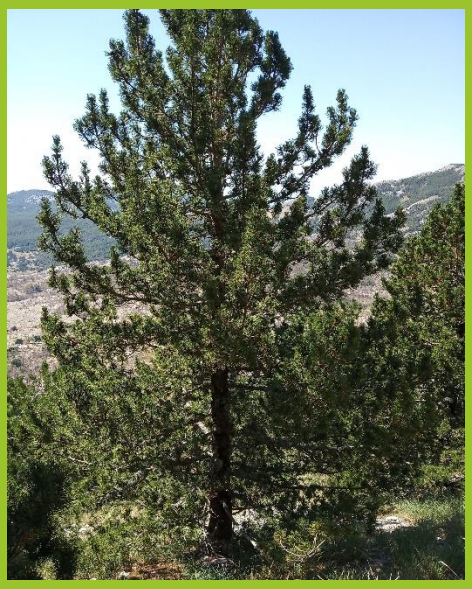
Interreg – IPA CBC
Italy - Albania - Montenegro
EUROPEAN UNION
LASPEH

ACTION PLAN FOR CONSERVATION OF *Pinus heldreichii* (H. Christ 1863) IN NATIONAL PARK LOVĆEN, MONTENEGRO



- **WP T1**: TRANSNATIONAL JOINT STRATEGY AND TOOLS FOR THE BETTER MANAGEMENT OF PRIORITY SPECIES IN NATURA 2000 SITES
- **ACTIVITY T1.1**: DEFINITION OF CONSERVATION GUIDELINES ON SPECIES
- **DELIVERABLE T1.1.2:** CONSERVATION PLAN ON A PRIORITY SPECIES
- **PARTNER:** NATIONAL PARKS OF MONTENEGRO (NPCG) – PP3
- **PARTNER COORDINATOR**: SLOBODAN STIJEPOVIĆ
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1. Endorsement

1.1. Project framework

The Conservation Plan of the Bosnian Pine (*Pinus heldreichii*) is a delivery defined by the Partnership Agreement signed by the project partners who have made the cooperation in the IPA II CBC Interreg Italy-Albania-Montenegro program. Especially in program priority: *Environment and Energy* (PA 3) in specific objective *Increase cross-border cooperation strategies on water & landscapes* (SO 3.1).

LASPEH (Low-Adriatic Species and Habitat) project partners:

1. Albanian National Agency of Protected Areas (Agjencia Kombëtare e Zonave të Mbrojtura)
2. Public Enterprise for National Parks of Montenegro (Javno preduzeće za nacionalne parkove Crne Gore)
3. Management Body of the Regional Natural Reserves of the Eastern Coast of Taranto (Ente di Gestione delle Riserve Naturali Regionali Orientate del Litorale Tarantino Orientale)
4. Municipality of Ugento (Comune di Ugento)
5. Municipality of Guardiaregia (Comune di Guardiaregia)

In order to increase cross-border cooperation strategies in this specific field, the partners decided that the partnership agreement commit themselves to cooperation in the development of the following project main outputs:

- Transnational Joint Strategy for the management of priority species in Natura 2000 sites
- Conservation plans in the involved areas
- Conservation pilot actions focused on selected habitat/species
- Awareness campaign on stakeholders:

Conservation Plan of *Pinus heldreichii* is one of plans which is necessary to develop in order to complete Transnational Joint Strategy for the management of priority species in Natura 2000 sites in 3 countries. Good practice developed using modern conservation methods of particular species and habitats of national importance developed in the practice of EU countries will be developed jointly through cross-border cooperation between partners with the aim of piloting conservation activities in 3 countries.

The priority of biodiversity conservation is not always only a national and European issue, but in cases where the natural communities are located on the cross-border zones of the two countries are a matter of importance for cross-border cooperation in conservation. All three countries face similar (sometimes the same) problems in biodiversity conservation; the LASPEH project is intended to transfer good practices in biodiversity conservation between partners like pilot action, to strengthen conservation and capacity-building through data sharing and measures.

This type of pilot activity will strengthen communication between partner institutions and establish long-term cooperation with the aim of establishing cross-border practices in strategic planning of conservation measures of importance for the three countries.

1.2. Legal framework

EUSAIR

"The EU Strategy for the Adriatic and Ionian Region (EUSAIR) is a macro-regional strategy adopted by the European Commission and endorsed by the European Council in 2014. The Strategy was jointly developed by the Commission and the Adriatic-Ionian Region countries and stakeholders, which agreed to work together on the areas of common interest for the benefit of each country and the whole region."

EUSAIR is the starting point for the joint cooperation of project partners in the development of strategic conservation measures of common interest to the three countries.

This strategy also defined the development of cooperation and capacity building in the Pillar 3. EUVIRONMENTAL QUALITY EUSAIR.

This part of EUSAIR defines that cooperation must be strengthened in order to halve the loss of biodiversity and degradation of ecosystem services in the EU by 2020 by the EU's Biodiversity Strategy.

One of the topics recognized as the most important in terms of environmental quality in the Adriatic-Ionian region is Theme 2 - Transnational Terrestrial Habitats and Biodiversity. The focused indicative actions are:

- Development of joint plans for managing transboundary habitats and ecosystems;
- Establishing transnational management plans for all terrestrial eco-regions shared by two or more participating countries;
- Improvement of NATURA 2000 and Emerald in the region.

After the assessment and data collection were completed, the project partners developed a joint plan to achieve some objectives of common interest, this cooperation was formalized by signing the Partnership Agreement.

The Partnership Agreement obliged the project partners to apply the conservation plans and the Join strategy in the following period until the defined objectives of the EURAIR strategy were achieved.

Reasons for the cooperation of partner institutions:

- The need to better implement the protection and management of NATURA 2000 and Emerald species;
- The need to learn from neighboring countries good biodiversity conservation practices;
- Joint capacity building of partner institutions to conserve biodiversity in the region;
- Establishing lasting cooperation on biodiversity protection;
- Providing opportunities for developing cooperation in further conservation activities;
- The development of cohesive strategy for biodiversity conservation in the region.

The Conservation plan for *Pinus heldreichii* is clearly defined by 92/43 /EEC and 79/409/EEC Directives, but also by other species that are the subject of conservation by partner institutions, which will jointly represent sources for capacity building in a number of conservation fields.

2. Introduction

Recently, biodiversity disturbances have reached alarming proportions. Various monotonous and poor, anthropogenically altered areas are replacing natural ecosystems and areas that are rich in biodiversity. The most visible manifestation of biodiversity degradation is the rapid extinction of species, the growing threat to the living world and their habitats. According to IUCN data and criteria (Baillie, J. E. M. Hilton-Taylor, C. & Stuart, S. N., 2004), more than 38,000 species are endangered.

The first and most important step towards preserving, protecting and enhancing the biodiversity of a particular area is to evaluate its size and value. Special attention is paid to areas of great diversity, having a large number of endemic and endangered species. Such areas have been designated as biodiversity hotspots (Myers et al., 2000, Mittermeier et al, 2004). So far, a total of 34 regions in the world have been recognised as biodiversity hotspots, and one of them is the entire the Mediterranean region.

Due to its geographical location, i.e. located between three continents (Europe, Africa and Asia), and the influence of various factors in this area, the Mediterranean is an area that has extremely great diversity of habitats and an area that is rich in terms of species. The Mediterranean vegetation is a biome that develops in temperate and subtropical climates, characterized by dry summers and mild and rainy winters. The ecoregions of this area include specific forest and shrub land ecosystems spread on all continents except Antarctica. The Mediterranean vegetation stands out in several main types of ecosystems: forests, macchia, garigues, and similar shrub land ecosystems; the Mediterranean savannah and similar grassland ecosystems. It is clearly seen in the Mediterranean area, but has been over centuries affected and degraded by humans.

