) Nym.
		Asperula cynanchica L.
		Asperula cynanchica L. var. *densiflora*
		Asperula rumelica
		Crucianella angustifolia
		Cruciata glabra (L.)Ehrend
		Cruciata laevipes Opiz.
		Galium album Mill.
		Galium aparine
		Galium divaricatum
		Galium lucidum
		Galium macedonicum
		Galium odoratum (L.) Scop.
		Galium palustre L.
		Galium pseudoaristatum Sdur.
		Galium schultesii Vest.
		Galium uliginosum
		Galium verum L.
	SALICACEAE	*Populus tremula* L.
		Populus alba
		Salix alba L.
		Salix appendiculata Vill.
		Salix caprea L.
		Salix cinerea
		Salix fragilis
		Salix purpurea L.
		Salix triandra L.
	SANTALACEAE	*Thesium alpinum* L.
		Thesium arvense
	SAXIFRAGACEAE	*Chrysosplenium alternifolium* L.
		Parnassia palustris L.
		Ribes alpinus
		Ribes petraeum Bieb.
		Ribes uva - crispa L.
		Saxifraga bulbifera L.
		Saxifraga paniculata Mill.
		Saxifraga pedemontana subsp. cymosa
		Saxifraga rotundifolia L.
		Saxifraga stellaris L. ssp. *alpigena* Temesy
	SCROPHULARIACEAE	*Digitalis grandiflora* Mill.

		Digitalis lanata
		Digitalis viridiflora Lind.
		Euphrasia hirtella Jord.ex Reut.
		Euphrasia liburnica Wettst
		Euphrasia minima Jack. et DC. ssp. *minima*
		Euphrasia rostkoviana Hayne
		Euphrasia salisburgensis Funck
		Gratiola officinalis L.
		Linaria concolor
		Linaria dalmatica (L.) Mill.
		Linaria genistifolia (L.) Mill.
		Linaria grandiflora Desf.
		Linaria pelisseriana
		Linaria simplex
		Linaria vulgaris
		Melampyrum arvense
		Melampyrum bihariense Kern
		Melampyrum pratense
		Melampyrum sylvaticum L.
		Odontites serotina
		Odontites verna
		Pedicularis leucodon Grsb.
		Pedicularis orthantha
		Rhinanthus minor
		Rhinanthus rumelicus
		Rhinanthus wagneri Deg. ssp. *anceps* (Bhrend) Soo
		Scrophularia aestivalis Griseb.
		Scrophularia canina L.
		Scrophularia nodosa L.
		Scrophularia umbrosa Dum.
		Verbascum abietinum Borb.
		Verbascum adamovicii Vel.
		Verbascum austriacum
		Verbascum banaticum
		Verbascum foeniceum
		Verbascum jankaeanum Panc.
		Verbascum longifolium Ten.
		Verbascum lesnovensis
		Verbascum nigrum
		Verbascum phlomoides L.
		Verbascum phoeniceum L. var. *amplexicaule* Vel.
		Verbascum thapsus
		Veronica austriaca
		Veronica angallis - aquatica L.
		Veronica beccabunga L.
		Veronica bellidioides L.
		Veronica chamedrys L.
		Veronica jacquinii
		Veronica officinalis L.

		Veronica serpyllifolia L.
		Veronica teucrium L.
		Veronica urticifolia Jacq.
		Veronica vindobonensis
	SOLANACEAE	*Atropa belladonna* L.
		Solanum dulcamara
	THYMELACEAE	*Daphne mezereum* L.
	TILIACEAE	*Tilia platyphyllos* Scop.
	ULMACEAE	*Ulmus glabra* Huds.
		Ulmus minor
	URTICACEAE	*Urtica dioica* L.
	VALERIANACEAE	*Valeriana officinalis* L.
		Valeriana tripteris L.
	VIOLACEAE	*Viola aetolica* Boiss. et Heldr.
		Viola alba Dess.
		Viola altaica x *lutea* x *tricolor*
		Viola biflora L.
		Viola canina L.
		Viola dacica
		Viola gracilis et Sm.
		Viola odorata
		Viola orbelica Panc.
		Viola pyrenaica Ramond ex DC.
		Viola reichenbachiana
		Viola sieheana W. Beck.
		Viola tricolor L.
	LILIOPSIDA	
	AMARYLLIDACEAE	*Galanthus nivalis* L.
	CYPERACEAE	*Carex acuta* L.
		Carex caryophyllea Latourr
		Carex cinerea
		Carex dacica Heuff.
		Carex distans
		Carex echinata Murr.
		Carex flava L.
		Carex gracilis
		Carex hirta
		Carex leporina
		Carex montana L.
		Carex muricata L.
		Carex nigra (L.) Rchb.
		Carex otrubae Podp
		Carex ovalis Good.
		Carex pallescens L.
		Carex panicea L.
		Carex remota L.
		Carex sylvatica Huds.
		Carex tricolor Vel.
		Eriophorum angustifolium Honck.

		Eriophorum latifolium Hoppe.
		Scirpus sylvaticus L.
		Scirpus lacuster
	IRIDACEAE	*Crocus chrysanthus* (Herb.) Herb.
		Crocus veluchensis Herb.
		Iris variegata L.
	JUNCACEAE	*Juncus acutiflorus* Ehrh. ex Hoffm.
		Juncus alpigenus C. Koch
		Juncus articulatus L.
		Juncus atratus Krock.
		Juncus compressus Jacq.
		Juncus conglomeratus L.
		Juncus effusus L.
		Juncus filiformis L.
		Juncus inflexus
		Juncus ranarius Song. Et Perr
		Juncus tenuis Willd.
		Juncus trifidus L.
		Luzula alpino-pillosa (Chaiex)Breistr. ssp *velenovskyi*(Koz.)Chr.
		Luzula campestris (L.) DC.
		Luzula forsteri (Sm.) DC.
		Luzula italica Parl.
		Luzula luzuloides (Lam.) Dandy
		Luzula nemorosa
		Luzula multiflora (Retz.) Lej.
		Luzula pillosa (L.) Willd.
		Luzula pindica (Hausskn.) Chr. et Krs.
		Luzula sylvatica (Huds.) Grand.
	LILIACEAE	*Allium carinatum* L.
		Allium cirrhosum
		Allium flavum L.
		Allium moschatum L.
		Allium paniculatum L.
		Allium rotundum
		Allium ursinum L.
		Allium sphaerocephalon
		Asphodelus albus
		Asphodeline lutea
		Colchicum autumnale L.
		Gagea arvensis (Pers.) Dum.
		Gagea lutea (L.) Ker. Gaw.
		Lilium jankae
		Lilium martagon L.
		Muscari racemosum
		Ornithogalum montanum
		Ornithogalum comosum
		Paris quadrifolia L.
		Polygonatum latifolium

		Polygonatum verticillatum (L.) All.
		Scilla bifolia L.
		Veratrum album
		Veratrum lobelianum Bernh.
		Veratrum nigrum L.
	ORCHIDACEAE	*Cephalanthera longifolia* (L.) Fritsch.
		Coeloglossum viride (L.) Hartm.
		Dactylorhiza cordigera (Fries.) Soo.
		Dactylorhiza incarnata (L.) Soo.
		Dactylorhiza saccifra (Brongn) Soo.
		Dactylorhiza sambucina
		Epipactis helleborine (L.) Krantz
		Epipactis purpurata Sm.
		Gymnadenia conopsea (L.) R. Br.
		Hymanthoglossum caprinum
		Neottia nidus - avis (L.) L. C. Rich.
		Nigritella nigra Rchb.
		Orchis laxiflora Lam.
		Orchis morio
		Orchis pallens L.
		Platanthera bifolia (L.) Rchb.
		Pseudorchis albida (L.) A. et D. Love
	POACEAE	*Agrostis canina* L.
		Agrostis capillaris L.
		Agrostis castellana ssp. *bizantina*
		Agrostis rupestris All.
		Agrostis stolonifera
		Agropyron repens
		Aira elegantissima
		Aira capillaris
		Aira capillaris var. ambigua
		Alopecurus gerardii Vill.
		Anthoxanthum odoratum L.
		Arrhenatherum elatius (L.) Beauv. ex J. et C. Presl
		Avenula pubescens (Huds.) Dum.
		Avenula versicolor (Vill.) Lainz.
		Bellardiochloa violacea (Bell.) Chiov.
		Brachypodium pinnatum
		Brachypodium sylvaticum
		Briza media L.
		Bromus mollis
		Bromus racemosus L.
		Bromus squarosus
		Bromus sterillis
		Calamagrostis arundinacea (L.) Roth.
		Calamagrostis villosa (Chaix.) Mutel.
		Chrysopogon grillus
		Cynodon dactylon (L.) Pers.
		Cynosurus cristatus L.

		Cynosurus echinatus
		Dactylis glomerata L.
		Danthonia calycina
		Danthonia decumbens
		Deschampsia caespitosa (L.)Beauv.
		Dichanthium ischaemum
		Elymus repens
		Festuca airoides Lam.
		Festuca altissima All.
		Festuca arundinacea Schreb.
		Festuca balcanica
		Festuca dalmatica
		Festuca gigantea (L.) Vill.
		Festuca heterophylla Lam.
		Festuca nigrescens
		Festuca paniculata (L.) Schinz. et Thell.
		Festuca picturata Pils.
		Festuca pirinensis (Acht.) Acht.
		Festuca pratensis L.
		Festuca riloensis (Hack. ex Hay.) Markgr. - Dannb.
		Festuca rubra L.
		Festuca spectabilis Jan.ssp.*affinis* (Boiss.et Heldr.ex Hack)Hack
		Festuca supina
		Festuca thracica
		Festuca valesiaca
		Festuca valida (Ueehtr.) Peuz.
		Glyceria fluitans R. Br.
		Holcus lanatus
		Holcus mollis L.
		Hordelymus europaeus (L.) Harz.
		Hordeum murinum L.
		Koeleria eriostachya Panc.
		Koeleria macrantha
		Koeleria nitidula
		Koeleria simonkaii Adam.
		Lerchenfeldia flexuosa (L.) Schur.
		Melica ciliata
		Melica uniflora Retz.
		Milium effusum L.
		Molinia caerulea (L.) Moench.
		Nardus stricta L.
		Phleum alpinum L.
		Phleum phleoides
		Phleum pratense L.
		Phragmites australis
		Poa badensis Haenke ex Willd
		Poa bulbosa ssp. *vivipara*
		Poa alpina L.

		Poa annua L.
		Poa cenisia All.
		Poa compresa
		Poa media Schur.
		Poa mollineri
		Poa nemoralis L.
		Poa palustris
		Poa pratensis L.
		Sesleria comosa Vel.
		Sesleria coerulans
		Sesleria rigida
		Vulpia ciliata
		Vulpia myuros
	TYPHACEAE	*Typha latifolia*

3.1 Valorization

The valorization of the floristic diversity of the Osogovo Mts. is performed according to international conventions and directives, ratificated from both countries: EU Habitat Directive 92/43EEC, Bern Convention Appendix I… it also has been used: Red Data Book of Bulgaria, Law on Biological Diversity in Bulgaria, Country study for Biodiversity of the Republic of Macedonia-first National Report, 2003, and Biodiversity Strategy and Action Plan of the Republic of Macedonia, 2004. According to these directives and national documents, the important plant taxa from Osogovo Mts. is presented in the following table:

Species name		**BC (Appendix I)**	**HD**	**National status (BG)**	**National status (MK)**
Acer heldreichii	Balkan endemic			Red Book – vulnerable	
Angelica pancici.	Balkan endemic			Red Book-rare	
Genista fukarekiana					National endemic (loc.class.)
Fritillaria gussichiae			Annex IV		
Peucedanum aegopodioides	Balkan endemic				
Peucedanum oligophyllum	Balkan endemic			Red Book – rare	
Achillea chrysocoma	Balkan endemic				
Centaurea nigrescens.				Law on	

				Biological Diversity	
Senecio subalpinus				The only locality found	
Barbarea balcana	Balkan endemic				
Campanula latifolia				Red Book – endangered	
Campanula trojanensis				National endemic	
Campanula velebitica				National endemic	
Jasione bulgarica				Law on Biological Diversity, national endemic	
Cerastium decalvans	Balkan endemic				
Dianthus microlepis	Balkan endemic				Rare, the only locality found
Dianthus tristis	Balkan endemic				
Silene asterias	Balkan endemic				
Silene roemeri	Balkan endemic				
Silene waldsteinii	Balkan endemic				
Knautia midzorensis	Balkan endemic				
Scabiosa webbiana	Balkan endemic				
Chamaecytisus absinthioides	Balkan endemic				
Stachys sylvatica	Balkan endemic				
Pinguicula balcanica	Balkan endemic				
Armeria rumelica	Balkan endemic				
Aquilegia nigricans				Law on biological diversity. Red book – rare	
Aquilegia aurea					
Allium melanantherum.	Balkan endemic				

Sibbaldia parviflora				The only locality found	
Viola aetolica	Balkan endemic				
Verbascum lesnovensis					National endemic (loc.class.)
Viola gracilis				Law on biological diversity. Red book – rare	
Viola orbelica				Law on biological diversity. National endemic. Red book – rare	
Viola biflora					Rare, the only locality found
Lilium jankae		+		Law on biological diversity	
Lilium martagon					
Dactylorhiza incarnata				Law on biological diversity	
Orchis morio	CITES				
Orchis laxiflora	CITES				
Orchis pallens	CITES				
Cirsium appendiculatum	Balkan endemic				
Cirsium candelabrum	Balkan endemic				
Crocus veluchensis	Balkan endemic				
Stachys plumosa	Balkan endemic				
Stachys scardica	Balkan endemic			Red Book – endangered	
Pedicularis orthrantha	Balkan endemic				
Scabiosa triniifolia	Balkan endemic				
Pastinaca hirsuta	Balkan endemic				
Jovibarba heuffelii	Balkan endemic			Red Book – rare	
Marsilea quadrifolia		+			

Lycopodium clavatum					Rare, the only locality found
Dryopteris borreri					Rare, the only locality found
Dryopteris carthusiana					Rare, the only locality found
Potentilla haynaldiana					Rare, the only locality found
Pyrola rotundifolia					Rare, the only locality found
Commelina communis					Rare, the only locality found
Genista depressa subsp. moesiaca					Rare, the only locality found
Chamaecytisus absinthioides var. grandiflorus					Rare, the only locality found
Lathyrus grandiflorus				Red Book – endangered	

4 FUNGI

Systematic research into mycodiversity of Osogovo Mt. has been conducted more intensively during the projects performed in the period 2007-2010, and there are relatively few mycological papers concerned only with individual species from this mountain before that. Publications making reference to individual species when comes to Macedonian parto of the mountain are as follows: *Amanita muscaria* (Karadelev et al. 2004, Karadelev & Spasikova, 2004a; Karadelev & Spasikova, 2004b); *Amanita pantherina* (Karadelev et al. 2004; Karadelev & Spasikova, 2004b); *Antrodia malicola* (Karadelev 1999); *Boletus aereus* (Karadelev et al. 2006); *Boletus edulis* (Karadelev et al. 2006); *Boletus fechtneri* (Karadelev et al. 2006); *Gyrophanopsis polonensis* (Karadelev 1999); *Hymenochaete rubiginosa* (Karadelev & Rusevska, 2004-2005); *Suillus luteus* (Karadelev et al. 2007); *Suillus variegatus* (Karadelev, et al. 2007) and *Xerocomus chrysenteron* (Karadelev et al. 2006; Karadelev et al. 2007). From the Bulgarian site only 11 species have been reported so far by the mountain territory. Eight types of wood decaying fungi are published in the affairs of Stoychev (1987, 1990), seven of which were confirmed within the projects obtained on Osogovo. A rare species of Ascomycetes found Dimitrova (1994). Other two types ascomycetes reported comparatively recently Dimitrova & Assyov (2004), and a rare Basidiomycetes published by Giosheva (in Peev, in press). Amid the diverse and well preserved habitats, this figure is insignificant and allows to conclude that virtually no data on mycota this extremely interesting mountain.