Nowhere else in the Mediterranean area is the relief of the land more complex than on the Balkan Peninsula (Cvijić 1904, Stanković 1960). The Balkan Peninsula is of great importance since it acts as a border between the Mediterranean and the Central European climate zones, and is also specific by the existence of many ancient forests (Griffiths et al. 2004). The Balkan Peninsula is a region having complex physical geography, climate interaction, an outstanding level of endemism (both flora and fauna), as well as numerous relict species preserved in natural ecosystems. Some of the most interesting habitats include the *upper border line* of *forest* vegetation. As part of the Mediterranean biome, there are following ecoregions in the Balkan Peninsula: Aegean and Western Turkey sclerophyllous and mixed forests; Illyrian deciduous forests; mixed Pinus forests; Tyrrhenian-Adriatic sclerophyllous and mixed forests ecoregion.

There are several large geotectonic units in the Balkan Peninsula. The Rhodope Mountains, the oldest mountain range in the Balkan Peninsula, are located in the central part of the Balkan Peninsula and represent the crystalline core of the Hercynian age. The Rhodope Mountains reach their highest point at Musala (2925 m), located on Rila Mountain in Bulgaria. The Rhodope range is succeeded in the north by the Pannonian mass. To the southeast, the link between the Rhodope mass and Asia Minor is disrupted by the Aegean Sea (Laskarev, 1924; turkeys, 1998). The Dinarides are a mountain range in South-eastern Europe, bordered by the Alps to the North and the mountain Prokletije to the South. The highest peak of these mountains is *Jezerca* Peak (*Maja Jezercë*) (2694 m), located along the Albania-Montenegro border.

The relief has a great influence on the climate in the Balkan Peninsula. The Mediterranean climate is felt along the Adriatic Sea and in the Greek-Aegean region, as well as on the islands. Mountain ranges prevent the Mediterranean climate to influence the continental part, but most of the peninsula is open to the influence of the Central European climate, while the eastern part is influenced by the Pontic climate. Due to the influence of different climate types and geographical location, the Balkan Peninsula is an area with the greatest abundance of flora and fauna in Europe and with an extremely large number of endemic and relict species. The biomes of the Balkans are distinguished by a large number (around 250 in total) of biotopes, meaning that there are approximately 35 biotopes in each biome. These facts indicate that the present living world of Central Europe originates from the Balkan Peninsula, where sanctuaries for the pre-glacial and glacial flora and fauna were located during the Glacial (Würm I-III). During the Postglacial, they populated the entire Europe, becoming different at the same time (Matvejev, 1995 in: Lopatin and Matvejev, 1995).

The living world of the Tertiary on the Balkan Peninsula was similar to the living world of the present tropic and sub-tropic belt, while the uppermost vegetation was made up of forests corresponding to the thermophiles variant of beech-fir forests of the recent vegetation (Lakušić and Dizdarević, 1983).

According to Horvat et al. (1974), the diversity of rich vegetation in Southeast Europe is reflected in seven different vegetation zones and 31 sub-zones. Central and Southern European vegetation is not clearly distributed; instead, due to the impact of complex morphological and climatic patterns, a mosaic of various types is created. The Pannonian province is recent in origin and secondary in nature; it has a steppe-like appearance and covers the plains of the Middle Danube in the Carpathian basin. This latter belongs to a woodland belt having riparian oak forests mixed with Central European forests. The Continental province is the heartland of the West Palaearctic broad-leaved deciduous forest. The Central European Highlands include the Alps proper, as well as northern outliers. In this province, there is much Mediterranean influence and endemism (Stanners and Bourdeau, 1995). There are 154 centres of vegetal biodiversity on our planet, and six of them are found in Europe, including mountains of the Balkan Peninsula (WCMC, 1989).

For such a small European country, Montenegro has a large number of species due to its geographic position, distribution and diversity of habitats, topographic variations, geological history and climate conditions (National Biodiversity Strategy, 2015). If we take the ratio of the number of species per square meter as a measure of abundance of flora of an area, Montenegro has the richest flora of all European countries (Stevanović et al., 1995). Despite a long tradition of botanical research, the floristic data for some areas is extremely poor (for example, surrounding of the city of Pljevlja) and many taxonomic problems remain unresolved.

Montenegro is one of the most forested states in Europe, with forests and forest lands accounting for about 70% of its territory, of which 67% are state-owned forests and 33% are private. The most common species are beech (about 42%), spruce (about 20%), and fir (about 12%) (NIF 2013).Currently, the protected areas cover 1763.62 km2 or nearly12.8% of the land area, whereby most of the protected area (7.3 %) belongs to the national parks.

2.1 Lovćen National Park

Lovćen National Park was founded in 1952with a view to protecting and maintaining the unique nature, flora and fauna, as well as authentic mountain settlements. Despite its unique natural beauties, Lovćen National Park is a specific type of park dominated by cultural and historical heritage, not by the nature. This National Park is located on Lovćen and its highest peaks are Štirovnik (1749 m) and Jezerski vrh (1660 m). The Park covers circa 6220 hectares and includes mainly the central and the highest part of Lovćen mountain massif. Numerous and various forms of relief meet in a relatively narrow space. Lovćen range belongs to the system of Dinarides and rises steeply above the Adriatic Sea. Kartification is evident in the Lovćen area due to the fact that the whole area is composed of carbonite sediments.

During the Mesozoic and Xenozoic eras, a terrain was created with all the phenomena, processes and forms of karst due to climate conditions favourable for these processes. The area includes karst surfaces, karst fields, valleys, gardeners, bays, gills, pits and caves, occasional and permanent springs, karst springs, side-water springs, karst, estavelles, karst aquifers and other forms of surface and underground relief.

Figure 1. *Jezerski vrh, slopes of National park Lovćen*

There are two groups of soil in Lovćen National Park: brown soil group and the chernozem group. Brown soil is formed on flysch and limestone. This group of soil belongs to shallow and medium-deep soils. The group of chernozem soil in the area of Lovćen is more present than the brown soil group. The National Park area is part of the karst plateau of old Montenegrin deep karst, and this site has been developed on eroded karst. Land capability classes ranging from 3 to 8 are present in this area. The third land capability class consists of soils on Njeguško polje, Vrela, and these are soils having good physical and chemical qualities, while the eight land capability class includes very steep terrain, rocks and rocky peaks of Lovćen.

There are no permanent surface waters on Lovćen, and they are mostly groundwater, typical for karst terrains where cracks are cut in the carbonate rocks, with karst aquifers.

This is due to the geological structure, climatic and geomorphological characteristics and its geographical position. According to the landscape typology classification, the landscape of Lovćen National Park is of territorial type, while the water landscape is not present here. When it comes to secondary classification, there is a mixed landscape, i.e. a natural landscape alternating with anthropogenic activity. The natural landscape is formed by mountain ranges, with a really dense formulation of karst and complexes of dense or sparse forest covers.

Complex ecological factors, as well as the anthropogenic factor, influenced the development of Lovćen's flora and fauna were. Lovćen used to be covered by lush forests, which have been to a large extent devastated by logging. Since Lovćen has been proclaimed a national park, natural regeneration of forests has been recorded, and reforestation took place several times. The Lovćen flora consists of about 1300 species (479 genera and 95 families), including a large number of endemics and relicts, rare and protected flora, medicinal, aromatic, meliferous and decorative herbs.