4.1 Number of fungi species

In total there are approximately 342 fungi species known from Osogovo Mt. This list was compiled on the basis of published data by Karadelev (1999); Karadelev & al. (2004, 2006 & 2007); Karadelev & Rusevska (2004/2005); Dimitrova & Assyov (2004) (Gyosheva et al. 2006) and Karadelev & Spasikova (2004a & b). The survey also includes citation of the unpublished records of species collected on Osogovo Mountain up till now, exiccata deposited in different collections, research notes of the present authors, other individual collectors, and data from field research trips organised by Macedonian Ecological Society (MES), Macedonian Mycological Society (MMS), Biology Students' Research Society (BSRS), students' field research trips, etc.

List of recorded fungi species

1. Abortiporus biennis
2. Agaricus arvensis
3. Agaricus campestris
4. Agaricus macrosporus
5. Agrocybe cylindracea
6. Agrocybe praecox
7. Aleuria aurantia
8. Aleurodiscus disciformis
9. Amanita battarae
10. Amanita caesarea
11. Amanita ceciliae
12. Amanita citrina
13. Amanita junquillea
14. Amanita mairei
15. Amanita muscaria
16. Amanita pantherina
17. Amanita phalloides
18. Amanita rubescens
19. Amanita vaginata
20. Amaurodon viridis
21. Amyloclitocybe clavipes
22. Antrodia malicola
23. Antrodiella romellii cf.
24. Armillaria mellea
25. Antrodia serialis
26. Antrodia sinuosa
27. Antrodia xantha
28. Ascotremella faginea cf.
29. Astraeus hygrometricus
30. Athelopsis glaucina
31. Auricularia auricula-judae
32. Auricularia mesenterica
33. Auriscalpium vulgare
34. Bertia moriformis
35. Biscognauxia nummularia
36. Bjerkandera adusta
37. Bjerkandera fumosa
38. Boletus aereus
39. Boletus aestivalis
40. Boletus edulis
41. Boletus erythropus
42. Boletus fechtneri
43. Boletus luridus
44. Boletus queletii
45. Boletus rhodoxanthus
46. Boletus satanas
47. Boletus subtomentosus
48. Bolbitius vitellinus
49. Botryobasidium
50. Bovista aestivalis
51. Bovista plumbea
52. Calocera cornea
53. Calocybe gambosa
54. Calvatia excipuliformis
55. Calvatia utriformis
56. Camarophyllus virgineus
57. Cantharellus cibarius
58. Ceriporia reticulata cf.
59. Cerrena unicolor
60. Chroogomphus rutilus
61. Chlorophyllum rhacodes
62. Clavariadelphus pistillaris
63. Clavulina cinerea
64. Clavulina rugosa
65. Clitocybe dealbata
66. Clitocybe gibba
67. Clitocybe nebularis
68. Clitocybe odora
69. Clitocybe phaeophthalma
70. Collybia butyracea
71. Collybia dryophila
72. Coltricia perennis
73. Coniophora puteana
74. Coprinus comatus
75. Coprinus domesticus
76. Coprinus micaceus
77. Coprinus picaceus
78. Coprinus silvaticus
79. Cortinarius trivialis
80. Cortinarius delibutus
81. Cortinarius hinnuleus
82. Cortinarius salor gr.

83. Cortinarius torvus
84. Craterellus cornucopioides
85. Crepidotus variabilis
86. Crepidotus mollis
87. Crinipellis scabellus
88. Crucibulum laeve
89. Cyathus olla
90. Cyathus striatus
91. Cyathus stercoreus
92. Cyclaneusma niveum
93. Cystoderma carcharias
94. Cystolepiota seminuda
95. Daedaleopsis confragosa
96. Dacrymyces stillatus
97. Dacrymyces variisporus
98. Daedalea quercina
99. Dasyscyphus virgineus
100. Diatrype stigma
101. Diatrype disciformis
102. Endoptychum agaricoides
103. Entoloma clypeatum
104. Entoloma sinuatum
105. Exidia glandulosa
106. Exidia truncata
107. Fistulina hepatica
108. Fomes fomentarius
109. Fomitopsis pinicola
110. Fuligo septica
111. Funalia trogii
112. Galerina marginata
113. Ganoderma applanatum
114. Ganoderma pfeifferi
115. Geastrum striatum
116. Gloeocystidiellum luridum
117. Gymnopus dryophilus
118. Gymnopus fusipes
119. Gyrodon lividus
120. Gyrophanopsis polonensis
121. Haasiella venustissima
122. Hemimycena crispula
123. Hebeloma sinapizans
124. Helvella lacunosa
125. Hericium coralloides
126. Hydnum repandum
127. Hygrocybe virginea
128. Hygrophoropsis aurantiaca
129. Hygrophorus eburneum
130. Hygrophorus discoxanthus
131. *Hygrophorus latitabundus
132. *Hygrophorus persoonii
133. Hygrophorus pudorinus
134. Hygrophorus vitellinus
135. Hymenochaete fuliginosa
136. Hymenochaete rubiginosa
137. Hymenochaete subfuliginosa
138. Hymenoscyphus fructigenus
139. Hyphoderma roseocremeum
140. Hyphoderma setigerum
141. Hyphodontia crustosa
142. Hyphodontia subalutacea
143. Hypholoma fasciculare
144. Hypholoma lateritium
145. Hypoxylon fuscum
146. Hypoxylon vogesiacum
147. Inocybe geophilla
148. Inonotus nodulosus
149. Ischnoderma benzoinum
150. Ischnoderma resinosum
151. Kuehneromyces mutabilis
152. Laccaria amethystea
153. Lactarius circellatus
154. Lactarius controversus
155. Lactarius fluens
156. Laccaria laccata
157. Lactarius deliciosus
158. Lactarius glaucescens
159. Lactarius piperatus
160. Lactarius pubescens
161. Lactarius torminosus
162. Lactarius violascens
163. Lactarius volemus
164. Laetiporus sulphureus
165. Laxitextum bicolor
166. Leccinum aurantiacum
167. Leccinum carpini
168. Leccinum scabrum
169. Lentinellus ursinus
170. Lentinus cochleatus

171.Lenzites betulina
172.Leotia lubrica
173.Lepiota cristata
174.Lepiota ignivolvata
175.Lepista nebularis
176.Lepista nuda
177.Lepista saeva
178.Leptogium sp.
179.Lobaria pulmonaria
180.Lopharia spadicea
181.Lycogala epidendrum
182.Lycoperdon bovista
183.Lycoperdon molle
184.Lycoperdon foetidum
185.Lycoperdon pyriforme
186.Lyophyllum connatum
187.Lycoperdon lividum
188.Lycoperdon nigrescens
189.Lycoperdon perlatum
190.*Macrolepiota excoriata
191.Macrolepiota mastoidea
192.Macrolepiota procera
193.Macrolepiota rhacodes
194.Marasmiellus androsaceus
195.Marasmius alliaceus
196.Marasmius oreades
197.Marasmius rotula
198.Megacollybia platyphylla
199.Melanogaster broomeianus
200.Melanoleuca polioleuca
201.Melanoleuca stridula
202.Meruliopsis taxicola
203.Merulius tremellosus
204.Morchella elata
205.Morchella esculenta
206.Mucilago crustacea
207.Mutinus caninus
208.Mycena galericulata
209.Mycena crocata
210.Mycena leptocephala
211.Mycena polygramma
212.Mycena pelianthina
213.Mycena pura
214.Mycena renatii
215.Mycena rosea
216.Nemania serpens
217.Nectria cinnabarina
218.Nephroma sp.
219.Omphalina baeospora
220.Omphalina velutipes cf.
221.Orbilia sp.
222.Otidea onotica
223.Oudemansiella mucida
224.Pachyella babingtonii
225.Panaeolus papilionaceus
226.Panaeolus semiovatus var. semiovatus
227.Panaeolus sphinctrinus
228.Paxillus involutus
229.Peltigera canina cf.
230.Peltigera elisabethae cf.
231.Peltigera elisabethae cf.
232.Peltigera horizontalis cf.
233.Peniophora lycii
234.Peniophora quercina
235.Peziza arvernensis
236.Phaeolepiota aurea
237.Phallus hadriani
238.Phallus impudicus
239.Phanerochaete sanguinea
240.Phanerochaete tuberculata cf.
241.Phanerochaete velutina
242.Phellinus ferruginosus
243.Phellinus igniarius
244.Phellinus pomaceus
245.Phellinus robustus
246.Pholiota cerifera cf.
247.Piptoporus betulinus
248.Pleurotus eryngii
249.Pleurotus ostreatus
250.Pleurotus pulmonarius
251.Pleurotus sapidus
252.Pluteus cervinus
253.Pluteus exiguus
254.Polyporus arcularius
255.Polyporus brumalis
256.Polyporus squamosus
257.Polyporus varius
258.Postia stiptica

259.Postia tephroleuca
260.Propolis farinosa
261.Psathyrella candoleana
262.Psathyrella tephrophylla
263.Pseudevernia furfuracea
264.Psilocybe merdaria
265.Psilocybe rhombispora
266.Pycnoporus cinnabarinus
267.Radulomyces molaris
268.Ramaria aurea
269.Ramaria botrytis
270.Ramaria flava
271.Resupinatus trichotis
272.Rhizocarpon geographicum cf.
273.Rhodocollybia butyracea
274.Russula alutacea
275.Russula cyanoxantha
276.Russula delica
277.Russula emetica cf.
278.Russula foetens
279.Russula lutea
280.Russula lepida
281.Russula nigricans
282.Russula mairei
283.Russula vesca
284.Russula virescens
285.Schizophyllum commune
286.Schizopora paradoxa
287.Scleroderma areolatum
288.Scleroderma bovista
289.Scleroderma cepa cf.
290.Scytinostroma aluta
291.Skeletocutis percandida
292.Steccherinum fimbriatum
293.Stereum gaussapatum
294.Stemonitis fusca
295.Stereum hirsutum
296.Stereum insignitum
297.Stereum rugosum
298.Strobilurus stephanocystis
299.Strobilomyces strobilaceus
300.Strobilurus tenacellus
301.Stropharia aeruginosa
302.Stropharia coronilla
303.Stropharia semiglobata
304.Subulicystidium longisporum
305.Suillus collinitus
306.Suillus fluryi
307.Suillus granulatus
308.Suillus luteus
309.Suillus variegatus
310.Tapesia fusca
311.Tomentella sp.
312.Tomentella bryophylla
313.Trametes gibbosa
314.Trametes hirsuta
315.Trametes versicolor
316.Trechispora farinacea
317.Tremella foliacea
318.Tremella mesenterica
319.Trichaptum biforme
320.Trichaptum fuscoviolaceum
321.Tricholoma imbricatum
322.Tricholoma inocybeoides cf.
323.Tricholoma nudum
324.Tricholoma portenosum
325.Tricholoma saponaceum
326.Tricholoma sejunctum
327.Tricholoma ustaloides
328.Tricholomopsis rutilans
329.Tubulicrinis calothrix
330.Tubulicrinis subulatus
331.Typhula micans
332.Typhula quisquiliaris
333.Uromyces pisi
334.Usnea sp
335.Ustulina deusta
336.Vararia ochroleuca
337.Vascellum pratense
338.Vuilleminia comedens
339.Xerocomus chrysenteron
340.Xerula radicata
341.Xylaria hypoxylon
342.Xylaria polymorpha

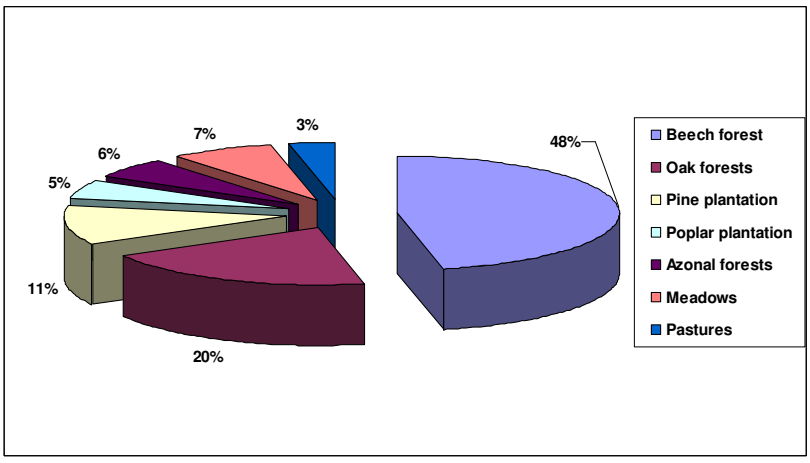
4.2 Short analysis

The largest number of species, belong to Basidiomycota, less of them are from Ascomycota and few species of lichens and Myxomycota group.

Of the lignicolous species, the main part was collected on Fagus, Quercus, Pinus and Populus. A few species were collected on Betula, Prunus, Malus, Picea, on mushroom fruiting body, etc. As far as the terricolous species are concerned, the majority of them were collected in two beech associations (*Calamintho grandiflorae-Fagetum* and *Festuco heterophyllae-Fagetum*) and three oak associations (*Querco-Carpinetum orientalis macedonicum, Quercetum frainetto-cerris* and *Orno-Quercetum petraeae)*, which are the best studied forests in the mountain.

The most common species were as follows: *Agaricus campestris, A.macrosporus, Amanita rubescens, Armillaria mellea, Boletus aestivalis, B.edulis, Bovista plumbea, Cantharellus cibarius, Diatrype disciformis, Diatrype stigma, Laccaria laccata, Lactarius piperatus, Lepista nuda, Lycoperdon perlatum, Marasmius oreades, Mycena pura, Panellus stypticus, Peniophora quercina, Polyporus arcularius, Pseudevernia furfuracea, Russula cyanoxantha, Schizopora paradoxa, Stereum hirsutum, Suillus granulatus, Trametes hirsuta, Trametes versicolor, Vuilleminia comedens* and *Xerula radicata.*

The largest number of species (about 48%) is known from the beech forests, then oak forests (about 20%), coniferous forests (about 11%), whereas in willow/poplar forests and different forest associations developing along the rivers and streams was found the rest of the species. Outside the forest communities, very few species (about 10%) are known from mountain pastures, meadows, forest edge, etc.



Share of fungal species in diferent forest comunities and habitat types on Osogovo Mt.

It is important to underline the parasitic species on the most frequent tree representatives in Osogovo Mt. These are the following species: *Armillariella mellea, Fistulina hepatica, Fomes fomentarius, Ganoderma applanatum, Polyporus squamosus, Phellinus igniarius, Phellinus pomaceus, Phellinus robustus, Laetiporus sulphureus, Piptoporus betulinus* and *Trametes gibbosa.* The species *Ganoderma applanatum, Polyporus squamosus, Trametes gibbosa* and *Fomes fomentarius* are established only as parasites on beech trunks, while *Laetiporus sulphureus* and *Phellinus igniarius* are recognised parasites on Salix. The species *Armillariella mellea* is a well-known dangerous parasite which grows equally on pine, oak and beech trees. *Phellinus pomaceus* is a very common parasite and grows exclusively on Prunus; *Piptoporus betulinus* is a parasite and saprobe on Betula, while *Phellinus robustus* is a dangerous parasite on older oak trees.

4.3 Edibility

The major problem related to fungal conservation is the enormous interest for commercial collecting of fungi, and also an augmented number of purchasers dealing with purchase of wild fungi. Due to the low purchase price, the lack of law regulations for protection of fungi or the absence of their implementation, there is an immense pressure by western European countries upon this region. The unplanned and uncontrolled purchase in specific areas has already reached devastating proportions.

Excessive collecting seriously endangers fungi, especially the rare and sensitive species. The inappropriate ways of collecting (taking fruit bodies with mycelium, raking, digging in search for truffles, etc.) destroy the fungi mycelia and their habitats. Also, in the last twenty years, the intensive popularisation of fungi collecting for food has led to a patent reduction of the populations of edible fungi in the vicinity of towns.

More than forty species of edible fungi grow in Osogovo Mt. In the last 10-15 years, the interest in certain fungi species as a source of economic benefit has greatly increased. Considerable amounts of fungi are collected in the forests and sold for export to Western

Europe. The species with the greatest demand and highest prices on the Macedonian "fungi market" are the following: *Amanita caesarea*, all edible boletes, (especially *Boletus edulis, B.aestivalis, B.aereus*), *Cantharellus cibarius* and *Morchella elata* of the class Ascomycetes. Some of these species are rare in Osogovo Mt. All of these facts are indicative of the current uncontrolled conditions under which fungal reserves are exploited within the country.

Regarding edibility/toxicity of fungi, the following can be ascertained: 17% of species found on Osogovo Mt. can be used for human nutrition, whereas 8% species are poisonous. Part of the edible ones, such as: *Agaricus macrosporus, Amanita caesarea*, *Armillaria mellea, Boletus edulis, Calocybe gambosa, Cantharellus cibarius, Marasmius oreades, Morchella elata, Lactarius deliciosus* and *Pleurotus eryngii* possess excellent culinary qualities. A great concern is the fact that the species *Amanita caesarea, Boletus aereus, B.aestivalis, B. edulis, Cantharellus cibarius, Lactarius deliciosus* and *Morcella elata* are gathered in large quantities by the local population and are sold at mushroom-purchase points. Owing to excessive exploitation and improper collection of fruit bodies, the vitality of these species has been reduced. The rest of the edible species are collected only for personal needs, which does not have an impact on their mycodiversity.

The following species of edible fungi are recommended for special attention in terms of conservation. They are the most intensively collected, and their populations should be more carefully managed on an annual basis, with the ultimate aim of initiating stricter management regimes as necessary.

Table 4 List of commercial and potentially commercial mushrooms on Osogovo Mt.

Fungi species	**International market**	**National market**	**Local markets**	**Personal needs**	**Potentially commercial species**
Agaricus campestris			*	*	*
Agaricus arvensis			*	*	
Agaricus macrosporus					*
Amanita caesarea	*	*	*	*	
Amanita rubescens				*	
Armillaria mellea			*	*	*
Auricularia auricula-judae				*	
Boletus aereus	*	*	*		
Boletus aestivalis	*	*	*	*	
Boletus edulis	*	*	*		
Boletus fechtneri					*

Boletus luridus				*	
Bovista plumbea				*	
Calocybe gambosa					*
Calvatia utriformis			*	*	
Cantharellus cibarius	*		*	*	
Chroogomphus rutilus	*		*	*	
Chlorophyllum rhacodes			*	*	
Clitocybe nebularis			*	*	
Collybia dryophila				*	
Coprinus commatus				*	
Craterellus cornucopioides	*		*	*	
Hydnum repandum	*		*	*	
Hygrophorus eburneum				*	
Lactarius deliciosus	*		*	*	
Lactarius volemus			*	*	
Lactarius piperatus			*	*	
Lepista nuda			*	*	*
Lepista saeva			*	*	
Leccinum aurantiacum			*	*	
Leccinum carpini			*	*	
Leccinum scabrum			*	*	
Marasmius oreades	*		*	*	
Macrolepiota procera			*	*	*
Macrolepiota mastoidea			*	*	
Morchella elata	*				
Morchella esculenta	*	*	*	*	
Pleurotus ostreatus			*	*	*
Pleurotus eryngii			*	*	*
Ramaria aurea				*	
Ramaria botrytis				*	
Russula cyanoxatha			*	*	*
Russula nigricans				*	
Russula vesca				*	
Russula virescens			*	*	
Suillus collinitus	*	*	*	*	
Suillus granulatus	*	*	*	*	*
Suillus luteus	*	*	*	*	

4.4 Most common edible fungi in the main ecosystems of Osogovo Mt.

I. Deciduous forest ecosystems

1. Beech communities: *Amanita rubescens, Armillaria mellea, Boletus edulis, Boletus aestivalis, Cantharellus cibarius, Chlorophyllum rhacodes, Calvatia excipuliformis, Clitocybe nebularis, Collybia dryophila, Craterellus cornucopioides, Hydnum repandum, Laccaria laccata, Lactarius piperatus, L.volemus, Lepista nuda, Macrolepiota rhacodes,*

Macrolepiota mastoidea, Macrolepiota procera, Pleurotus ostreatus, Polyporus squamosus, Russula cyanoxantha, Russula nigricans, Russula vesca, R.virescens and *Xerula radicata.*

2. Oak communities: *Amanita caesarea, Armillaria mellea, Auricularia auricular-judae, Boletus edulis, B. aestivalis, B. aereus, B. erythropus, B. fechtneri, Cantharellus cibarius, Laccaria laccata, Lactarius volemus, Lepista nebularis, L. nuda, Leccinum carpini, Russula cyanoxantha, R. virescens* and *Xerocomus chrysenteron*

3. Poplar planting: *Morchella elata, Leccinum aurantiacum, Macrolepiota excoriata* and *Pleurotus ostreatus.*

4. Riparian habitats along rivers and streams: *Auricularia auricula-judae, Morchella elata, Laetiporus sulphureus, Pleurotus ostreatus* and *Polyporus squamosus.*

II. Herbaceous ecosystems

1. Meadows and hill/alpine pastures*: Agaricus arvensis, Agaricus campestris, A.macrosporus, Bovista aestivalis, B.plumbea, Coprinus comatus, Calocybe gambosa, Calvatia excipuliformis, Calvatia utriformis, Laccaria laccata, Macrolepiota mastoidea, M.procera, Marasmius oreades Morchella esculenta* and *Pleurotus eryngii.*

III. Coniferous forest

1. Planted pine forest: *Amanita rubescens, Armillaria mellea Boletus edulis, B. erythropus, Cantharellus cibarius, Chlorophyllum rhacodes, Chroogomphus rutilus, Clitocybe nebularis, Collybia dryophila, Hydnum repandum Laccaria laccata, Lactarius deliciosus, Lactarius piperatus Macrolepiota procera, Pleurotus ostreatus, Suillus fluryi, S.luteus, Suillus collinitus* and *S. granulatus.*

4.5 Best known poisonous fungi on Osogovo Mt.

Of the poisonous species, particularly frequent is *Amanita pantherina,* whose consumption may lead to death. The rest of the poisonous fungi, except of the species *Galerina marginata* and *Clitocybe dealbata* are not deadly poisonous.

List of poisonous fungi species on Osogovo Mt.

Amanita muscaria	*Lepiota cristata*
Amanita phalloides	*Lycoperdon pyriforme*
Amanita pantherina	*Mycena pura*
Boletus rhodoxanthus	*Mycena rosea*
Boletus luridus	*Panaeolus papilionaceus*
Clitocybe dealbata	*Panaeolus semiovatus*
Coprinus micaceus	*Panaeolus sphinctrinus*
Entoloma sinuatum	*Paxillus involutus*

Hebeloma sinapizans
Hypholoma fasciculare
Inocybe geophylla
Lactarius pubescens
Lactarius torminosus
Phaeolepiota aurea
Russula emetica
Stropharia aeruginosa
Stropharia coronilla
Stropharia semiglobata

Amanita pantherina - a very common deadly poisonous mushroom from Osogovo Mt.

4.6 Medicinal fungi species

The representatives of fungi are practically inexhaustible source of useful substances with therapeutic action. The majority of fungi are not yet explored in this respect at European scale, but almost all of the studied species show one or other health benefits. Out of all recorded species on Osogovo Mt., about 31% possess natural gene pool that can serve as a suitable selection of strains for the farmaceutical industry. It is necessary to highlight that the listed medicinal species as a whole can not be applied directly to achieve a beneficial effect.

List of fungi species recorded on Osogovo Mt. with proven content of biologically active substances

Agaricus arvensis
Agrocybe cylindracea
Amanita rubescens
Armillaria mellea
Auricularia auricula-judae
Boletus edulis
Calvatia excipuliformis
Calvatia utriformis
Cantharellus cibarius
Chlorophyllum rhacodes
Coprinus commatus
Flammulina velutipes
Hydnum repandum
Hypholoma fasciculare
Lycoperdon molle
Macrolepiota procera
Marasmius oreades
Morchella esculenta
Pleurotus eryngii
Pleurotus ostreatus
Ramaria flava
Russula cyanoxantha
Russula delica
Russula nigricans
Schizophyllum commune
Stereum hirsutum
Stropharia coronilla
Suillus collinitus

Lactarius deliciosus	*Suillus granulatus*
Lactarius piperatus	*Suillus luteus*
Lactarius volemus	*Trametes versicolor*
Leccinum aurantiacum	*Tricholomopsis rutilans*
Lepista nuda	

4.7 Rare fungi on Osogovo Mt.

Certain species can be categorised as rare and interesting findings. The species: *Agaricus campestris, A.macrosporus, Amanita caesarea, Auricularia auricula-judae, Boletus aereus, B. fechtneri, Lopharia spadicea, Macrolepiota procera, Phellinus robustus* and *Tremella foliacea* have been proposed for protection according to the Preliminary Red List of Fungi of the Republic of Macedonia (Karadelev 1999, 2000, 2001, 201). The species: *Aleurodiscus disciformis, Astraeus hygrometricus, Lopharia spadicea* and *Tremella foliacea* belong to the group of particularly rare or rare species in Macedonia, *Phellinus robustus* is a species existing only in an endangered or rare habitat, while *Agaricus macrosporus, Amanita caesarea, Boletus aereus, B. fechtneri* and *Macrolepiota procera* belong to the group of particularly rare or rare species, threatened due to excessive exploitation. Species like, *Amanita caesarea*, *Boletus aereus*, *Boletus satanus*, *Ganoderma pfeifferi, Clavariadelphus pistillaris, Haasiella venustissima, Lentinellus ursinus, Mutinus caninus, Pachyella babingtonii* are chategorized as endangered or critically endangered according the IUCH criteria thus special attention in terms of protection of habitats where they can be found should be taken in to consideration.

The species *Aleurodiscus disciformis, Astraeus hygrometricus, Amanita caesarea, Boletus aereus, Boletus fechtneri* and *Lopharia spadicea* are also part of the Red List of Europe, while *Astraeus hygrometricus, Boletus queletii, Cyathus stercoreus, Funalia trogii, Ganoderma Pfeifferi, Geastrum striatum, Hericium coralloides, Hygrophorus pudorinus, Ischnoderma resinosum, Lactarius violascens, Scitinostroma aluta* and *Tricholoma sejunctum* have not been included in the Preliminary Red List of Fungi of the Republic of Macedonia, but are species protected in the European Red List of Fungi (Ing, 1993).

Antrodia malicola and *Suillus variegatus* are species known from two localities in Macedonia, one of them Osogovo Mt., while for the species *Gyrophanopsis polonensis* this mountain is the only locality in Macedonia. Another interesting data known only from this region is *Pluteus exiguus*, collected from the guest house (inn) of St. Joakim Osogovski Monastery, on moist wood in a bathroom. Mycodiversity of Osogovo Mt. has about thirty

new species for the Republic of Macedonia. The species *Amanita caesarea* and *Panaeolus semiovatus (*as *Panaeolus fumiputris)* have been mapped by Lange (1974).

The species *Crinipellis scabellus, Cyclaneusma niveum, Endoptychum agaricoides, Ganoderma pfeifferi, Gyrophanopsis polonensis, Hemimycena crispula, Hygrophorus latitabundus, Hygrophorus persoonii, Hymenoscyphus fructigenus, Hyphoderma roseocremeum, Hypoxylon vogesiacum, Lactarius glaucescens, Macrolepiota excoriata, Morchella elata, Mucilago crustacea, Mycena leptocephala, Peltigera elisabethae cf., Peltigera horizontalis cf., Phallus hadriani, Pholiota cerifera cf., Pluteus exiguous, Psathyrella tephrophylla, Russula mairei, Scleroderma areolatum, Scleroderma bovista, Tricholoma imbricatum, Tricholoma inocybeoides cf., Typhula micans, Typhula quisquiliaris* and *Uromyces pisi* stand as new species for the Republic of Macedonia.

The fungi species that contributes to forest management are also worth to be mention here. This group includes wood decaying parasitic fungi, which have a huge role in forest management. Saprotrophs decaying fungi, conversely, have a clear positive impact by participating in the decomposition of dead wood, and thus contribute to the preservation and improvement of soil fertility. Important economic decaying fungi are *Armillaria mellea*, *Fomes fomentarius* and *Fomitopsis pinicola*.

Valorisation of fungi species on Osogovo Mt. according to national and international criteria

	IUCN category and criteria (BG)	**IUCN category and criteria (MK)**	***Macedonian Red List**
Agaricus macrosporus			MRL
Aleurodiscus disciformis			ERL
Astraeus hygrometricus			ERL
Amanita caesarea	**VU** A2acd+3cd; B1ab(i,iii)	**EN** A2acd	MRL, ERL, L
Auricularia auricula-judae			MRL
Boletus aereus		**VU** A2acd	MRL, ERL
Boletus queletii			ERL
Boletus fechtneri			MRL, ERL
Boletus rhodoxanthus	**VU** B1ab(iii)+2ab(iii)		
Boletus satanas	**VU** B1ab(iii)+2ab(iii)	**VU** A2ac	
Cyathus stercoreus			ERL
Funalia trogii			ERL
Ganoderma pfeifferi		**EN** B2ab(iii,iv)	ERL
Geastrum striatum			ERL

Clavariadelphus pistillaris	**VU** B1ab(iii,iv)	**VU** A3acd	
Haasiella venustissima	**CR** B2ab(i,ii,iv)		
Hericium coralloides		**NT**	ERL
Hygrophorus pudorinus			ERL
Ischnoderma resinosum			ERL
Lactarius violascens		**NT**	ERL
Lentinellus ursinus	**CR** B1ab(i,ii,iii,iv)		
Lopharia spadicea			MRL, ERL
Macrolepiota procera			MRL
Mutinus caninus	**VU** B1ab(iii,iv)	**NT**	
Otidea onotica	**VU** B1ab(i,ii,iii,iv)		
Panaeolus semiovatus			L
Pachyella babingtonii	**EN** B2ab(ii,iv)		
Phellinus robustus			MRL
Scitinostroma aluta			ERL
Strobilomyces strobilaceus			
Tremella foliacea	**VU** B1ab(iii)+2ab(iii)		MRL
Tricholoma sejunctum			ERL

* Macedonia is studied relatively well but it does not have an official Red List of Fungi. The current preliminary Red List (published by Karadelev (2000) in ECCF Newsletter 10) incorporating 67 species, is obsolete. The species categorisation in compliance with IUCN category system could not have been applied entirely given that at the time the country was not studied sufficientlyMRL – Macedonian Red List (Karadelev 2000); ERL – European Red List (Ing 1993); L – mapped by Lange (1974)

Typhula quisquillaris - a very rare species on dry stem of *Pteridium aquillinum.*

Tremella foliacea – rare species on Osogovo Mt.

4.8 Important localities and habitats for fungi on Osogovo Mt.

On the basis of species diversity (species number, conservation status, rarity) some localities and habitats can be pointed out as very important for the conservation of mycodiversity of Osogovo Mt.