Several vegetation belts can be seen on the vertical profile of the Lovćen mountain range, with a clear difference between the southern and northern slopes. The climatogenic vegetation of the lowest belt on the southern slopes is represented by evergreen shrub communities- macchia, which is represented by forest association *Orno-Quercetumilicis*. Macchia represents a degradation stage of former evergreen coastal forests. Although representing the degradation stage, it has a multi-purpose significance: it protects the ground against erosion, provides shelter and food for many animal species, and it also has aesthetic significance and gives the Mediterranean characteristic landscape architecture. Many species are aromatic, spreading a specific smell across the entire area, and are also used in traditional Mediterranean cuisine. For this reason, many Mediterranean countries have launched initiatives aimed at preserving it. Unfortunately, the degradation process in the southern piedmont area of Lovćen has not stopped on macchia, but macchia has been degraded to the garigue, and the garigue further to rocky pastures. Above the belt of evergreen vegetation on the southern slopes, there is a belt of oriental (white) hornbeam (*Carpinus orientalis*), which connected to the belt of eastern (black) hornbeam (*Ostrya carpinifolia*).

Thickets and low forests of black hornbeam, belonging to the *Seslerio-Ostryetum carpinifoliae* association, is the first vegetation belt in the National Park. The tree floor of this association is floristically poor and has an absolutely dominant edificatory, European hop-hornbeam (*Ostrya carpinifolia)*, Turkey oak (*Quercus cerris*), sycamore maple (*Acer pseudoplatanus*) and flowering ash (*Fraxinus ornus*) can be found scattered, while European beech (*Fagus sylvatica*) can be found at higher altitudes. The shrub floor is somewhat diverse in terms of flora, where the progeny of the tree floor, such as common hawthorn (*Crataegus monogyna*), Montpellier maple and filed maple (*Acer monspessulanum*, *Acer campestre),* prickly juniper (*Juniperus oxycedrus*), common hazel (*Corylus avellana*) can be found. The floor of herbaceous plants of this community is quite poor (around 30 species have been recorded), whereby the following species can

be frequently seen: *Aristolochia pallida*, *Sesleria automnalis*, *Pteridium aquilinum*, while species belonging to the plan community growing on common sage (*Stipo-Salvietum officinalis*) can also be found along forest edges, which came here into existance due to the ultimate degradation of eastern hornbeam forests. The eastern hornbeam community on Lovćen can be found at altitude ranging between 800 and 1000m, but there are deviations as well, depending on the exposure. It is much degraded, particularly near settlements. Representing the final stage of degradation of eastern hornbeam forests is the growing of vegetation of rocky pastures belonging to the *Stipo-Salvietum officinalis* community. Although being a degradation stage, this type of vegetation is very significant because it is very rich in terms of flora and represents NATURA 2000 habitat (*62A0* Eastern sub-Mediterranean dry grasslands (*Scorzoneratalia villosae*)). Characteristic species of the community are: *Salvia officinalis*, *Micromeria parviflora* and *Stipa bromoides*. The association is developed on skeletal soil and is characterized by poor land coverage. There are significant differences between the coastal and continental constituents of the association, so the following two sub-communities can be distinguished: *Stipo-Salvietum inuletosum viscoe* and *Stipo-Salvietum genistetosum sericeae*. The first sub-association, rich in Mediterranean floral elements, has not been developed within the boundaries of the National Park. The second sub-association, growing within the boundaries of the National Park, lacks a series of thermophilic elements and the differential species are the following ones: *Genista sericea*, *Globularia belidifolia*, *Carex laevis*.

The eastern hornbeam belt is joined with beech forests, which are on the basis of floristic composition and environmental conditions divided into two sub-communities: *Fagetum montenegrinum seslerietosum* and *Fagetum montenegrinum subalpinum*. The belt of beech forests can be found at altitude ranging between 1000 and 1650m, but in bays, the altitude where it can be found drops to 800m. Characteristic species belonging to this association are: *Fagus sylvatica, Lathyrus vernus, Viburnum lantana, Rhamnus fallax, Cardamine bulbifera,* while the differential species of the *Fagetum montenegrinum seslerietosum* sub-association are the following ones: *Sesleria automnalis*, *Aristolochia pallida*, *Fraxinus ornus*, *Quercus cerris*, *Ostryacarpinifolia*. This sub-association is directly linked to the eastern hornbeam belt. The differential species of the other sub-association are: *Ranunculus oreophyllus, Cystopteris fragilis, Saxifraga rotundifolia, Polystichum lonchitis*.The subalpine beech forest covers the slopes of Lovćen's highest peaks, reaching the altitude above 1200m, but fragments of this sub-association can also be found at lower altitudes, i.e. in sinkholes and deeper bays. On the mountaintops, it mostly grows as a thicket, having thin branches mostly bent due to the pressure of snow, while in bays, it grows as high forest. In the stands of beech forests, it is also possible to find species that came from other communities by chance, most of them belonging to the *Genisto-Genisto-Globularietum belidifoliae association*, which is a result of the ultimate degradation of beech forests. There are many floors in these forests of Lovćen. The tree floor, which has the largest number of floors, comprises almost only beech. The shrub floor has a more diversified floral structure, but is characterized by poorer land coverage. The development of the ground floor in a community depends on soil and light intensity.

Forest stands in which the tree floor, due to its density, allows only a little bit of light to get through, have a poorly developed floor of herbaceous plants. The most permanent species of ground floors are the following ones: *Lathyrus vernus, Cardamine bulbifera, Aremonia agrimonioides,* and *Polystichum lobatum* and *Symphytum tuberosum*.

The steep slopes of the highest peaks of Lovćen are covered by Bosnian pine, which appears dominantly in the mixed forest stands with Austrian pine. It is part of the vegetation of rocks, rock creeps and lawns. The geological substratum is made up of limestone, while the soil is coarse skeletal. Once, Bosnian pine used to be widely spread on Lovćen, but the population cut them down for tinder, and intensive grazing made the recovery difficult, so it dominated mostly in inaccessible areas. (Tomić-Stanković, 1970)

Endemic species have a special importance when it comes to the flora of the National Park. The flora of the park includes narrowly distributed endemic species, many Balkan endemic species, and legally protected plant species, as well as diverse and very rich medicinal, aromatic and meliferous herbs. The local endemic species of Lovćen are Lovćen bellflower (*Edraianthus lovcenicus*), *Bertero agintlii*, while the Balkan endemic species that can be found within the boundaries of the National Park are the following ones: *Leucanthemum chloroticu, Tulipa grisebachiana, Amphoricarpos neumayerianus, Heliospermatom masinii, Seseliglobiferum* (Vuksanović, 2016). On the list of centres of endemism, Lovćen shares the second place with Komovi. Due to the fact that it is exceptionally rich in terms of flora, as well as due to the significant number of habitats included in the Habitats Directive, Lovćen National Park has been granted the IPA (Important Plant Areas) status. The following NATURA 2000 habitats have been recorded within the boundaries of Lovćen National Park: 4090 *Endemic oro-Mediterranean heaths with gorse*, 6170 *Alpine and subalpine calcareous grassland*, 62A0 *East sub-Mediterranean dry grasslands (Scorzoneretalia villosae*), 6520 *Mountain hay meadows*, 8120 *Calcareous and calcshist screes of the montane to alpine levels (Thlaspietea rotundifolii*), 8210 *Calcareous rocky slopes with chasmophytic vegetation*, 95A0 *High oro-Mediterranean pine forests*, 91K0 *Illyrian Fagus sylvatica forests (Aremonio-Fagion*).