4.8.1 Forests

In the forest belt (both oak and beech), a significant number of associations included in Resolution No 4 of the Bern Convention and by Habitats Directive-Annex I can be found: Those are the following associations: Festuco heterophyllae-Fagetum Em 1965, Calamintho grandiflorae-Fagetum Em 1965, Salicetum albae-fragilis Issler 1926, Orno-Quercetum petraeae Em 1968, Quercetum frainetto-cerris Ht. (1959) and ***Querco-Carpinetum orientalis*** macedonicum Rud. 1939 apud. 1946;

4.8.2 Beech Forests

The fungi data primarily refer to the pure beech associations (*Festuco heterophyllae-Fagetum* and *Calamintho grandiflorae-Fagetum*) at the altitude 900 – 1,570 m;

Part of the recorded species, such as *Fomes fomentarius, Inonotus nodulosus, Laxitextum bicolour, Marasmius alliaceus, Mycena renatii, Oudemansiella mucida, Sterem insignitum, S.rugosum* and *Xerula radicata* are rather typical for beech forest. The most common species have been the following: *Amanita rubescens, Armillaria mellea, Diatrype disciformis, Diatrype stigma, Laccaria laccata, Lactarius piperatus, Lycoperdon perlatum, Mycena pura,*

Mycena rosea, Panellus stypticus, Russula cyanoxantha, Schizopora paradoxa, Stereum hirsutum, Trametes hirsuta, Trametes versicolor and *Xerula radicata*.

Certain species such as *Amanita rubescens, Boletus aestivalis, B.fechtneri, Cortinarius trivialis, Lactarius glaucescens, Lactarius piperatus, Lactarius volemus, Russula lutea, R. foetens, R. cyanoxantha, R. mairei* and *R. virescens* are mycorrhizal fungi known to associate with beech. The rest of the species are saprobes.

It is particularly important to highlight the parasitic species on the most frequent tree representatives in beech associations on Osogovo Mt. These are the following species: *Armillariella mellea, Fomes fomentarius, Ganoderma applanatum, Polyporus squamosus* and *Trametes gibbosa.* The species *Ganoderma applanatum, Polyporus squamosus* and *Fomes fomentarius* are established as parasites on beech trunks only.

Some rare species such as *Ganoderma pfeifferi, Gyrophanopsis polonensis, Hymenoscyphus fructigenus, Lactarius glaucescens, Typhula quisquiliaris* were collected in beech forests.

4.8.3 Thermofilous and Supra-Mediterranean Oak Woods

The oak associations (*Orno-Quercetum petraeae* Em 1968, *Quercetum frainetto-cerris* Ht. 1959 and *Querco-Carpinetum orientalis macedonicum* Rud. 1939 apud. 1946) are developed at the foot of the mountain, at an altitude between 700 to 1,100 m. The tree belt is dominated by *Quercus petraea, Quercus cerris, Quercus frainetto, Fraxinus ornus, Carpinus betulus* and *Acer campestre*. In the oak forests many macromycete species, both lignicolous and terricolous, have been found. The most common species are the following: *Amanita caesarea, Armillaria mellea, B. aestivalis, B. aereus, B.queletii, Cantharellus cibarius, Clitocybe gibba, Lactarius volemus, Lepista nebularis, L. nuda, R. virescens, Stereum hirsutum, Trametes hirsute*, *T. versicolor* and *Xerocomus chrysenteron.* Some of the species such as *Amanita caesarea, Cortinarius trivialis, Boletus aereus, B. aestivalis, B. luridus, B. queletii, Lactarius volemus, L. violascens, Russula virescens, Tricholoma sejunctum* and *Tricholoma ustaloides* are known mycorrhizal fungi associated with oak. Some of the lignicolous species usually grow as saprobes on fallen branches, stems and stumps of oak and other deciduous trees such as: *Daedalea quercina*, *Exidia truncata, Hymenochaete rubiginosa, Radulomyces molaris, Peniophora quercina* and *Vuilleminia comedens.* Some rare species such as *Hygrophorus persoonii, Lactarius glaucescens, L.violascens* and *Crinipellis scabellus* have been collected in oak forests.

Amanita caesarea – one of the most common and economically important mushroom from oak forests on Osogovo Mt

4.8.4 Salix alba and Populus alba galleries

The association *Salicetum albae-fragilis* Issler 1926 is spread along the gorges of the main rivers/streams and theirtributaries. It occupies alluvial soils rich in organic matter. The tree belt is dominated by *Salix alba*, accompanied by *Salix fragilis, Alnus glutinosa, Populus tremulla,* etc. The majority of the known species were lignicolous and they were collected as parasites and saprobes on *Salix alba* and *Populus tremulla.* Part of the registered species, such as *Laetiporus sulphurous,* is typical of *Salix*, while *Oxyporus populinus* grows exclusively as a saprotroph on bark of *Populus*. It is vital to underscore the parasitic species in these associations such as the following: *Fomes fomentarius, Ganoderma applanatum, Trametes gibbosa* and *Laetiporus sulphureus*. The species *Phellinus igniarius* and *Laetiporus sulphureus* are established only as parasites on *Salix alba*. Part of the registered terricolous species are mycorrhizal such as *Leccinum aurantiacaum* known to associate with poplar and *Leccinum scabrum* with Betula. It is worth emphasising some rare species collected here such as *Endoptychum agaricoides, Macrolepiota excoriata, Phallus hadriani* and *Typhula micans.*

Phellinus igniarius - dangerous parasitic species on willow.

4.8.5 Pinus plantations

In some places within the mountain regions of Osogovo Mt. there are plantations mainly consisting of *Pinus nigra* and *Pinus silvestris*. These forests have not been studied sufficiently and only a small number of data exist. Planted pine forest is very rich in commercial and edible mushrooms such as: *Boletus edulis, Cantharellus cibarius, Lactarius deliciosus* and *Suillus granulatus.* The majority of terricolous species such as *Amanita battarae, Amanita muscaria, Russula lutea, Russula emetica, Tricholoma imbricatum, Suillus fluryi, Suillus luteus, S.variegatus* are known to associate with pine.

4.9 Outside forests

4.9.1 Mountain pastures

The mountain pastures, due to the unfavourable climatic conditions, are not characterised by a great diversity of fungal species. The fungi data primarily refer to the area above 1,500 m mainly terricolous. The most common species are: *Agaricus macrosporus*, *Calvatia excipuli-formis, Calvatia utriformis, Marasmius oreades* and *Stropharia semiglobata*.

4.9.2 Meadows in the forest belt

The meadows in the forest belt are characterised by great fungi species diversity, both mycorrhizal and non-mycorrhizal. The most abundant species have been as follows: *Agaricus campestris, A.macrosporus, Bovista aestivalis, B.plumbea, Coprinus comatus, Calocybe gambosa, Calvatia excipuliformis, Calvatia utriformis, Laccaria laccata, Macrolepiota mastoidea, M.procera, Marasmius oreades, Pleurotus eryngii, Stropharia semiglobate* and

some others. The majority of the species such as *Marasmius oreades, Stropharia semiglobata, Psilocybe bullacea, Vascellum pratense, Bovista plumbea, Calocera cornea, Panaeollus papilionaceus, Stropharia coronilla,* etc. are saprobes.

Economically important are the following edible species: *Agaricus campestris, A.macrosporus, Macrolepiota procera, Marasmius oreades* and *Pleurotus eryngii.* Poisonous species are as follows: *Panaeolus semiovatus, Stropharia coronilla* and *S. semiglobata*.

4.10 Conservation problems

The threats to the fungi on Osogovo Mt. can be summarised in the following points:

Gaps in knowledge of macromycetes

Thorough review and analysis of the mycological literature on fungal research in the area of Osogovo Mt. leads to the conclusion that the available scientific information about macromycetes is still scarce. Mycological studies using the stationary method have been conducted only in recent years. These studies have begun to provide more information on the species composition, phenology, and productivity of macromycetes. A very significant gap in the exploration of the macromycetes is the lack of systematic longterm studies of species composition, and the mapping of these fungi. Too little is known about the species composition and productivity of the edible fungi. There is practically no scientific information on the reserves of edible fungi in the area. The low awareness on the part of the public authorities of the values and importance of fungal diversity on Osogovo Mt. should be underpinned.

These major gaps in the knowledge are great obstacles to the creation of a science-based programme for fungal diversity protection. In order to overcome these obstacles, mycological research in the area must be intensified and the facts about species composition and macromycetes distribution ascertained.

Fragility

Observations in seriously disturbed ecosystems - near towns, in industrial regions, in tourist complexes, along roads, and so forth have revealed a number of correlations, testifying to the high fragility of macromycetes with respect to human activities. In these ecosystems, the species composition and trophic structure of the fungi communities are considerably altered, and a number of ruderal and nitrophilic species become dominant.

The macromycetes are susceptible to other anthropogenic influences such as:

- Clearing and burning of forests rapidly alters macromycetes species composition. Some fungi groups are replaced by others in the process of secondary succession.
- Additional anthropogenic activities that threaten the survival of the macromycetes and the structure of fungi in the ecosystems in Osogovo Mt. include the intensive collection of edible fungi.
- Pollution – based on mining activities in the area.
- Climate change - although there are no data about the climate change impact on the ecosystems of Osogovo Mt., a negative influence on certain species can be expected.
- Destruction of forest communities. Most vulnerable to these pressures are the edible fungi, the mycorrhizal fungi, the litter saprotrophs, and species that are strictly acidophilic or calciphilic.
- Uncontrolled collection of mushrooms. There is uncontrolled collection of mushrooms, particularly Amanita caesarea, Boletus edulis, Boletus aestivalis, Boletus aereus, Cantharellus cibarius, Lactarius deliciosus and Morchella spp.

4.11 Recommendations

Even though the research concerning the fungi on Osogovo Mt. is rather insufficient, it still provides an opportunity to give these some recommendations to ensure the conservation and sustainable use of fungi species of Osogovo Mt.

Recommendations for inventory and monitoring of fungi diversity and resources as a necessary basis for their management and conservation

1. Take steps to initiate systemic longterm research of the fungi variety of Osogovo Mt. Such research will lead to the multiplication of known species and contribute to their better protection. The focus of this study should be:

a) Species diversity in important habitats. The direct practical benefit of such study is the broadening of the spectrum of possible collection of fungy, which in turn leads to a more uniform load of species populations.
b) Fungi diverstiy on rare and endemic plants. Many of these species are parasites and therefore have an important role in the survival of populations of rare plants. They are also often with very narrow specialization (often on only one type of plant), which is why many of them are probably too rare.
c) Conducting continuous observations on the productivity of important economic fungi in

key habitats. It will help to refine the value of ecosystem services that can be obtained from fungi, as well as sustainable use of fungy as one of the natural resources.

2. Monitoring of conservation important fungi

Recommendations for protecting the fungi important habitats as a key factor in conserving biodiversity and natural resources

Fungi are extremely vulnerable to changes in habitat and this is one of the main threats to their conservation and sustainable use. In this regard, especially recommended are the following measures:

1. Strict compliance with the restrictions in the Natura 2000 "BG0001011 Osogovo" of habitats 9110, 9130, 9150, 91W0.
2. Limited loging.
3. Use good and friendly practices in forestry activities, eg. limit and avoid distortions in the soil layers when conducting activities, avoidance of penetration of heavy equipment in the forest; conversion of uniformed to diverse plantations.
4. Leave the forests of sufficient amount different politype wood. This ensures a variety of non-parasitic wood decaying fungi.
5. Limit the planting of: non-native species in the mountain, inapropriate for the altitude belts species and limit the gradual replacement of existing plants with non-native species with native ones.

Recommendations for conservation and management of fingi resources

1. Maintain a database of commercialy collected fungi (coordinated with the local forestry units).
2. Promoting the cultivation of some comercial fungi species as a form of employment and additional income. A number of species of fungi can be successfully cultivated at low costs of funds and higher profit rival efforts to obtain the wild fungi from nature.

Recommendations for education as an approach that provides protection of fungal diversity and resources

1. Development and implementation of a training program focused on:

a) Conducting educational activities to explore the edible and poisonous fungi and prevention of poisoning cases;

b) Taking steps to educate the local population about both the value and need for sustainable use of fingi resources and best practices in collecting wild fungi;

c) Promoting opportunities for the cultivation of fungi as a cheap, profitable and less labor-intensive alternative in comparision to collection of wild fungi;

d) Promotion of good labor-intensive and low-friendly forestry practices supporting fungus infection and fungal diversity resources

5 ASSESSMENT OF THE HABITAT TYPES AND THEIR VALORIZATION

Natural habitats are created by the complex of a site natural conditions (climate, water, geology, soil type, altitude) and the living communities of plants, animals, microorganisms and fungi. Several factors can determine vegetation. Firstly, geological substrate, whether is acidic or carbonate. Secondly, climatic conditions such as annual allocation and quantity of rainfall, annual temperature fluctuations, etc. On the other hand, vegetation is involved in soil formation and microclimate. Vegetation affects soil's water regime and structure and protects soil erosion. Therefore, vegetation is considered as basis for inventory and classification of natural habitats on Earth. Based on vegetation, natural habitats such as deciduous and coniferous forests, shrubs, grasslands, and alpine pastures can be determinated. Why should we classify and inventory the natural habitats? For decades environmentalists around the world have been working to protect species from extinction. It is not enough to stop or limit its use as a resource. The main task is to protect species habitats, those in which it dwells with a complex of other species.

Namely, for this the most important approach - wildlife conservation, the European Union creates Directive 92/43, which obliges Member States to protect currently 231 natural habitats - from the seabed to the top of high mountains. The network of protected areas in the EU Member States, which protect habitats and species, is called NATURA 2000. Bulgarian protected areas are part of this network, and the accession of the Republic of Macedonia to the EU and already identified potential areas there will also become part of the European network.

According the NATURA 2000 standard form, Osogovo Mt. in Bulgaria is protected zone (code BG0001011) of European and ecological network in Bulgaria. It protects 27 natural habitats - almost 1/3 of all occurring in Bulgaria.

Applying the EUNIS habitats classification system, the following habitats were registered in the area investigated:

1. **D2.3: Transition mires and quaking bogs**

NATURA 2000 code: 7140 - Transition mires and quaking bogs

Habitat type that includes marsh communities from the sub-alpine and alpine belt, typical for silicate mountains, which thrive on habitats where wellspring waters spill over or where underground waters burst out every now and then, and the soil itself is rich with dead organic matters . On the Osogovo Mts., this type of habitat is present in the sub-alpine belt, in the foothill of the Sultan Tepe summit, at Slana Bara, between Mrtvachki Rid and Sultan Tepe, at

Babina Chesma, Ajduchka Chesma etc ??? dodadi BG, at altitude of 1700 - 2000 m. In these habitats there are often populations of the genus *Sphagnum*, together with different species such as, *Eriophorum angustifolium*, *Deschampsia caespitosa*, *Parnassia palustris*, *Geum rivale*, *Alchemilla flabelata*, *Drosera rotundifolia*, *Pinguicula balcanica, Equisetum fluviatile*, *Carex echinata*, *Carex curta*, *Potentilla erecta*.

2. **D5.11 – [Phragmites australis] beds normally without free-standing water**

NATURA 2000 code: 7230 Alkaline fens

Marsh vegetation with reed is sparsely represented on small-size areas, generally along the lower course of the rivers (Bela Reka, Mala Reka, Zletovica in the Macedonian part of Osogovo). Since this vegetation is scantily distributed, this habitat can be considered as an insignificant one and need not be taken into consideration when making biological valorisation on larger scale. It is rarely found in its typical form. Rather, it is found in fragmented populations, dominated by *Phragmites australis* and *Typha latifolia*.

3. **E1.D:Unmanaged xeric grasslands**

These are xeric grassland that are not currently mown or used for pasture.

4. **E1.332 - Helleno-balcanic short grass and therophyte communities**

NATURA 2000 code: 6220 *Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea

This habitat type includes the hilly pastures which are basically secondary vegetation formations created by reduction of the forests, and stretch in the lower vegetation belt that is most interfered by human factor, which is the reason why they frequently exist in highly eroded habitats. They are represented by ass. Helianthemo-Euphorbietum thessalae Micev. 1973, subass. chrysopogonetosum Micev. 1978 and subass. agrostidetosum Micev. 1978 (all. Trifolion cherleri Micevski 1970). Having in mind the climatic conditions they exist in, the hilly pastures are, from floral point of view, fairly rich and include a great number of sub-Mediterranean species, which is obvious from their terofitic nature. They are maintained by grazing. However, diminished stockbreeding on the whole territory of the Osogovo mountain, in particular in its lower parts, results into their gradual becoming overgrown. Better preserved populations can be found above Kochani, at altitude above the village of Beli, Cigansko Malo, Kratovo-Blizanci, Probishtip-Lesnovo etc. Vo BG????