The forests of Lovćen National Park are mainly used for scientific research and teaching, recovery, recreation, etc. And, as such, have been identified as forests having special purpose. The forests cover an area of 4,299 hectares (accounting for around 70% of the total area of the Park), while the bare forest land covers an area of 1,921 hectares (accounting for 30% of the total area of the Park (barren land, pastures, meadows, agricultural land and land used for business and non-business facilities) (Lovćen National Park, Management Plan for the period 2011-2015).

Bearing in mind the type of cultivation, the forests can be divided into three groups: high forests (307.20 ha or 12.0%), planted trees (40.30 ha or 1.6%), offshoot forests (2,020.80 ha or 78.8%), thickets (196.40 ha or 7.6%). The forests in the area of the National Park are also divided according to their ecological state: 1) forests with slightly modified, having relatively stable natural environment. These forests include high density young beech

forest stands where nothing has been treated or done since the first stage of development – progeny stage, young growth stage, then thicket stage, then pole stand stage; 2) highly modified forests, having unstable natural environment. These forests are characterized by poor layout and poor structure, poor condition in terms of health, where offshoot trees are the ones mostly present; 3) forests with completely modified, extremely degraded natural environment. These are completely degraded areas formed due deforestation (Lovćen National Park, Management Plan for the period 2011-2015).

As regards Lovćen fauna, it is characterized by the complexity and richness of species. As for the entomofauna, there is a large number of species in the Park, of which *Formica rufa (*forest ant) is one of the species protected by law. Furthermore, Lovćen is home of many butterfly species, of which the following ones can be found on the list of protected ones: *Papilio swallowtail, Papilio podalirius-pars, Papilio alexanor* and *Parnosius apollo.* Among beetles present in the National Park, there are also two protected by law due to their attractiveness and increasing habitat loss: *Lucanus cervus L*. and *Oryctes nasicornis L*. As for the herpetofauna, Lovćen is one of the most powerful centres when it comes to the diversity of the European herpetofauna. So far, a total of 16 species have been recorded within the National Park. Most amphibians and reptiles in the National Park are enjoying international protection and can be found on the list of species protected by law in Montenegro. Some of the protected species are: western Hermann's tortoise *(Testudo hermanni)*, grass snake *(Natrix natrix)*, common wall lizard *(Podarcis muralis)*, viper species found in southern Europe *(Vipera ammodytes*), Mosor rock lizard (*Lacerta mysorensis*). The National Park has a large number of birds - more than 200 species nest here or have the status of migratory species. Some of the species nesting in this are: Sardinian warbel *(Sylvia melanocephala)*, the African stonechat (*Saxicola torquata*), European robin (*Erithacus rubecula*), western rock nuthatch *(Sitta neumayer*), rock partridge (*Alectoris graeca*), common nightingale (*Luscinia megarhynchos*), Eurasian jay (*Garrulus glandarius*), etc. When it comes to mammals, the following ones can be seen in the National Park: *Canis lupus* (gray wolf), *Vulpes vulpes* (red fox), *Ursus arctos* (brown bear), *Putorius putorius* (European polecat), *Mustella nivalis* (least weasel), *Meles meles* (European badger), *Martes martes* (European pine marten), *Martes foina* (beech marten), *Felis silvestris* (wild cat), *Erinaceus romanicus* (European hedgehog), *Talpa europaea* (European mole), *Talpa caeca* (blind mole), *Neomys fodiens (*Eurasian water shrew), *Sorex minutus* (Eurasian pygmy shrew), *Crocidura leucodon* (bicolored shrew), *Crocidura russula* (greater white-toothed shrew), *Rhinolophus ferrumequinum* (greater horseshoe bat), *Rhinolophus hipposideros* (lesser horseshoe bat), *Plecotus auritus* (brown long-eared bat), *Nyctalus leisleri* (Leisler's bat or the Irish bat), *Nyctalus noctula* (common noctule), *Vespertilio murinus* (particolored bat), and others (Lovćen National Park, Management Plan for the period 2011-2015).

The National Park appears to have favourable conditions for fungus growth. Up to date, around 200 species have been recorded in the area, but many believe that there are more than 1,500 species growing in the Park.

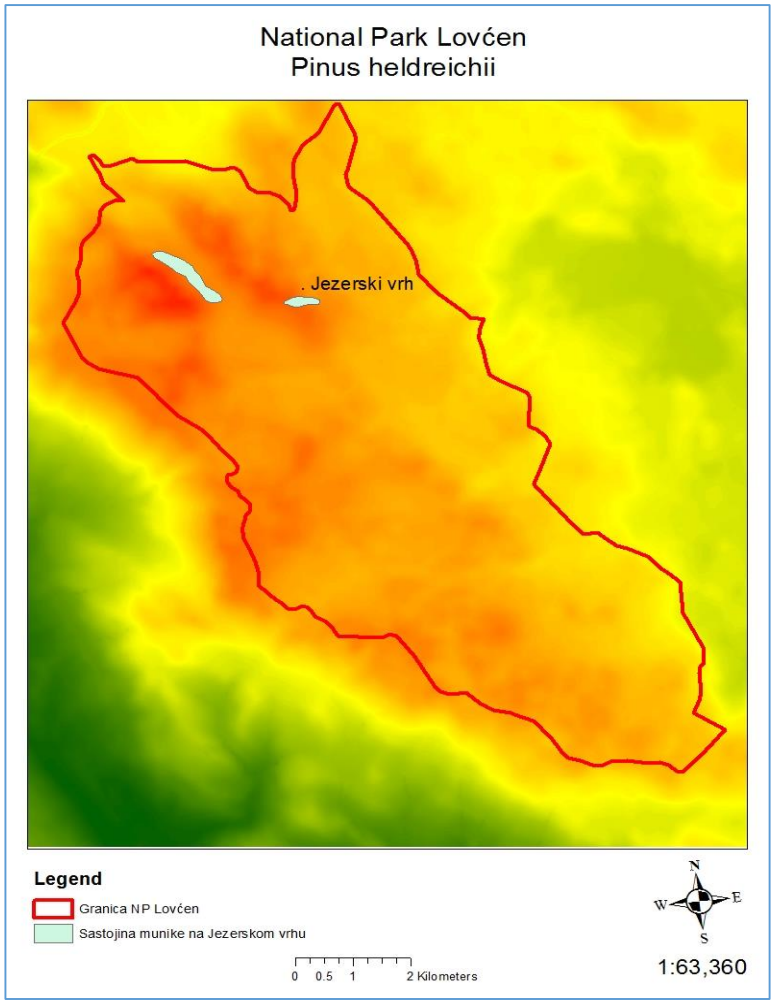

Figure 2. Bosnian pine within Lovćen National Park
(Explanation of Figure 1: red line is used for marking the boundaries of Lovćen National Park, while light blue colour is used for marking Bosnian pine forest stands on Jezerski vrh)

There are three protection zones in Lovćen National Park: first-level protection zone, second-level protection zone, and third-level protection zone. Three reserves in the first-level protection zone have been singled out: 1. the first reserve includes offshoot beech forests (area between Jezerski vrh, Štirovnik, Trešteničkі vrh, Babljak and Goliš), 2. The reserve includes individual trees and group of trees as remnants of the former Bosnian pine forest that can be found on Štirovnik and Jezerski vrh, covering an area a total area of 34.5 ha, 3. The reserve includes high beech forests located on Konjsko (Lovćen National Park, Management Plan for the period 2011-2015).