5. **E1.72 - [Agrostis]-[Festuca] grasslands**

This habitat type includes habitats in the higher-belt hilly pastures, that are vertical continuation of the previous habitat and which grow at altitude of 1000-1400 m. In this area, both the number and significance of the sub-Mediterranean types decreases, and this habitat is dominated by more continental species. There are two communities of this habitat type – ass.Genisto-Agrostidetum byzanthinae Micev. 1978 and ass. Koelerio-Festucetum stojanovii Micev. 1978 (Armerio-Potentillion Micev. 1978). This habitat type on the Osogovo mountain is represented at a few localities, at altitude above the monastery of "St. Joakim Osogovski", at Kalin Kamen, Churiljska Chuka Toranica, Kratovo - the village of Kavrachko, Makedonska Kamenica - Shamska Chuka, etc. Vo BG????

6. **E1.73 - [Deschampsia flexuosa] grasslands**

This habitat type on the Osogovo Mt. could not be associated with any particular plant community, as the species *Deschamsia flexuosa* makes up miscellaneous communities in the sub-Alpine pastures belt, where it frequently takes the form of facies. That is the reason why it is rather difficult to claim that on the Osogovo Mt. there is a particular "Deschampsia flexuosa comm", since it is this species which is commonly considered as most typical for the alliance Poion violaceae Horv. 1937. Especially beautiful localities of this species can be found under the summit of Ruen - Ajduchka Chesma, Sokol, Lisec (at altitude of 1500-1950 m) vo BG?????

7. **E1.833 - Balcanic montane [Nardus stricta] swards**

NATURA 2000 code: 6230 - *Species-rich Nardus grasslands, on silicious substrates in mountain areas (and submountain areas in Continental Europe)

Generally speaking, the habitat type with *Nardus stricta*, found on the Osogovo Mts. in its sub-Alpine belt, is easily recognized, both from floral and from ecological aspect. These are commonly flattened or mildly inclined habitats, with deep soil and low pH level, where *Nardus stricta* prevails both from numerical and coverage aspect. However, this community with *Nardus stricta* presents a huge problem in the Balkan Peninsula syntaxonomy. The views of different authors, regarding the structure and location of the great number of communities with this species registered in the phitocenological system, drastically vary. Efforts are made, though, to sort out their pretty intricate syntaxonomy. On the Osogovo Mt., this habitat exists on fairly small areas, in the foothill of the summit Sultan Tepe, Babina Chesma, Sokol, Kalin Kamen etc vo BG???, in a belt at altitude of 1670-1950 m. It does not, however, mean that smaller areas with *Nardus stricta* cannot be found at higher altitudes.

8. **E2.33: Balkan mountain hay meadows**

This type of habitat are represented by mesophile tall grasslands in the mountain and sub-alpine areas of Osogovo Mts. in the beech forest zone. They are dominated by *Trisetum flavescens*, *Cynosurus cristatus*, *Festuca pratensis*, and geographically differentiated by Balkan endemic species *Armeria rumelica*, *Knautia dinarica*, *Rhinanthus rumelicus*.

9. **E3.4: Moist or wet eutrophic and mesotrophic grassland (*Deschampsia caespitosa* stands)**

This habitat represents the wet eutrophic and mesotrophic grasslands and flood meadows, dominated by grasses *Poaceae*, rushes *Juncus* spp. or club-rush *Scirpus sylvaticus*. On Osogovo?....

10. **E3.5: Moist or wet oligotrophic grassland**

Grasslands on wet, nutrient-poor, often peaty soils. Includes coarse acid grassland dominated by *Molinia caerulea* and shorter wet heathy grasslands with *Juncus squarrosus*, *Nardus stricta* and *Scirpus cespitosus*. On Osogovo?....

11. **E3.31 - Helleno-moesian riverine and humid [Trifolium] meadows**

The habitat type of lowland meadows, owing to configuration of the terrain, hydrological conditions, gradual reduction in cattle and the like, is present at relatively small areas in the lower parts and in the foothill of the Osogovo Mt. Areas with meadows can still be found nearby rivers and in the vicinity of villages, where they are maintained by mowing, but at locations where they are abandoned, there is pretty advanced succession and they gradually become overgrown. From phitocenological aspect they belong to the sub-Mediterranean alliance Trifolion resupinati Micev. 1957. Smaller populations with meadows have been registered in Kocani region - Novo Selo, Bela Reka, in Probishtip region - the village of Lesnovo, the village of Zletovo, Kriva Palanka - the village of Psacha, Toranica (at altitude of 670-1100 m.). vo BG????

12. **E4.39: Oro-Moesian acidophilous grasslands with Nardus stricta**

NATURA 2000 code: 62D0 - Oro-Moesian acidophilous grasslands

This habitat type comprises plant communities from the sub-alpine vegetation belt on the Osogovo Mt., which grow on silicate geological ground or on deep acid soil and which syntaxonomically belong to the alliance Poion vioaceae Horvat 1937 (ass. *Thymo-Poetum violaceae* K. Micevski 1978) alliance Seslerion comosae Horvat 1935. (ass. *Jasioni-Festucetum supinae* Ht. 1937, ass. *Lino-Seslerietum* Horv. 1935), cl. Caricetea curvulae Br.-

Bl. 1948. These are dominant communities in the sub-Alpine belt of the Osogovo Mt. (at altitude of 1550-2250 m.), stretching at vast areas and determining the feature of this belt, at the route from Ponikva, Lopen, Mrtvachki Rid, Markova Stapka, Ajduchka Chesma, Sokol, Lisec, Sultan Tepe, Slana Bara, Ruen etc. vo BG???? They also bear special economic significance, being a prerequisite for development of lifestockbreeding, all in compliance with the principles of their sustainable usage.

13. **E4.394: Oro-Moesian aeolian grasslands**

This habitat is characteristic for the mountains of Balkan Peninsula. It is represented by open, short, acidophilous grasslands of windswept, shallow, easily desiccated, nutrient-poor soils with little snow cover of the mountains. On Osogovo Mt. they are represented by a variety of Poaceae species: *Sesleria comosa, Belardiochloa violacea, Deschampsia flexuosa, Festuca valida, F. rubra.*

14. **E5.3:[Pteridium aquilinum] fields**

The habitat with common bracken (Pteridium aquilinum comm.) stretches at wide areas on the Osogovo Mt., mostly at glades in the upper boundary, immediately above the beech belt. It is an undesirable and unwelcome habitat which is constantly expanding, taking over areas belonging to other communities, i.e. habitats. There are numerous examples all over Europe, where the governments are taking measures and steps to prevent this cosmopolitan species from expanding, in particular when it takes over new habitats. Populations with this species can be found almost everywhere on the Osogovo Mt. – "St Joakim Osogovski", Kalin Kamen, Lopen, Ponikva, Jastrebnik, Churiljak, Ratkova Skala, Novo Selo-Bela Reka, Sasa vo BG??? (at altitude of 850-1600 m.).

15. **E5.41: Screens or veils of perennial tall herbs lining watercourses**

This are the habitats spread along the watercourses represented by tall herbs fringe communities on gleyic soils with humus horizon. Characteristic species are *Petasites* spp., *Filipendula ulmaria*, *Aegopodium podagraria*, *Chaerophyllum hirsutum*, *Urtica dioica*, *Mentha longifolia*, *Angelica sylvestris*, *Caltha palustris*, *Crepis paludosa*, *Epilobium hirsutum* and *Geranium palustre*. Vegetation of *Calthion*, *Senecionion fluviatilis*, and *Petasition officinalis* is found in this unit. Often replaced by neophytes or ruderal plants. On Osogovo Mts. ???

16. **E5.572: Moesian tall herb communities**

Habitat type specific by its montane meso-hygrophile tall herb formations of small splashing mountain torrents, moist hollows and gullies. This type of habitat is typical for the Balkan Range, the Rhodope Mountains, the Moeso-Macedonian mountains and the Pelagonides, irradiating southwards, in the montane, sylvatic, and level of the northern Pindus and the Pieria. These communities harbour many species of the genus *Alchemilla*. On Osogovo Mt. ???

17. **E5.58: Alpine [Rumex] communities**

This habitat type is represented by alpine and subalpine meso-hygrophile nitrophilous tall herb formations characteristic of the vicinity of cattle and game resting places, with *Rumex alpinus*, *Senecio alpinus*, *Cirsium spinosissimum*, *Aconitum napellus*, *Geranium phaeum*, *Peucedanum ostruthium*, *Urtica dioica*, *Phleum alpinum*. This habitat may have sometimes ruderal character. On Osogovo Mt. ???

18. **F2.2A: Alpine high mountain dwarf [Vaccinium] heaths**

Vaccinium-dominated dwarf heaths of the subalpine belt with *Vaccinium myrtillus*, *Vaccinium uliginosum* s.l., *Vaccinium vitis-idaea*. They are rich in grassland species and often take the appearance of alpine grassland with dwarf shrubs. *Vaccinium myrtillus* also plays a much more dominant role, in lieu of *Vaccinium uliginosum*. On Osogovo Mt. ???

19. **F2.2A2: Balcano-hellenic dwarf bilberry heaths**

NATURA 2000 code: 4060 – Alpine and Boreal heaths

This is a habitat where prevailing communities are the bilberries (*Vaccinium myrtillus* and *Vaccinium uliginosum*) and it stretches on broad areas in the sub-alpine belt on the mountain (Sultan Tepe, Babina Chesma, Ruen, Kalin Kamen, Toranica, Sokol, Ajduchka Chesma) at altitude of 1600-2200 m. Most dominant species within this habitat is, most often, *Vaccinium myrtillus*, whereas in fewer populations the prevailing species is *Vaccinium uliginosum*. The habitat with blueberies prospectively bears economic value for the local population, and the management plan should include appropriate sustainable usage of this resource.

20. **F2.26: [Bruckenthalia] heaths**

NATURA 2000 code: 4060 – Alpine and Boreal heaths

Populations with the species *Bruckenthalia spiculifolia* on Osogovo Mt. exist on a number of localities (Sultan Tepe, Babina Chesma, Ruen, Kalin Kamen, Sokol, Ajduchka Chesma etc.), most often alongside cranberries (*Vaccinium myrtillus* and *Vaccinium uliginosum*). The

bilberries heats (*Vaccinium myrthilus, V. uliginosum*) (F2.2A2 Balkano-Hellenic dwarf bilberry heaths) and *Bruckenthalia spiculifolia* heats (F2.26 [Bruckenthalia] heats) are also spread at the expense of pastures. The last can be also found on heavily eroded and rocky areas where represent primary vegetation. Unlike the mountains of Rila -Rhodope massif, undergrowth of Siberian juniper (*Juniperus sibirica*) (F2.231 Mountain Juniperus nana scrub), are very rare on Osogovo and are found only on the northern slopes mainly in the Bulgarian part of the mountain. The composition of these shrubs involved many herbaceous species, primarily attributable to the subalpine zone. All these constitute the habitat of the Habitats Directive 4060 Alpine and Boreal heaths. Their importance is rather economical. In some places, especially the bilberries naturally strengthen the eroded slopes, hence are valuable resource used by local people.

21. **F2.2B2: Balcano-rhodopide [Chamaecytisus absinthoides] heaths**

NATURA 2000 code: 4060 – Alpine and Boreal heaths

This habitat with the bush-like species *Chamaecytisus absinthoides* develops in two separate vegetation belts. Some of the populations of this species can be found at lower altitude (at 1200-1250 m) – at glades and semiarid habitats in a beech forest belt, whereas other populations thrive at higher altitude (at 1600-1850 m.) - Ruen, above Sasa, Sokol, Gorna Bachija etc. It is most likely an intra-species variability represented by lowland populations (subsp. absinthoides) and populations in the sub-Alpine belt (subsp. rhodopaeus). This is a habitat which bears a considerable significance in the overgrowing process.

After the abandonment of grazing, especially in the Bulgarian part of the mountain range, shrubs have rapidly invaded part of the alpine pastures. Particularly characteristic for Osogovo are the associations of *Chamaecytisus absinthioides* (F2.2B2 Balkano-Rhodopide [Chamaecytisus absinthioides] heaths). These low gray shrubs, does not take such large areas in any other mountain in the Balkan Peninsula like on Osogovo. Even though they are especially beautiful when they bloom with bright yellow inflorescences, they represent degradation of pastures, since they have not been grazed by the livestock.

22. **F3.16: [Juniperus communis] scrub**

Temperate and mediterranean-montane communities dominated by *Juniperus communis*, mostly *Juniperus*-dominated variants of units F3.11, F3.13, F3.22-F3.24. *Calluna vulgaris*, *Crataegus* spp., *Pinus sylvestris*, *Quercus petraea*, *Bromus erectus* and *Festuca rupicola* are

also present. On Osogovo Mts. this type of habitat can be found in complex units together with E4.39 (Oro-Moesian acidophilous grasslands)

23. **F3.24311: Thracio-macedonian oriental hornbeam thicket**

NATURA 2000 code:40A0 – *Subcontinental peri-Pannonic scrub

The habitat with Oriental hornbeam develops in the lowest parts of Osogovo, in its foothill, where the impact of the modified sub-mediterranean climate is most expressed. These are, mainly, highly degraded bush-like populations which do not create a continuous belt, but rather grow in a scattered manner, in particular in Kocani and Probishtip parts of the Osogovo vo BG???, up to altitude of 750-800 m.

24. **F5.1311: [*Juniperus oxycedrus*] arborescent matorral**

NATURA 2000 code: 5210 - Arborescent matorral with Juniperus spp.

Juniperus oxycedrus ssp. oxycedrus-dominated formations of dry, rocky slopes and deforested areas.

25. **G1.11: Riverine [Salix] woodland**

NATURA 2000 code: 92A0 – Salix alba and Populus alba galleries

Riparian vegetation exists on small-size areas, primarily in the lower course of the rivers making up the Osogovo Mt. watershed - Bela Reka, Orizarska Reka, Zletovska Reka, Durachka Reka vo BG ??? etc. Dominating species composing this habitat are: *Salix alba*, *Salix fragilis*, *Salix amplexicaulis*, *Populus alba* etc.

26. **G1.1.2: Mixed riparian floodplain and gallery woodland**

NATURA 2000 code: 91E0 – *Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae)

This habitat type, in most cases, cannot be distinguished as a separate from the rest of the riparian vegetation with willows, because very often alder and willow populations exist one next to each other. Such is the case with a few localities down the lower course of Zletovska Reka (at altitude of 570-600 m.) where these habitats interlace and could not be distinguished as separate ones. Vo BG???

27. **G1.691: Southwestern moesian beech forests**

NATURA 2000 code: 91W0 – Moesian beech forests

This habitat includes beech forests which are widespread on the Balkan Peninsula, starting from Southern Dinarids, continuing to the Mesic and Macedonian mountains, ending with the Rhodope Mountains. The beech region on the Osogovo Mt. comprises the area with forest vegetation at altitude of 800-1700 m. It is divided into sub mountain and mountain beech forest belt. The submountain beech belt stretches at altitude of 800-1300 m. (ass. *Festuco heterophyllae-Fagetum*), whereas the mountain beech belt stretches at altitude of 1300-1600 m. (ass. *Calamintho grandiflorae-Fagetum*). Above the mountain beech belt there are fragments of subalpine beech forest (*Fagetum subalpinum*) which is, from both floristic and ecological aspect, clearly differentiated from the rest of the beech belt, followed above with a belt of sub-Alpine pastures and heats with *Bruckenthalia spiculifolia, Vaccinium myrtillus* etc.

28. **G1.762: Helleno- moesian Quercus frainetto forests**

NATURA 2000 code: 9280 - *Quercus frainetto* woods

The habitat with Italian oak forests (*Quercus frainetto*) covers climate zonal oak forests on the Osogovo Mt., which are present in larger numbers at the Kochani side of the mountain, and above Makedonska Kamenica, down the course of the Kamenichka Reka vo BG???. They are quite degraded due to, on the one hand, their long-lasting exploitation, and on the other hand, some of these habitats had been turned into hilly pastures for the stockbreeding purposes, which had been a common practice in these regions in the course of the previous years.

29. **G1.8A: Continental [Quercus petraea] forests**

NATURA 2000 code: 91M0 – Pannonian-Balkanic turkey oak-sessile oak forest

The habitat with Sessilee (Durmast) oak vertically adds up to the belt of Quercus frainetto forests, and it has broader distribution on Osogovo, shaped as a continuous belt, at altitude of 850-1150 m. from Kocani, as well as from Probishtip, Kratovo, Kriva Palanka and Kamenica side of the mountain vo BG????. The populations of this habitat, depending on the local climatic, orographic, geological and pedological features, alternately interlace with oak forests in the sub-forest belt (ass. *Festuco heterophyllae-Fagetum* Em 1965).

30. **G1.A32: Eastern [Carpinus betulus] woodland**

The habitat with *Carpinus betulus* is sparsely represented on the Osogovo Mt. In the course of the investigation only one well preserved representative population was registered on the Probishtip side of the mountain, at altitude of the village of Ratkovica vo BG????.

31. **G1.2: Mixed riparian floodplain and gallery woodland**

NATURA 2000 code: 91E0 - Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)

Mixed gallery riverside communities represented with major edificator *Alnus glutinosa*. In places edificators are *Alnus incana*, *Platanus orientalis* and *Fraxinus excelsior*. Also can be found *Salix fragilis* and *Salix alba*. This type of gallery forests are more common in the low mountain belt and rare in the middle mountain belt. They develop on damp to wet, occasionally flooded, drained and aerated soils. In turf area of this habitat most commonly are found *Aegopodium podagraria*, *Carex remota*, *C. sylvatica*, *Circaea lutetiana*, *Cirsium appendiculatum*, *Equisetum spp*., *Filipendula ulmaria*, *Galium aparine*, *Impatiens noli-tangere*, *Lycopus europaeus*, *Lythrum salicaria*, *Myosotis scorpioides*, *Ranunculus repens* , *Rumex sanguineus*, *Scirpus sylvaticus*, *Stellaria media*, *S. nemorum*, *Urtica dioica* and others. The mixed riparian gallery communities with Black alder as main species differ from communities dominated and participatied of this edificator in the lowlands and in the lower reaches of major rivers. They featuring thermophilic species is very limited. Floods are rare and short-lived due to the higher slope and narrow riparian valleys. In the higher parts of the mountains, galleries dominated by *Alnus glutinosa* give way to galleries dominated by *Alnus incana* and participation of a large number of boreal species.

32. **G1.61: Medio-European acidophilous [Fagus] forests**

NATURA 2000 code: 9110 - Luzulo-Fagetum beech forests

Forests dominated by beech, located on poor acidic and moist soils. The habitat includes acidophilus deciduous and mixed deciduous-coniferous forests with *Fagus sylvatica* as main species. They develop on relatively poor (sometimes eroded), bright brown forest soils formed mainly on the diorite, granite, rhyolite, sand, crystalline schists and others. These forests occupy most steep slopes with different exposures - both shady and sunny and have a great vertical range - from 700 to 1700 m.a.s.l. In the lower part of this range (700-1100 m.a.s.l.) forests are monodominant beech and mixed deciduous with relatively greater presence of *Carpinus betulus* and *Quercus dalechampii*, and in some places *Betula pendula*. At higher altitudes (1300-1700 m.a.s.l.) this habitat transfers into mixed forests of *Abies alba*

and *Picea abies*. Single participation at places with *Sorbus aucuparia*, *Populus tremula, Populus alba*, and *Pinus sylvestris* are registered. Acidophilus beech forests have well-developed herbaceous floor dominated by species whose distribution is related to acidic soils. In some communities is formed moss cover too. Based on the differences and particularities of the soil (mechanical structure, stoniness, humidity) and floristic composition two subtypes of acidophilus beech forests are present: Typical acidophilus beech forests (ass. *Luzulo luzuloidis-Fagetum sylvaticae*) and acidophilus beech forests on scree and rocky terrain (ass. *Geranium macrorrhizum-Fagus sylvatica*).

33. **G1.63: Medio-European neutrophile [Fagus] forests**

NATURA 2000 code: 9130 - Asperulo-Fagetum beech forests

Neutrophilic beech forests are formed on relatively high altitudes from about 700 to about 1800 (2100) m in a typical mountain climate. Mainly occupy northern slopes, ravines and gorges. The soils are neutral, weakly acidic or slightly alkaline, nutrient rich, moist brown forest. These forests grow at an average hydrothermal system and are characterized by the participation of a number of Middleeuropean and boreal species, making them similar to the average European beech forests. Predominant tree species is European beech (*Fagus sylvatica* subsp. *sylvatica* and *Fagus sylvatica* subsp. *moesiaca*), which sometimes in the lower parts forme mixed deciduous forests with *Acer heldreichii, A. pseudoplatanus, Betula pendula, Carpinus betulus, Fraxinus excelsior, Populus tremula, Sorbus aucuparia, Ulmus glabra*, and in the high mountains form a mixed deciduous-coniferous forests with *Abies alba, Picea abies* and *Pinus sylvestris*. Bush floor usually is absent, but species such *Daphne mezereum, Lonicera xylosteum, Rubus idaeus, Salix caprea, Sambucus racemosa* can be found. Mesophilic beech forests are characterized by rich and diverse floristic composition and abundance of grass floor compared to other beech forests. The dominant species are most often *Anemone nemorosa, Dentaria bulbifera, Galium odoratum, Lamiastrum galeobdolon, Sanicula europea, Melica uniflora*.
This type of forests are included in the Red Book of Bulgaria Vol. III Habitats (Biserkov and others. 2011) category "almost endangered habitat."
On the territory of Osogovo Mts. neutrophilic beech forests are represented by the following subtypes: Typical neutrophilic beech forests (Ass. *Asperulo-Fagetum*) and mesophilic beech forest on relatively poor soils (Ass. *Festuco drymejae-Fagetum*)

34. **G1.66: Medio-European limestone [Fagus] forests**

NATURA 2000 code: 9150 -Medio-European limestone beech forests of the Cephalanthero-Fagion

Xerotermophilous forests growing on limestone, often shallow soils. Main tree species is European beech (*Fagus sylvatica* subsp. *sylvatica* and *Fagus sylvatica* subsp. *moesiaca*). Other trees registered are: *Tilia tomentosa, T. cordata, Carpinus betulus and C. orientalis*. Shrub floor is built of *Acer campestre, Cornus mas, Fraxinus ornus* and *Ligustrum vulgare*. In the herbaceous floor species typical of thermophilic oak forests can be found (*Brachypodium pinnatum, Lathyrus niger, Mycelis muralis, Physospermum cornubiense*). Characteristic is the presence of species from Orchidacea family (*Cephalanthera spp., Dactylorhiza cordigera, Epipactis spp., Neottia nidus-avis, Orchis pallens* etc.) (Dimitrov and others. 2011).
This type of forests are included in the Red Book of Bulgaria Vol. Habitats III category "potentially endangered habitat" (Biserkov and others. 2011)

35. **G1.69: Moesian [Fagus] forests**

NATURA 2000 code: 91W0 - Southeastern Moesian beech forests and Balkan range Moesian beech forest

Pure and mixed deciduous forests with main species *Fagus sylvatica* subsp. *sylvatica* and *Fagus sylvatica* subsp. *moesiaca*. They occur mainly in the foothills and lower parts of the mountain in the range of 100 to 1300 m.a.s.l. under conditions of continental climate. Occupy mainly shady areas in ravines with relatively high air humidity and soil moisture. Moesian beech forests are characterized by thermophilic character, underlined by the presence of oak, lime, hornbeam and others. At the top of its vertical range of distribution Moesian beech mixed with *Capinus betulus* and *Quercus dalechampii*. In the lower stretches can bee seen: *Acer hyrcanum, Corylus colurna, Ostrya carpinifolia, Quercus cerris, Q. frainetto, Sorbus torminalis* and *Tilia tomentosa*. Bush floor is usually not formed. General coverage of the herbaceous layer varies widely depending on the coverage of trees and features a mosaic structure. Most often micro-groups with a predominance of the following types can be seen: *Aremonia agrimonoides, Dentaria bulbifera, Euphorbia amygdaloides, Galium odoratum, Luzula forsteri, Melica uniflora* and *Sanicula europaea*. Other species that can be found are also: *Dryopteris filix-mas, Hedera helix, Lamiastrum galeobdolon, Melissa officinalis, Mycelis muralis, Piptatherum virescens, Polygonatum latifolium, P. odoratum, Potentilla micrantha, Sanicula europaea, Tamus communis, Viola odorata, V. reichenbachiana* and *V* .

riviniana. The presence of *Glechoma hederacea*, *Arum maculatum*, *Geum urbanum*, *Helleborus odorus*, *Lathyrus niger* and *Physospermum cornubiense* is indicative of thermophilic nature of this type of beech forests. Characteristic species for spring time in these forests are: *Arum maculatum, Geum urbanum, Glechoma hederacea, Helleborus odorus, Lathyrus niger, Physospermum cornubiense* and others. (Dimitrov 2011). This type of forests are included in the Red Book of Bulgaria Vol. Habitats III category "potentially endangered habitat" (Biserkov and others. 2011).

36. **G1.737: Eastern sub-Mediterranean white oak woods**

NATURA 2000 code: 91AA - *Eastern white oak woods

This habitat is associated with xerothermic oak forests dominated by *Quercus pubescens* and is distributed mainly in the limestone hills of the places with continental climate. These forests are part of the mixed oak forests usually occupy drier and warmer places mainly on slopes with southern or western exposure. Such forests are found mostly in karst areas. Due to continental conditions, poor soils and anthropogenic influence, forests are mostly fragmentared and at places with shrubby appearance. Wood floor is dominated or co-dominanated by *Quercus pubescens*, reaching a height most often of 4-8 m. The trees are branched and often crooked. Besides *Quercus pubescens*, in this floor usually ca be found *Acer campestre, Fraxinus ornus, Quercus cerris, Q. frainetto, Q. virgiliana*. Often, especially in places with shallow limestone, *Carpinus orientalis* is quite dominant due to the open lighting. Typical classes of Trifolio-Geranietea and Festuco-Brometea are present in this forests. Some represenative species are: *Acanthus balcanicus, Althaea cannabina, Bothriochloa ischaemum (= Dichanthium ischaemum), Chrysopogon gryllus, Dictamnus albus, Echinops sphaerocephalus, Euphorbia polychroma, Festuca rupicola, Filipendula vulgaris, Geranium sanguineum, Orchis purpurea, Primula veris*.
Oak forests are usually found in complexes with other xerothermic oak forests formed by *Quercus cerris* and *Q. frainetto*, as well as *Carpinus orientalis*. Compared with the first two types, *Quercus pubescens* is more modest and occupies inappropriate places, sometimes manifested as their degradation stage. A comparison with *Carpinus orientalis* is radically different - communities of this kind of places can replace *Quercus pubescens*, especially in advance of erosion and degradation due to human activities - grazing, logging, fires and more. (Tsonev and others. 2011).

This type of forests are included in the Red Book of Bulgaria Vol. Habitats III category "potentially endangered habitat" (Biserkov and others. 2011).

37. **G1.7C411: Moesian silver lime woods**

NATURA 2000 code: 91Z0 - Moesian silver lime woods

38. **G1.A: Meso- and eutrophic [Quercus], [Carpinus], [Fraxinus], [Acer], [Tilia], [Ulmus] and related woodland**

NATURA 2000 code: 9170 - Galio-Carpinetum oak-hornbeam forests:

G1.A1C3 Moesian oak-hornbeam forests

G1.A32 Eastern [Carpinus betulus] woodland

39. **G1.A46: Southeastern European ravine forests**

NATURA 2000 code: 9180- Tilio-Acerion forests of slopes, screes and ravines

40. **G3.16: Moesian silver fir forests**

NATURA 2000 code: 91BA - Moesian silver fir forests

41. **G3.1E1: Southeastern Moesian spruce forests**

NATURA 2000 code: 9410 Acidophilous Picea forests of the montane to alpine levels (Vaccinio-Piceetea)

42. **G3.4C2: Rhodopide Scots pine forests**

NATURA 2000 code: 91CA - Rhodopide Scots pine forests

43. **G3.561A: Moeso-Macedonian Pallas' pine forests**

NATURA 2000 code: 9530 - (Sub-) Mediterranean pine forests with endemic black pines

44. **G1.76A Thracian sub-continental thermophilous oak woods**
45. **G1.7C13 Montane hop-hornbeam woods**

G1.7D1 Helleno-Balkanic *Castanea sativa* forests

G1.8A Continental [*Quercus petraea*] forests

46. **G3.F12 Native pine plantations**

47. **H3.152 - Carpatho-Balkano-Rhodopide campion siliceous cliffs**

NATURA 2000 code: 8220 – Siliceous rocky slopes with chasmophytic vegetation

A habitat including the hasmofitic vegetation on bare silicate rocks was found on a few localities on the Osogovo Mt. However, most representative populations are those on the Ruen summit, at Kalin Kamen, in the Zletovska Reka ravine and in front of the village of Lesnovo. In silicate rocks (H3.152 Carpatho-Balcano-Rhodopidae campion siliceous cliffs) vegetation is poor and it is represented mainly from communities which can tolerate extreme conditions such as mosses and lichens. Typical types of rock crevices are *Silene lerchenfeldiana, Sedum sartorianum, Poa mollineri, Plantago holosteum, Saxifraga pedemontana subsp. cymosa, Thymus balcanus*. As scree, rocks are on Habitat Directive 92/43 / EEC, respectively 8110 Siliceous scree of the montane to snow levels (Androsacetalia alpinae and Galeopsietalia ladani) and 8220 Siliceous rocky slopes with chasmophytic vegetation.

48. **H2.3116: Rhodopide mountain sorrel screes**

Siliceous *Oxyria digyna* screes of the high Rila and Pirin mountains, with *Poa cenisia ssp. contracta*, *Geum reptans*, *Satureja alpina*, *Pedicularis verticillata*, *Armeria alpina*, *Luzula spicata*, *Bellardiochloa violacea*. On Osogovo Mt. this habitats occupy relatively small areas and are virtually lacking vegetation.

49. **I1: Arable land and market gardens**

Osogovo Mt., is inhabited by humans since ancient times. Traces of millennial human impact are everywhere. Many of the habitats and vegetation have undergone major changes and transformations. Dynamics continues today and should peculiarities of economic and social development of settlements in and around the mountain. Many natural habitats, especially in the lower parts of Osogovo are entirely created by humans - farmland by fields and vegetable gardens (I1 Arable land and market garden), orchards (G1.D Fruit and nut tree orchards) coniferous forest plants, mines and galleries and many others. Croplands planted for annually or regularly harvested crops other than those that carry trees or shrubs. They include fields of cereals, of sunflowers and other oil seed plants, of beets, legumes, fodder, potatoes and other forbs. Croplands comprise intensively cultivated fields as well as traditionally and extensively cultivated crops with little or no chemical fertilisation or pesticide application. The human pressure has changed and continues to change the nature of Osogovo. It is essential to strike a balance between development and conservation of the diverse nature of

the mountain. Faunal and floral quality and diversity depend on the intensity of agricultural use and on the presence of borders of natural vegetation between fields.

50. **Rocks/Open ground**

Table 6 List of habitats included in EUNIS that occur in Osogovo Mt.