2.1. Bosnian Pine (*Pinus heldreichii*)

Bosnian pine is a tree up to 30 m high, with a diameter breast height (DBH) up to 2 m; crown is rounded-pyramidal or pyramidal. Bark is very thick, ash-grey in young trees, becoming ridged and furrowed with yellowish-brown flattened and angular patches in adult trees (Vendramin et al., 2008). The root system is strong, extensive, often penetrating deeply into cracks of rocks. Buds are up to 2 cm, not resinous. Needles: 6-9 cm x 1.5 mm, in pairs, rigid, denticulate. Cone 7-8 x 2.5 cm, slightly shining Tutin et al., 1993). Seeds are grey, 5–7 mm long with a 25–30 mm long wing. Seed production begins at 15–20 years of age, typical for pines (Vendramin et al., 2008).

3. Regulatory framework

3.1. International legislation

IUCN

According to IUCN in some parts of the range of *Pinus heldreichii*, conservation actions are required, and research is needed into habitat and population trends. This species is present in several protected areas. For example, in North Macedonia, it habitats can be found in Galičica National Park and Mavrovo National Park (V. Matevski pers. comm. 2016). In Greece, it is protected within areas included NATURA2000: Oros Olympos (GR1250001), Ethnikos Drymos Pindou (Valia Kalnta) – Evryteri Periochi (GR1310003), Koryfes Orous Orvilos (GR1260005) and Oros Vermio (GR1210001). In Bulgaria, where the species has been assessed as Vulnerable, a significant part of the species habitat is within the Bayuvi Dupki – Dzhindzhiritsa Strict Nature Reserve (Pirin National Park) and in the Ali Botush Strict Nature Reserve in the Slavyanka Mts., and the species is present in NATURA 2000 areas and protected under the Law on Biodiversity (Valchev and Roussakova 2015). In Italy, the species can be found within Pollino National Park (IT9310014) and in NATURA 2000 areas: Pollino and Orsomarso (IT9310303), Serra delle Ciavole-Serra di Crispo (IT9310013), Pollinello-Dolcedorme (IT9310003). In Kosovo, the species is protected within the Oshljaku, Pisha e madhe, and Maja e Arnenit Bosnian pine reserves, and is present within Mali Sharr National Park (KEPA 2008). In Albania, the tree can be found on Gjallica, Korabi, Koritnik, Munella, Pashtriku, Valamara and Zeba mountains, including the northern Albanian Alps, as well as in the Llogara, Lura Shebenik-Jabllanica, and Tomorri National Parks.

The IUCN category of the Bosnian pine (*Pinus heldreichii* H. 1) is Least Concerned.

3.2. European directives

Habitat directive

Bosnian pine habitats are in the Habitats Directive- 95A0 High-oro Mediterranean pine forest, whereby this type of habitat also includes the habitat of the endemic Balkan Macedonian pine (*Pinus peuce*). The European Red List of Habitats - Forests Habitat Group reports that the IUCN category of this habitat in EU countries is NT (Near Threatened), while EU28+ countries have LC (Least Concern) IUCN categories. There is no accurate data on the population trend of Bosnian pine, as well as no accurate data regarding the (potential) decline in habitat quality in individual countries. The report notes that the following States have a declining quantitative trend: Bulgaria, Italy, Montenegro, and Republic of Kosovo, Bosnia and Herzegovina; but there is no sufficient accurate data to assess the threat under criterion a (population decline).

3.3. National legislation

In Montenegro, Bosnian pine is protected by national law (Decision protecting individual plant and animal species, Official Gazette of the Republic of Montenegro 76/06 of 12 December 2006). But there are no accurate data based on which national assessment of the IUCN category of threatened species. According to the Law on Nature Protection, it is prohibited to pick, collect, use, destroy, reduce populations of protected wild plant species, destroy or threaten their habitats or alter their living conditions. Pursuant to Article 91 of the aforementioned Law, Bosnian pine in Montenegro enjoys strict protection.

3.4. Local regulations

The Municipality of Cetinje, within which Lovćen National Park is located, has so far prepared two documents regarding the protection of biodiversity in the municipality area, which also include the habitats of Bosnian pine on Lovćen: Local Action Plan for Biodiversity of the Old Royal Capital Cetinje for the period 2016-2020, and Local Plan for Protection of Environment of the Old Royal Capital Cetinje for the period 2017-2021.

As part of the Local Action Plan for Biodiversity of the Old Royal Capital Cetinje, an action plan has been proposed aimed at protecting the biodiversity of the Municipality of Cetinje in the period from 2016 to 2020. This Action Plan includes some general measures that need to be implemented, which also address the stands of Bosnian pine on Lovćen.

3.5. Natura 2000

The NATURA 2000 project has been launched in Montenegro, and the stage of mapping habitats and species is in progress, which will result in a proposal concerning those areas that will become part of the network of protected areas in Europe. Given that Bosnian pine is one of the species habitats belonging to 95A0 High oro-Mediterranean Pine forests, Bosnian pine forests are also being marked. Bosnian pine habitats on Prokletije, Komovi and Sinjajevina have been marked so far. At the moment, potential NATURA 2000 areas do not have a status of a protected area in Montenegro, but after joining the international network, the use of these areas should be based on strict principles of sustainable development.

3.6. Management plans

So far, no management plan has been drafted in Montenegro aimed at addressing issues regarding Bosnian pine forests, pure or mixed, or a Conservation Plan that would deal with the areas covered by this endemic species. The forests of Bosnian pine enjoy some level of protection within national parks. Each national park has a special-purpose spatial plan defining the protection zones within their boundaries, which further define the management of individual areas. Within Prokletije National Park, Bosnian pine stands can be found in the first, second and third zones of protection. The first zone represents the strictest regime of protection, where the use of natural resources is prohibited and construction of facilities is not allowed. Only visits for research and education purposes are allowed. The second zone implies active regime of protection, while the third one represents a regime of sustainable use. The Bosnian pine stands on Lovćen mountain are enjoying the status of a special reserve in which, according to the Montenegrin Law on Nature Protection, it is prohibited to perform actions and activates that could adversely affect its characteristics for which it has been declared a protected area. This implies construction of facilities and road infrastructure, mining, plant harvesting, intentional introduction and spreading of non-indigenous species, starting fires outside the places designated for this purpose, etc. Bosnian pine stands on the coastal Dinarides (Orjen, Lovćen, and Rumija) are natural monuments.

3.7. Regional legislation

In Serbia, Bosnian pine is protected under the Rulebook on declaration and protection of protected and strictly protected species of plants, animals and fungi: Annex I - Strictly protected wild species of plants, animals and fungi (Official Gazette of the republic of Serbia 36/09). In 1975, a symposium on Bosnian pine was held in Belgrade, organised by the Institute of Forests and Forestry and the Faculty of Forestry.

Conserving the diversity of Bosnian pine must include not only ecological and genetic considerations at local and landscape scales, but also social, economic and legal issues. While national parks and nature reserves are a necessary first step for conserving this species, another indispensable step is acquiring and compiling knowledge on existing forest genetic resources. This information is available for the Italian and Greek populations, but is still lacking for the rest of the natural range (Vendramin et al., 2008).

4. Context analysis

4.1. Terittorial framework

Bosnian pine is a tertiary relic and endemic species of limited, intermittent and small natural range that extends over the middle and Western Balkans and over the southern part of the Apennines peninsula (Barbero et al. 1998). The range of Bosnian pine extends to Bosnia and Herzegovina, Montenegro, Serbia, Republic of Kosovo, Macedonia, Bulgaria, Greece, and southern Italy. In Italy, only some minor and isolated relict populations survive, though in the past the Italian range was probably much wider (Avolio 1984). Given the mountain type of disjunction that characterizes its range, the global population of this species is fragmented and consists of fairly small stands. The biggest stands are recorded in Albania. In vertical extent, it usually grows within altitudes ranging between 1000 and 1900m, but it can also be found at lower altitudes, i.e. at 720m in Greece, as well as at altitudes higher than 2000m,i.e. at2500m on Olympus. The entire range at higher altitudes includes slowly recovering older stands, while self-recovery at stands at lower altitudes is much better. Although it has a narrow and highly restricted range, the forests of Bosnian pine, especially pure stands, are of particular importance among forest vegetation due to the rarity of this species (Meštrović, 1999).

In the past, *Pinus heldreichii* forests formed a well-developed and continuous belt in the Balkans. Today, the remaining *Pinus heldreichii* forests are of key importance for nature conservation, protection against gravitational natural hazards, landscape conservation and recreation. Therefore, these stands require special attention through the elaboration and implementation of conservation (Lazarević, Menkis, 2017).

Tables 1, 2 and 3 show the geographic occurrence of habitat G3.6 Mediterranean and Balkan subalpine *Pinus heldreichii-Pinus peuce* forest land. This habitat corresponds to the NATURA 2000 habitat 95A0 High oro-Mediterranean pine forests.

Table 1. Geographic occurrence and trends of Mediterranean and Balkan sub alpine *Pinus heldreichii-Pinus peuce* forest land in EU countries (European Red List of Habitats - Forests Habitat Group).

EU 28	Present or Presence Uncertain	Current area of Habitat	Recent trend in quantity (last 50 yrs.)	Recent trend in quality (last 50 yrs.)
Bulgaria	Present	65 Km2	Decreasing	Decreasing
Greece	Greece (mainland and other islands): Present	286 Km2	Stable	Increasing
Italy	Italy mainland: Present	3.5 Km2	Decreasing	Stable

Table 2. Geographic occurrence and trends of Mediterranean and Balkan subalpine *Pinus heldreichii- Pinus peuce* forest land in non-EU countries (European Red List of Habitats - Forests Habitat Group).

EU 28+	Present or Presence Uncertain	Current area of Habitat	Recent trend in quantity (last 50 yrs.)	Recent trend in quality (last 50 yrs.)
Albania	Present	Unknown Km^2	Unknown	Unknown
Bosnia and Hercegovina	Present	65 Km2	Decreasing	Decreasing
North Macedonia	Present	20 Km2	Increasing	Stable
Kosovo	Present	3.8 Km2	Decreasing	Decreasing
Montenegro	Present	189 Km2	Decreasing	Unknown
Serbia	Present	Unknown Km^2	Unknown	Unknown

Table 3. Extent of occurrence, area of occurrence and habitat area of Mediterranean and Balkan sub alpine *Pinus heldreichii- Pinus peuce* forest land (European Red List of Habitats - Forests Habitat Group).

	Extent of Occurrence (EOO)	**Extent of Occurrence (EOO)**	**Extent of Occurrence (EOO)**	**Extent of Occurrence (EOO)**
EU 28	147300 Km2	77	445 Km2	
EU 28+	285700 Km2	135	722 Km2	Data from Albania, Kosovo and Serbia are still missing (for EOO and AOO). Kosovo habitat area has been included in Current estimated Total Area

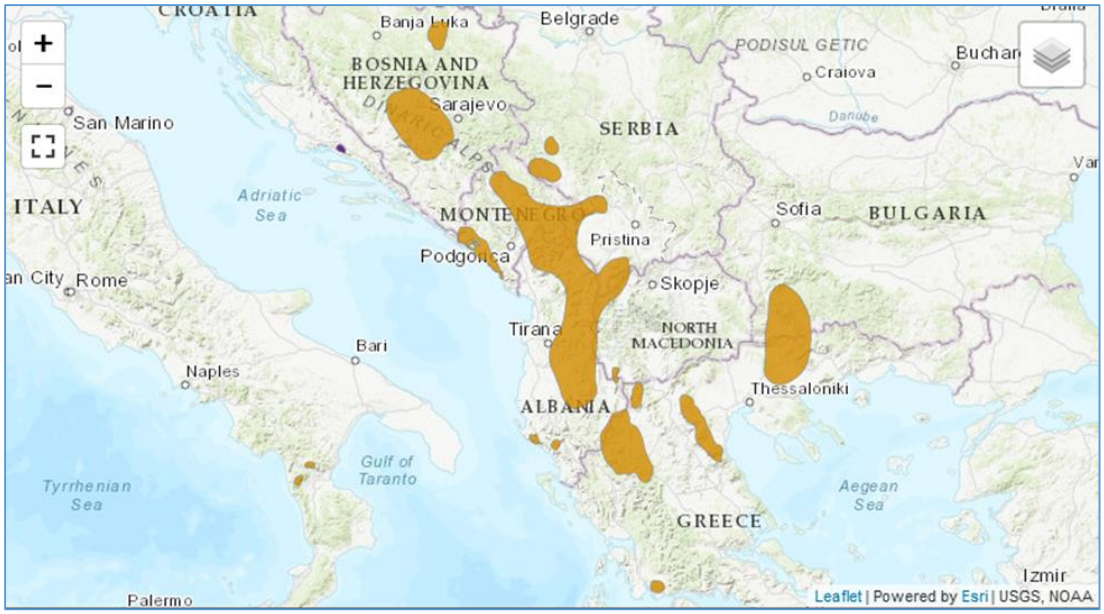

Figure 3. European Red List 2016.*Pinus heldreichii*, The IUCN Red List of Threatened Species. Version 2019-2

4.2. Phytoclimatic framework

Bosnian pine is a xerothermic, predominantly basophilic species; on acidic, silicate substrates, it grows only on southern exposures. It belongs to the pioneer species of trees, requiring little when it comes to the nutrients from the soil. It grows slowly in stands and occupies extreme habitats with narrow reefs, steep slopes, cliffs and flints, and rarely limestone areas. In such conditions, on shallow and rocky lands, the stands of Bosnian pine are maintained as permanent stages of vegetation. Stands are often interrupted, ruptured and open, while coherent complexes can be found only where relatively favourable habitat conditions prevail. It often builds pure stands, while mixed stands are built with beech and fir, juniper, Macedonian pine, white pine and Austrian pine. It is suitable for reforestation of dry and steep deforested areas, given that it tolerates extreme environmental conditions: strong wind, drought, big snow. It is also a good choice for reforestation because it tolerates various forms of air pollution and because it is less likely to be attacked and harmed by pests than other pine species. It has a wide ecological valence for moisture and temperature, so it withstands high amount of rainfall and severe droughts, very low winter temperatures, and high summer temperatures. When it comes to requirements in terms of light, Bosnian pine is an extremely heliophile species (Cvjetićanin et al, 2016).