	EUNIS code	Name	HD code	Priority	Occurrence in Osogovo
1	C2.2	Permanent non-tidal, fast, turbulent watercourses		Relation to one or more Annex I habitat types (EU HD)	BG&MK
2	C2.24	Waterfalls			BG&MK
3	C2.26	Lime-rich oligotrophic vegetation of fast–flowing streams		Relation to one or more Annex I habitat types (EU HD)	BG&MK
4	D2.2C1	Soft water bryophyte springs			BG&MK
5	*D2.3	Transition mires and quaking bogs	7140	Resolution 4 habitat type used for designation of Emerald sites (Bern Convention) Unclear HD status	BG&MK
6	D5.11	[Phragmites australis] Beds Normally without Free-Standing Water			MK
7	E1.332	Helleno-Balkanic short grass and therophyte communities	6220	* Included in a Resolution 4 habitat type (Bern convention) at a higher level (E1.3)	BG&MK
8	E1.4344	Moesio-Carpathian meadow-steppes			BG
9	E1.55	Eastern sub-Mediterranean dry grassland		Relation to one or more Annex I habitat types (EU HD)	BG
10	E1.72	[*Agrostis*] – [*Festuca*] grasslands		Relation to one or more Annex I habitat types (EU HD)	BG&MK
11	E1.73	[*Deschampsia flexuosa*] grasslands		Relation to one or more Annex I habitat types (EU	BG&MK

				HD)	
12	E1.833	Balcanic montane [*Nardus stricta*] swards	6230	* Included in a Resolution 4 habitat type (Bern convention) at a higher level (E1.83)	BG&MK
13	E2.3	**Mountain hay meadows**	6520	Relation to one or more Annex I habitat types (EU HD)	BG
	E2.33	**Balkan mountain hay meadows**	6520		BG
14	E2.252	Moesio-Thracian hay meadows		Included in a Resolution 4 habitat type (Bern convention) at a higher level (E2.25)	BG
15	E3.31	Helleno-Moesian riverine and humid [*Trifolium*] meadows			BG&MK
16	E3.5	**Moist or wet oligotrophic grassland**	6410	Resolution 4 habitat type used for designation of Emerald sites (Bern Convention) Relation to one or more Annex I habitat types (EU HD)	BG
17	E4.1????	Boreo-alpine acidocline snow-patch grassland and herb habitats			BG
18	E4.318	Oro-Moesian mat-grass swards	*6230		BG
19	E4.39	Oro-Moesian acidophilous grasslands	62D0	Relation to one or more Annex I habitat types (EU HD)	BG&MK
20	E5.3	[*Pteridium aquilinum*] fields			BG&MK
21	E5.41	Screens or veils of perennial tall herbs lining watercourses		Relation to one or more Annex I habitat types (EU HD)	BG
22	E5.572	Moesian tall herb communities	6430		BG&MK
23	E5.58	**Alpine [Rumex] communities**		Relation to one or more Annex I habitat types (EU HD)	BG

24	F2.231	Mountain [*Juniperus nana*] scrub	400		BG
25	F2.26	[*Bruckenthalia*] heaths	4060	Resolution 4 habitat type used for designation of Emerald sites (Bern Convention) Relation to one or more Annex I habitat types (EU HD)	BG&MK
26	F2.27	Alpide [*Arctostaphylos uva-ursi*] and [*Arctostaphylos alpinus*] heaths		Relation to one or more Annex I habitat types (EU HD)	BG
27	F2.2A2	Balkano-Hellenic dwarf bilberry heaths	4060		BG&MK
28	F2.2B2	Balkano-Rhodopide [*Chamaecytisus absinthioides*] heaths	4060		BG&MK
29	F3.164	Sub-Mediterranean common juniper thickets			BG
30	F3.24311	Thracio-Macedonian oriental hornbeam thickets	40A0	*	BG&MK
31	F3.2432	Moesian lilac thickets			BG
32	F5.1311	[*Juniperus oxycedrus*] arborescent matorral			BG
33	F.B4	Vineyards			BG
34	G1.11	Riverine [Salix] Woodland	92A0	* Resolution 4 habitat type used for designation of Emerald sites (Bern Convention)	BG&MK
35	G1.2	Mixed Riparian Floodplain and Gallery Woodland	91E0	* Relation to one or more Annex I habitat types (EU HD)	BG&MK
36	G1.1217	Rhodopide grey alder galleries		Included in a Resolution 4 habitat type (Bern convention) at a higher level (G1.12)	BG
	G1.69	Moesian [Fagus] Forests			
37	G1.691	Southwestern Moesian Beech Forests		Included in a Resolution 4 habitat type (Bern convention) at a higher level (G1.6)	MK
38	G1.737	Eastern sub-Mediterranean		Included in a	BG

		white oak woods		Resolution 4 habitat type (Bern convention) at a higher level (G1.7)	
39	G1.76A	Thracian sub-continental thermophilous oak woods		Included in a Resolution 4 habitat type (Bern convention) at a higher level (G1.7)	BG
40	G1.762	Helleno-Moesian *Quercus frainetto* Forests	9280	Included in a Resolution 4 habitat type (Bern convention) at a higher level (G1.7)	MK
41	G1.7C13	Montane hop-hornbeam woods		Included in a Resolution 4 habitat type (Bern convention) at a higher level (G1.7	BG
42	G1.8A	Continental [*Quercus petraea*] forests		Included in a Resolution 4 habitat type (Bern convention) at a higher level (G1.8	BG
43	G1.A1C3	Moesian oak-hornbeam forests		Included in a Resolution 4 habitat type (Bern convention) at a higher level (G1.A1)	BG
44	G1.A32	Eastern [Carpinus betulus] Woodland			BG&MK
45	G1.A46	Southeastern European ravine forests		Included in a Resolution 4 habitat type (Bern convention) at a higher level (G1.A4) Relation to one or more Annex I habitat types (EU HD)	BG
46	G1.C	Highly artificial broadleaved deciduous forestry plantations			BG
47	G1.D	Fruit and nut tree orchards			BG
48	G3.16	Moesian [*Abies alba*] forests		Resolution 4 habitat type used for designation of Emerald sites (Bern	BG

				Convention) Relation to one or more Annex I habitat types (EU HD)	
49	G3.4C	Southeastern European [*Pinus sylvestris*] forests		Resolution 4 habitat type used for designation of Emerald sites (Bern Convention)	BG
50	G3.561A	Moeso-Macedonian Pallas' pine forests		Included in a Resolution 4 habitat type (Bern convention) at a higher level (G3.56)	BG
51	G3.F12	Native pine plantations			BG
52	H2.311	**Mountain sorrel screes**	8110		BG&MK
53	H2.3116	Rhodopide mountain sorrel screes			BG
54	H3.152	Carpatho-Balkano-Rhodopide campion siliceous cliffs	8220		BG&MK
55	H3.1B	Bare siliceous inland cliffs			BG
56	H3.25	Alpine and sub-mediterranean chasmophyte communities		Relation to one or more Annex I habitat types (EU HD)	BG
57	H3.2E	Bare limestone inland cliffs			BG
58	I1	Arable land and Market Garden			BG&MK
59	J1	Buildings of sites, towns and villages			BG&MK
60	J2	Low density buildings			BG&MK

Habitats on Osogovo listed in Habitat Directive:

- E1.332 - HELLENO-BALCANIC SHORT GRASS AND THEROPHYTE

COMMUNITIES (NATURA 2000: 6220 *Psudo-steppe with grasses and annuals of the Thero-Brachypodietea)

- E1.833 - BALCANIC MONTANE [Nardus stricta] SWARDS (NATURA 2000: 6230 - *Species-rich Nardus grasslands, on silicious substrates in mountain areas (and submountain areas in Continental Europe)

- F3.24311 - THRACIO-MACEDONIAN ORIENTAL HORNBEAM THICKET (NATURA 2000:40A0 – *Subcontinental peri-Pannonic scrub)

- G1.1.2 - MIXED RIPARIAN FLOODPLAIN AND GALLERY WOODLAND (NATURA 2000: 91E0 – *Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)

- G1.11 - RIVERINE [Salix] WOODLAND (NATURA 2000: 92A0 – Salix alba and Populus alba galleries)

The priority habitat types listed in the Habitat Directive, which are registered on Osogovo, cannot be considered as prevailing and predominant habitat types on this mountain, judging by the area they cover and the significance they bear. The habitat with Oriental hornbeam (NATURA 2000:40A0) is mainly represented with rather degraded, bush-like populations which do not create a continuous belt, but rather appear in a scattered manner up to altitude of 750-800 m.

The habitat type on the hilly pastures (NATURA 2000:6220), i.e. the communities belonging to this habitat, are maintained by grazing. However, diminished stockbreeding on the whole territory of the Osogovo Mt., in particular in its lower areas, has led to their gradual becoming overgrown.

The habitats with riparian vegetation (NATURA 2000:91E0; 92A0) which develop down the lower course of the rivers belonging to the Osogovo Mt. thrive on relatively small areas and are potentially threatened by prospective waterworks which could be performed on higher altitudes, or by pending construction of water accumulations for water supply or for irrigation.

The habitat (NATURA 2000: 6230) with Nardus stricta is not particularly threatened, as it is part of the sub-Alpine pasture vegetation. On the Osogovo Mt. there are substantial number of important habitat types, which are, however, not reported in the list of Priority Habitat Types of the Habitat Directive. From phitocenological aspect, they are extremely important, as inside them some important plant communities develop. Besides, they are habitats with an exceptional floral diversity. Such habitats are the sub-Alpine pastures (NATURA 2000:62.D0), the mountain marshes and peat bogs (NATURA 2000:7140), Hydrophylous tall herb fringe communities of plains and of the montane to alpine levels (NATURA 2000:6430), vegetation of Alpine and boreal heaths (NATURA 2000:4060), as well as

miscellaneous types of forest habitats. Hydrophylous tall herb fringe communities of plains and of the montane to alpine levels

5.1 Important areas to be protected

The important habitats with grass-like, bush-like and marsh vegetation is located in the sub-alpine belt of the Osogovo Mt.

D2.3 - TRANSITION MIRES AND QUAKING BOGS (NATURA 2000: 7140 - Transition mires and quaking bogs) (1700-2000 m.)

E1.332 - HELLENO-BALCANIC SHORT GRASS AND THEROPHYTE COMMUNITIES (NATURA 2000: 6220 *Psudo-steppe with grasses and annuals of the Thero-rachypodietea)

E1.833 - BALCANIC MONTANE [Nardus stricta] SWARDS (NATURA 2000: 6230 - *Species-rich Nardus grasslands, on silicious substrates in mountain areas (and submountain areas in Continental Europe) (1670-1950 m.)

E4.39 - ORO-MOESIAN ACIDOPHILOUS GRASSLANDS (NATURA 2000: 62D0 - Oro-Moesian acidophilous grasslands (1550-2250 m.)

E5.572 - MOESIAN TALL HERB COMMUNITIES (NATURA 2000: 6430 – Hydrophylous tall herb fringe communities of plains)

F2.26 - [BRUCKENTHALIA] HEATS (NATURA 2000: 4060 – Alpine and Boreal heaths) (1800-1900 m.)

F2.2A2 - BALCANO-HELLENIC DWARF BILBERRY HEATHS (NATURA 2000: 4060 – Alpine and Boreal heaths) (1600-2200 m.) The important habitats with grass-like, bush-like and marsh vegetation are located in the sub-Alpine belt of the Osogovo Mt. (Sultan Tepe-Ruen).

Ratkova Skala

5.2 Threats

The communities which are part of the habitats in the mountain marshes and peat bogs - Sphagnum comm. (NATURA 2000:7140), as well as the vegetation of the Alpine and sub-Alpine high grass-like plants (NATURA 2000:6430), belonging to the Cirsion appendiculati alliance, are increasingly represented on silicate mountains, which is the case with the Osogovo mountain. They thrive beside wellsprings and mountain brooks at higher altitudes,

which means that possible waterworks related to capture of the waters on higher altitudes could have an adverse effect on these habitats. Decreased stockbreeding and considerable reduction in the cattle will lead to loss of the habitats, both in the hilly pastures and in the sub-Alpine pastures zones (their being overgrown with Chamaecytisus absinthoides, Pteridium aquilinum and other species is already in progress). Mine openings, disposal of the slag (dross) and the numerous access paths altogether cause fragmentation of the habitats of the communities in the hill and mountain belt.

From aspect of presence of significant habitats with grass-like vegetation, presented in the heading "Important areas to be protected", special attention must be paid to the sub-Alpine part of the Osogovo Mt. (at altitude of 1600-2250 m.) and to protection, in an integral manner, of the set of habitats (marshes, sub-Alpine pastures, bushes with *Bruckenthalia spiculifolia* and *Vaccinium*-species, silicate rocky places), especially on the Sultan Tepe and Ruen peaks. On these two mountain tops there are also some rare plant species (*Genista fukarekiana, Dianthus microlepis, Anthyllis aurea, Thymus balcanus, Geum rivale, Cardimine glauca* etc.). When zoning, these areas must be included in the strong protection zone, because beside their habitat, vegetation and floral value, they are magnificent landscapes, too.

6 ASSESSMENT OF THE ECOSYSTEM TYPES AND THEIR VALORIZATION

In the conservation practice in the world, there is a frequent talk of ecosystem diversity, usually to attribute value to an area worth of conservation. In fact, ecosystem diversity has emerged as a term from the very definition of biological diversity. Nevertheless, in time, the term has been less and less used owing to the fact that there is no comprehensive, detailed and accurate classification of ecosystems or ecosystem types. Even more, development of such classification is not expected given the fact that description and systematization of ecosystem types should also include the basic feature of ecosystems – their mass-energy balance.

Yet, the need to define and classify ecosystem types has been constantly growing nowadays, especially upon the introduction of the new concept for biological diversity valuation and conservation – *ecosystem services*. Thus, depending on the purpose, ecosystems are in practice grouped on different levels, but mostly rather roughly: marine, lake, river, forest, grassland, mountainous, etc. These divisions cannot meet the requirements for the purpose of presentation of ecosystem diversity of an area, and they can hardly serve as basis for valuation of ecosystem services either.

Contrary to ecosystems, habitats in the world and in Europe especially, are covered by detailed and mostly comprehensive classification. The text below uses all three terms and they have equal meaning (synonyms). The most frequently used classification of habitats in Europe is the one of the EUNIS database (http://eunis.eea.eu.int/index.jsp).

As habitats are defined mainly by their floral component, and are essentially homologous with ecosystems, we may take that classification of habitats is similar to the one of ecosystems. However, diversity of ecosystems might be even bigger, because certain differences in the vitality or degradation phases of a given habitat assume different mass-energy balance or different ecosystem. For practical reasons, ecosystem types should be generalized to the extent at which conservation practices will be applicable. Generalization leads inevitably to the definition of the so called “key ecosystems”. Hierarchically set classification of Europe’s habitats EUNIS can serve as basis for such generalization.

Total of 28 basic sets of habitats has been identified in Macedonia. Some of these habitats are of anthropogenic origin, but still have certain significance for biological diversity and are thus part of this classification. The number of thus generalized ecosystem types reflects great ecosystem diversity in Macedonia.