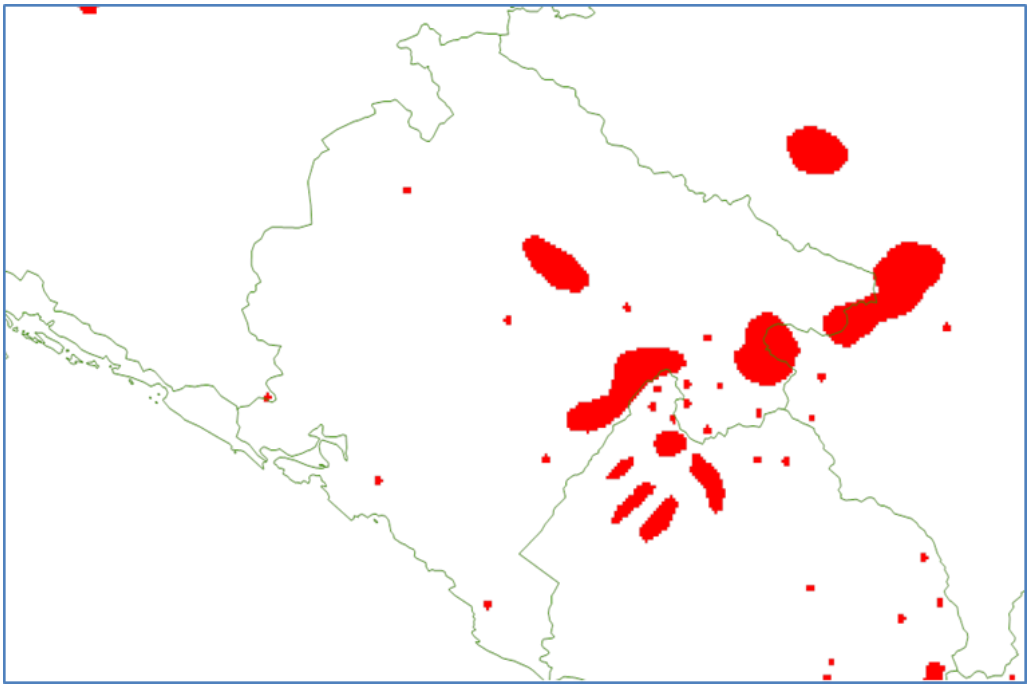

Figure 4. Distribution of Bosnian pine in Montenegro

Bosnian pine communities are registered in habitats with different climate conditions. Thus, the forest stands in the coastal Dinarides of Montenegro develop at high temperatures during the growing season, the absolute maximum of which in the Mediterranean-Mountain region reaches 40°C. In this area, there is a typical Mediterranean rainfall schedule characterized by summer drought and the highest rainfall in the spring-autumn period (see Annex I – Summary table of the results collected during research in order to prepare this conservation plan and Annex II- Pictures). The stands on Bjelasica, Sinjajevina and Prokletije develop in continental and continental-mountain climate within mountainous areas, with an average annual temperature of about 7°C.As regards mountain areas, there may be more than 150 frosty days, and snow cover can persists for more than 120 days, while the temperature can go below-25°C.

As a tertiary relic and a species reaching very advanced age, in the Balkan hemisphere, Bosnian pine represents one of the most interesting species for dendrochronological research. Given the effects of climate change and dry seasons, which occur occasionally and adversely affect local communities and economies, this could make a big difference. Dendrochronological studies in Bulgaria have shown that although Bosnian pine has a broad ecological valence when it comes to environmental factors, a significantly better growth can be recorded if more rainfall occurs in early summer and if the temperature is not too high. Furthermore, these studies have shown that there are negative correlations between growth and high June-July temperatures. Studies in Italy have shown that summer rainfall has a positive impact on Bosnian pine (Todaro et al. 2007). In both Italy and Bulgaria, studies have shown that milder winters (higher temperatures in December and January) have a positive impact on the growth of Bosnian pine. It is well-known that milder temperatures during winter may not directly affect tree growth, but this is probably due to more rainfall and less snow during a milder winter (Solomon et al., 2007).Furthermore, damages to the root system of Bosnian pine, which is near the surface, in very cold winters, cause slow growth.

5. Biology and status of Bosnian pine

5.1. Distribution and description of *Pinus heldreichii* associations in Montenegro

According to the first National forest inventory, Bosnian pine in Montenegro accounts for 1.1% of the total area under forests. As for the volume, it accounts for 1.9% of the total volume of forests in Montenegro. Bosnian pine forests are found in Montenegro on the following mountain ranges: Durmitor, Golija, Sinjajevina, Štitovo, Maganik, Kamenik, Prekornica, Piperska Lukavica, Bjelasica, Prokletije, Hajla, Hum Orahovski, Komovi, Orjen, Lovćen, Rumija (Stešević, Caković, 2013).

In recent years, research into Bosnian pine undertaken in Montenegro has been related to ectomycorrhiza(Stojičić et al., 1999), germination and growth of isolated embryos (Stojičić et al., 2008, 2009), ectomycorrhiza

(Lazarević, 2013; Lazarević et al.2016a, b; Lazarević, Menkis, 2018; Lazarević et al., 2018), diseases (Lazarević et al., 2014; Lazarević et al., 2017) and genetic characterization (Lazarević et al., 2016). Furthermore, a bilateral project with Italy, entitled *Adaptive responses to drought in Pinus heldreichii along altitudinal transects in the Apennines and the Balkans*, has been implemented. The project was funded by the Montenegrin Ministry of Science and an Italian partner. The forestry sector has scarce data on *Pinus heldraichii* forests, which can be explained by the fact that forests are not important in terms of exploitation, but in forestry, they are considered to be protective forests. The lack of data regarding annual growth, forest health status, progressive/regressive succession, implies that poor management is in place. Due to the aforementioned, it is necessary to conduct systematic research into Bosnian pine forests in Montenegro.

Phytocenological researches into Bosnian pine forests have not been carried out in Montenegro in recent decades, meaning that the old phytocenological division into geographic variants is still used, which is not in line with the current International Code of Phytosociological Nomenclature (ICPN) (Weber et al., 2000). The following geographic variants are listed: *Pinetum heldreichii mediterraneo-montanum*, includes forests in the coastal Dinarides and on the mountains around Nikšić (Blečić, Lakušić, 1969), *Pinetum heldreichii bertiscum*, includes forests on Prokletije and Komovi (Blečić, 1959), while the geographical variant *Pinetum heldreichii continentale* can be found on Bjelasica and Sinjajevina (Blečić, Lakušić, 1969).

The forests of Bosnian pine in the area of the northern part of Prokletije belong to *Pinetum heldreichii bertisceum association, and can be found at altitudes* ranging between 1550 and 2000m. They do not usually occupy large areas, but can be are found in the form of small stands or scattered trees. Bosnian pine *(Pinus heldreichii) is the most dominant species,* but in some stands, Macedonian pine *(Pinus peuce)* can be found as well. The following species can be found within the tree floor: *Picea abies, Populus tremula,* rarely *Abies alba*, *Betula pendula, Acer pseudoplatanus*. The floor of shrubs is more rich in terms of flora and the following species can be found here: *Salix caprea, Rubus idaeus, Rosa alpine, Rhamnus fallax, Corylus avellana, Lonicera alpigen*, *Daphne mesereum, Juniperuscommunis*.When it comes to herbaceous plants, the following ones have been recorded: *Aremonia agrimonioides, Luzula silvatica, Stachys officinalis, Fragaria vescai,* etc.

In the area of Žijov, Kučke Prokletije, Hum Orahovski and Kaženik, the *Pinetum heldreichi bertisceum* association meets eastern hornbeam or beech forests. In some localities (e.g. Korita), Bosnian pine is extensively spreading and suppressing the beech, especially on the southern limestone slopes. However, in habitats with a thicker layer of humus, beech is increasingly penetrating the Bosnian pine forest and preventing its regeneration from

the seed. *Pinus heldreichii* is the dominant species in the water catchment areas of rivers Morača, Mala rijeka and Cijevna, within the tree floor of the *Pinetum heldreichi bertisceum* association, while beech can rarely been seen. As for other species, the following ones have been recorded: *Ostrya carpinifolia*, *Quercus cerris*, *Lonicera alpigena*, *Vaccinium myrtillus*, *Rosa pendulina,* etc. (Bulić, 2008). As regards Hum Orahovski and Žijovo, the *Pineto-Fagetum silvaticae montenegrinum prov* association has been recorded (Bulić, 2008), with *Pinus heldreichii* and *Fagus silvatica*being the dominant species within the tree floor.