1. Lake ecosystems (ecosystems of surface standing water bodies, including accumulations, larger ponds and glacial lakes)
2. River ecosystems (ecosystems of surface running water bodies, including streams)
3. Marsh and swamp ecosystems (including saline marshes)
4. Ecosystems of dry montane grasslands
5. Ecosystems of mesophilous and seasonally wet grasslands and meadows
6. Ecosystems of mountainous grasslands (including subalpine and alpine grasslands, as well grasslands on rocky grounds)
7. Alpine dwarf scrub ecosystems
8. Alpine scrub ecosystems
9. Degraded forest ecosystems (including pseudomacquis, arborescent matorral, Thermo-Mediterranean thickets and garrigues)
10. Riparian and fen scrub ecosystems
11. Anthropogenic scrub ecosystems
12. Deciduous forest ecosystems (broadleaved woodlands)
13. Coniferous forest ecosystems
14. Mixed deciduous and coniferous forest ecosystems
15. Cave ecosystems (including water bodies therein)
16. Rocky and stone ground ecosystems (including rocks, rocky terrains and screes)
17. Ecosystems without or with sparse vegetation (including eroded areas)
18. Farming agro-ecosystems
19. Aquatic agro- ecosystems (fishponds)
20. Urban ecological systems
21. Ecological systems of rural settlements
22. Ecological systems of mining and industrial excavations
23. Ecological systems of entirely artificial water bodies
24. Ecological systems of waste deposits and landfills

6.1 Key ecosystems

In order to define the most important (key) ecosystem types in Macedonia, we took the third level of EUNIS habitats classification as basis. This classification of the ecosystems in Macedonia can be used to assess ecosystem services of natural ecosystems.

Some of these ecosystems have lesser importance in terms of ecosystem services as they are represented on small areas, while some are key ecosystems and cover significant area of Macedonia's territory. Key ecosystems are crucial for proper accomplishment of

biogeochemical cycles, supply of water, circulation of gases in atmosphere, supply of timber and other products, etc. (lake and river ecosystems, deciduous, evergreen and mixed forest ecosystems). However, less represented ecosystems have enormous importance for biological diversity in Macedonia, as they are habitats that accommodate rare, relict and endemic species (for instance, acid and base peats, saline steppe ecosystems, rocky and stone ecosystems, cave ecosystems).

6.2 Identification and analysis of threats to different ecosystem types

Identification of threats to ecosytems can provide a conceptual and integrated ecological and economic thinking for strengthening conservation and providing a rationale for public spending in ecological restoration. The goals can be summarized as follows:

a) Raise awareness on the economic values of effective conservation in the local population, financial planners and decision-makers in the area, so as to create a climate more conducive to sustainable policy and behavioral change;

b) Evaluate the costs and benefits of specific habitat management actions to inform conservation and public funding decisions;

c) Identify financial opportunities for the region associated with the provision of ecosystem services and with specific management actions;

d) Generate participation and training opportunities for conservation managers and local/regional decision-makers in economic valuation for integrated ecosystem management.

7 MAIN THREATS TO BIOLOGICAL DIVERSITY

All factors and processes leading to accelerated extinction of species and reduction in their populations, loss of genetic material, degradation of ecosystems and reduction in ecosystem services can be regarded as threats to biological diversity. Analysis of threats is crucial in detecting the causes for biological diversity reduction and planning of measures for its protection.

Considering the necessity to determine the threats precisely in order to elaborate efficient plan for biological diversity protection, on this ocassion identification of threats was made in accordance with the generally recognised international terminology and by precise methodology. Attention was primarily devoted to threats prioritization to enable planning of the activities that are necessary for efficient protection of the most endangered biodiversity components in conditions of lack of financial and human resources for protection of all threatened species and ecosystems.

For the sake of conciseness and primarily for compatibility of data with those on international level, the analysis was made in accordance with the existing classification of threats of the EU used by Member States for reporting under Article 9 of the Habitat Directive.

Balmford et al. (2009) mainatain that classification and terminology of IUCN-CMP, upon which the EU one has been built, combine the two key, but consecutive aspects of threats into a single and incomplete linear system. These are ’mechanisms of threats’ and their ’sources’ which are in IUCN-CMP classification presented as ’direct threats’. This means that, taking the unfavourable ’status’ as starting point (e.g. reduced population of a species) of the ’target’ (the specific species), we should determine the ’mechanism of threat’ (e.g over-hunting) to reach the ’source’ (e.g. sector of hunting or more precisely poaching). Then, we can also look for the’hidden’ or ’root cause’ of the threat (e.g. absence or insufficient enforcement of laws), which is actually ’indirect threat’. Unfavourable status of the target species or ecosystem is also defined by Salafsky et al. (2008) as ’stress’ (degraded condition or disordered attribute).

Definition of several terms related to threats (IUCN-CMP 2006):

The main assumption in threats identification is the **’target’**of protection or conservation for which the threat is identified. This can include endangered wild species, communities or ecosystems (or components of agrobiological diversityunder threat for extinction). Synonims: ’conservation target’, biodiversity target’ or ’focal target’.

'Direct threat'is direct (essentially human) activity or process that has caused, causes or might cause destruction, degradation and/or damage of the components of biological diversityand natural processes (e.g. bare cuts in forest ecosystem, over-fishing, etn.). Synonims: 'source of stress' and 'direct pressure'.

'Principal' or **hidden causes'**are factors, usually social, economic, political, institutional or cultural in nature, enabling (or otherwise contributing to) the existence and duration of direct threats (e.g. trends in market prices of certain biological resources, planning of the space, etc.). There is normally a chain of hidden causes behind each direct threat. Hidden causes are basically 'indirect threats', but they can also be 'opportunities' (factors of positive effect). Synonims: 'drivers' (fosterers) or 'root causes'.

7.1 Direct threats to biological diversity on Osogovo Mt.

From the list of threats under the EU classification, threats relevant for Macedonia (249 in total) were selected first. Simple methodology was used to prioritize the threats by which all threats were assessed according to five criteria based on expert judgement: (1) **geographical distribution**, (2) **scope**, (3) **intensity**, (4) **urgency** and (5) **reversibility** of threat, with scores 1 to 3. Grades of each threat were formed on the basis of data available on each of the threats in Macedonia. Thus obtained grade (sum) was used to prioritize the threats according to the following scheme: from 0.5-3.5 low priority; from 4 – 6.5 medium priority; from 7 – 9.5 high priority and from 10 – 12 very high priority.

Following the analysis of the threats in Macedonia, we were able to identify 17 threats of very high priority, 68 threats of high priority, 115 threats of medium priority and the rest of 49 threats have low priority.

Threats of I and II priority (very high and high priority) are 85 in total, and they are priority for biological diversity protection and have been addressed accordingly in the Biodiversity Action Plan. The 17 threats assessed with highest priority, because of their importance, have been presented and commented separately.

Table 7 List of priority threats to biological diversity with explanations and root causes for threat endurance

	Threat	**Explanation**	**Root causes**
1	**Abandonment / lack of mowing**	These two threats are related to agricultural sector, as they result from *abandonment of traditional modes of meadows and pastures exploitation* through mowing and grazing, respectively. Root causes lie in the depopulation of rural cores and low economic	Wrong policies– historically and presently
2	**Abandonment of pastoral systems,**		Wrong policies– historically and

	lack of grazing	cost-effectiveness of those activities without subsidies. Great village-city migration resulted in significant reduction of livestock. Former areas under meadows are no longer mowed and they are transformed into other types of habitats – montane pastures.	presently
3	**Open cast mining**	This threat derives from the sector of mineral and non-mineral resources exploitation (mining and quarries). It causes permanent loss of habitats of high number of important species associated with marbleized limestones, especially among plants ("marble flora") and invertebrates.	Lack of economic policies; inconsistent implementation of laws and procedures, unsustainable development, inadequate planning
4	**Continuous urbanization**	These three threats are associated with urbanization and lead to direct uptake of habitats and disturbance of species on the whole territory of Macedonia. Several plant communities are particularly affected (especially swampy) and representatives of flora. Due to the wide range, intensity and irreversibility of the threat, this group also includes *disposal of municipal waste and demolition waste*.	Lack of laws and procedures implementation, inadequate planning
5	**Disposal of household / recreational facility waste**		Lack of laws and procedures implementation, lack of awareness
6	**Disposal of industrial waste**		Lack of laws and procedures implementation
7	**Trapping, poisoning, poaching**	Poaching is one of priority threats associated with hunting. It is the cause for reduction of the populations of several species of concern (roe deer, chamois), and directly (through killing) or indirectly (through reduction in the number of natural pray). On the other side, illegal use of poisonous baits, led to extinction of Lammergeier and Black Vulture and to drastic reduction in the populations of Egyptian and Griffon Vultures.	Poverty, lack of laws implementation, low awareness, markets
8	**Missing or wrongly directed conservation measures**	One of the greatest problems in nature and biological diversity protection in Macedonia is the inadequate mainstreaming of constrained available financial resources and human capacity. This was indicated by the analysis of	Low capacity of institutions, wrong policies, insufficient funding

		the implementation of the Action Plan of the first biological diversity strategy, but also series of other strategic documents.	
9	**Groundwater pollution by leakages from waste disposal sites (WFD)**	Due to the wide spread use of chemical protection products in agriculture, as well as lack of sanitary landfills with water impermeable layer, entry of such waste and agricultural waters into ground aquifers is a wide spread and irreversible problem, especially with regard to endogean fauna, and the use of these waters (e.g. for irrigation) or their linkage with lake basins transfers the risk to a great number of aquatic organisms.	Lack of laws and procedures implementation
10	**Diffuse groundwater pollution due to agricultural and forestry activities**		Lack of knowledge, lack of awareness, implementation of laws
11	**Reservoirs**	Construction of artificial water accumulations is a severe threat, primarily due to its irreversibility. As by rule, river gorges are the most suitable places for their construction and they are often refuge shelters rich in rare (relict), endangered or endemic flora and fauna. In certain cases, small hydro power plants are constructed within the boundaries of protected areas. Surface water intakes for irrigation, through construction of water accumulations, lead to the same problem.	Lack of laws implementation, unsustainable development, policies
12	**Surface water abstractions for agriculture (WFD, e.g. irrigation)**		Lack of planning
13	**Surface water abstractions for hydro-energy (WFD)**		Lack of laws implementation, unsustainable development, economic policies
14	**Temperature changes**	Climate change is another priority threat, which concerns the expected raise in temperature and decrease in the volume of precipitations, to result in extinction or reduced area range of several sub-alpine and/or alpine species and habitats, as well as expansion of arid areas, increased risk of fires and increased erosion.	Climate change
15	**Droughts and less precipitations**		Climate change

7.2 Indirect and root causes for biological diversity loss

Conservation practice in the world has shown that activities aimed at mitigating or eliminating direct threats have not produced the desired result. Despite huge funds invested in

the prevention of poaching in Africa, prevention of devastation of Amazon forests, fragmentation of forests in Europe and series of other direct threats, degradation of the components of biological diversity has proceeded with equal or almost equal intensity. It is obvious that other, indirect threats lie in the basis of direct threats and they render inoperative the halt of species and ecosystems in modern world. It is necessary that these are identified and addressed adequately in order to enable the efforts for biological diversity conservation to achieve results.

The same rules with regard to biological diversity loss that are typical for developing countries that face transition from one system of political ruling and governance to another and cope with poverty are applicable in Macedonia, too (Wood et al. 2000). There is an amalgamof indirect threats underlined with several root causes for biological diversity loss. Indirect threats are associated mainly with economic sectors and other areas of human living.

Several root causes lie in the essence of negative impact of sectors on biological diversity. Growing inequality between different social classes, change in lifestyle of economically stronger individuals and consolidation of agricultural land managed by a low number of economically powerfull companies will result in falling trends with many now widely spread species.

For the purpose of clearer presentation of the relation between root causes for biological diversity loss in Macedonia and direct threats, analysis was made of the 17 most priority threats in our environment. It can be noted that several root causes can exist for one threat or one root cause can control several threats. Thus, for example, weak implementation of the existing environmental legislation is partially or fully responsible for 10 of the 17 most priority threats. The table shows that very prominent position is also held by root causes like low (public and institutional) awareness, lack of modern planning of space, inadequate policies and unsustainable development, etc.

We may not expect that elimination of one of the threats will divert negative trends. There is weak coordination between sectoral strategies (e.g. tourism, forestry, energy), as well as the goals of sustainable development and nature protection.

7.3 Key sectors affecting biological diversity

At present, Macedonia stands on a cross-road between more intensive economic growth and constantly increasing devastation of natural values. The focus of nature

conservation has to be searched for in the integration of the principles of sustainable development into other sectors' policies, while identifying mechanisms and alternatives that will not slow down significantly the projected economic growth, contribute to the ultimate objective of poverty reduction and improve the quality of living, and at the same time enable long-term survival of (nationally and internationally) most significant components of biological diversity.

On the basis of the analysis of threats on biological diversity, the following key sectors were identified to affect the biological diversity: agriculture, forestry, hunting, transport, energy, fishery and aquaculture, water management, industry and pollution and use of natural resources.

The main sectors with greatest impact on biological diversityin Macedonia came out of the analysis of the threats. Brief analysis of these sectors is presented below.

All identified threats to biological diversity in Macedonia have been grouped in 13 main sectors / areas. For each of the sectors, cumulative sum of scores was calculated (out of all threats originating from that sector). Scores presented by sectors may provide only indication of the impact, but it cannot be used for absolute comparison of sectors. We may note that the greatest impact on biological diversityoriginates from the areas J-Modification of natural systems, H-Pollution, G-Intrusion and disturbance by man and A-Agriculture. The scores of area H-Pollution are high because this area also includes threats stemming from agriculture, forestry, and not only industry, transport, etc. What is really relevant is the number of priority threats occurring by sectors. The highest number of threats occurs in the areas J-Modification of natural systems (18), H-Pollution (15), followed by E-Urbanization, residential and commercial development (8), A-Agriculture (7), GIntrusion and disturbance by man (7) etc.

Table 8 Analysis of threats by sectors/areas

Sector/area	**Sum of scores**	**Number of threats by priority**			
		I	**II**	**III**	**IV**
A Agriculture	**155.5**	***2***	***5***	*13*	*12*
B Silviculture, forestry	**72.5**	***0***	***5***	*5*	*3*
CMining, extraction of materials and energy production	**77.5**	***1***	***3***	*8*	*0*

DTransport and service corridors	**84**	***0***	***5***	*7*	*6*
EUrbanization, residential and commercial development	**105.5**	***3***	***5***	*6*	*1*
FOther use of biological resources except agriculture and forestry	**103.5**	***1***	***4***	*8*	*8*
GIntrusion and disturbance by man	**175**	***1***	***6***	*20*	*6*
H Pollution	**182.5**	***2***	***1 3***	*10*	*1*
IInvasive, other problematic species and genes	**23.5**	***0***	***1***	*2*	*1*
JModification of natural systems	**230.5**	***5***	***1 3***	*13*	*9*
KNatural biotic and abiotic processes (without disasters)	**122**	***0***	***5***	*14*	*2*
LGeological events, natural disasters	**26.5**	***0***	***2***	*2*	*4*
M Climate change	**50.5**	***2***	***0***	*4*	*4*

7.4 Assessment of potentials of ecosystems important for economy and biodiversity conservation

Blueberries represent significant natural resource that provides additional income for number of people. However, the systems for collection, licensing, control and monitoring are still not well developed in most of the Republic of Macedonia which puts pressure on natural habitats and wild species and leads to unsustainable use. The aim of this paper is to assess the economic potential based on sustainable usage of blueberries (*Vaccinium myrtillus* – European blueberry and *Vaccinium uliginosum* – Bog blueberry) on Osogovo Mtn., north-east Macedonia by intensive field assessment of annual production of fruits and leaves along with chemical characterization of the leaves and analysis of the importance of blueberries for local population. Field methods for assessment of surface of the heathlands and were based on remote sensing and ground truth data by using GIS; leaves and fruits production was estimated by standard transect square method; chemical characterization of the leaves was done by HPLC/DAD/ESI-MS^n . The average production of dry leaves and fruits was 11.7 g m^{-2} and 213.2 g m^{-2}, respectively. The total dry fruits biomass on Osogovo Mtn. in 2008 was estimated at 249.11 t (218.82 t in heathlands)

From which 53% was European blueberry fruits. The total dry leaves biomass was estimated at 1459.4 t (927.1 t of European bilberry). Estimated economic income of sustainable use of fruits and leaves is 1.6 and 0.5 milion Euros, respectively. This amount can support 340 people with average Macedonian annual gross salary.

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