The forests of Bosnian pine on Bjelasica *(Pinetum heldreichiicontinentale)* inhabit arid and warm habitats on limestones exposed to the South and are characterized by a predominance of species belonging to the *Erico-Pineteadokclass*. Species from the *Vaccinio-Piceeteaclass*are almost completely absent, despite the fact that these forests grow in the climate zone of spruce. The following species can also be seen there: *Daphne blagayana, Pinus silvestris, Brachypodium silvaticumi,* etc.

The *Pinetum heldreichii mediterraneo-montanum* community can be found throughout wide-open spaces on the mountains around Nikšić, in the central part of Montenegro, such as Štitovo, Maganik and Prekornica. The forests of the area have been very susceptible to human impacts through history, but despite this fact, they are considered to be the most spacious and the most typical stands that are indigenous in nature. This area is an area of high Dinaric Alps karst, with high summer temperatures reaching up to 40°C. Furthermore, the schedule of rainfall has a typical Mediterranean character (summertime minimum), while the terrains are located on limestones that are permeable to water. All of these habitat characteristics indicate that these areas are an ideal habitat for Bosnian pine and that the presence of beech in the basins does not, in any way, mean that the Bosnian pine is secondary vegetation here. This is supported by the fact that the Bosnian pine forests in this area are very vital, the age structure of the forest, natural withering, as well as natural regeneration, being in favour of the aforementioned. The most common types of soil on the mountains around Nikšič are chernozem and brown limestone, which are most often eroded. Beautifully pieced together Bosnian pine stands used to be present throughout these terrains, on all exposures and slopes with the gradient ranging between 0 to 40°. All these facts indicate that the Bosnian pine forests in this area are the climatic vegetation of the Mediterranean-Montana and subalpine zone of coastal and some middle and south-eastern Dinarides (Blečić and Lakušić, 1969). The characteristic and indicative species of this association are the following ones: *Pinus heldreichii, Senecio visianianus, Lonicera formanekiana, Dianthus petraeus, Viburnum maculeatum*, followed by: *Poanemoralis, Fragaria vesca, Aremonia agrimonioides, Calamagrostis varia, Selerianitida, Leucanthemum chloroticum.* Several Balkan endemic species have been recorded in the association, while sub-Mediterranean floristic elements also have a significant share. Due to favourable lighting conditions, the floor of herbaceous plants includes many different types of plants, whereby hemicriptophytes predominate in the biological spectrum. A significant percentage of halophytes have been recorded, all due to drought during the growing season.

Over the last decade, the Bosnian pine forests on the mountains around Nikšić have been to a large extent destroyed by fires.

Along coastline Dinarides, the Bosnian pine forests form a belt only on Orjen, while on Rumija and Lovćen, they do not form one.

On Orjen, the Bosnian pine forests cover the upper, last forest belt, which extends from 1400m to the highest peaks (Veliki kabao, 1894m above sea level), meaning that here Bosnian covers 500m in terms of height. Two associations of Bosnian pine have been recorded on Orjen: *Fritillario-Pinetum heldreichii* and *Paladino Pinetum heldreichii* (Janković, 1960; Janković, 1967).The first association is the Balkan-Mediterranean highland community of Bosnian pine. The nature of this community depends on the specific conditions prevailing on this mountain, which slopes upwards directly from the Adriatic coast, influenced by the Mediterranean climate, which has somewhat been changed by the altitude of individual high-altitude zones. Within the association, the author has singled out two sub-associations. One grows on the northern and north-western slopes, under colder and wetter conditions when compared to the other one that can be found on the southern slopes, exposed to more extreme environmental factors (larger daily and annual fluctuations). The author named the sub-associations found in wetter and colder habitats *Fritillario-Pinetum heldreichii fagetosum*, and the other one, warmer sub-association, *Fritillario-Pinetum heldreichii ceteretosum (Janković, 1960).*

The *Peucedano-Pinetum heldreichii association can be found* on steep limestone, on very sunny and warm terrains, at altitudes ranging from 1550 to 1700m. The soil on which the association grows is rendsina, being more or less skeletal. The tree floor is formed of Bosnian pine trees, which are quite low (8-10m). *Peucedanum langifolium* is a dominant species within the floor herbaceous plants. This species is large in number, implying large land cover. With regard to the number and social features, this species if followed by the family of grasses *(Poaceae)*: *Sesleria argentea, Bromus erectus, Festuca heterophylla, Festuca vallesiaca, Festuca pungens (Janković, 1967).*

Down the very top of Rumija, on southern exposure, there is one stand of Bosnian pine comprising few dozen trees that are quite far apart from each other, implying that Bosnian pine does not have much of an impact on the floristic composition of this habitat (Lakusić, 1961). The stand is located in a very remote area, so it is almost impossible to conduct studies regarding floristic composition. The following species have been frequently recorded in the surrounding areas: *Sesleria robusta, Moltkea petrea, Globularia cordifolia, Cardamine glauca, Alyssum montanum, Edraianthus wettsteinii* (Petrović, 2011). Due to the lack of a more detailed data regarding the floristic composition of the stand, its phytocenological affiliation has not been determined, but it can be considered to be part of the *Pinetum heldreichii mediterraneo-montanum* association (Blečić and Lakušić 1969).

Despite the fact that there are only around fifty Bosnian pine trees on Rumija, this site has a great importance. This is the most southern locality inhabited by this Balkan-Apennine sub-endemic species in Montenegro. In addition, this locality and Bosnian pine site on the mountains near Naples represent the closest points of disjunctive range of Bosnian pine and confirm the theory of the existence of the Adriatic land (Lakušić, 1961).

Fukarek (1966) described four Bosnian pine communities found along the border area of Montenegro, on the Herzegovinian Mountains. The *Amphoricarpeto-Pinetum heldreichii* can be found on narrow Dolomite ridges, steep slopes, at altitude ranging from 1300 to 1800m (Fukarek in 1966). Community indicators are: *Amphoricarpus neumameri, Thesium auricilatum, and Hieracium vilosum. Senecioni-Pinetum heldreichii* has been recorded on slightly milder rocky habitats, was formed (Fukarek, 1966). The following two endemic species belong to this community: *Senetio vissianianusand Sesleria coerulans*. Natural hybridization occurs spontaneously along borders inhabited by Austrian pine and Bosnian pine (*Pinus* × *nigradermis* Fuk. et*Vid)* and this is where the *Pinetum-nigrae leucodermis* community came into existence (Fukarek, 1966). The highest altitudes of the subalpine border area is inhabited by the community of Bosnian pine and creeping pine, *Mugeto-Pinetum leucodermis* (Fukarek, 1966).

5.1.1. Bosnian pine on Lovćen

The steep slopes of the highest peaks of Lovćen, above the subalpine beech forest, are covered by Bosnian pine. The geological substratum is made up of limestone, while the soil is coarse skeletal. It has unusual shapes on steep cliffs, while sometimes it grows as a shrub. It is part of the vegetation of rocks, rock creeps and lawns, where Bosnian pine is located individually or in small groups.

Taking into consideration the current distribution of Bosnian pine, orographic characteristics of Lovćen's peaks and its specific characteristics in terms of climate, it can be assumed that Bosnian pine has never formed a closed forest type here. Its stands were probably open in the past as well, having a floristically rich floor of herbaceous plants. It has been speculated that the Bosnian pine forests on Lovćen belong to the *Pinetum heldreichii patulectorum* association, given the ecological and floristic affinity of these communities. (Tomić-Stanković, 1965/1966)

We would like to point out that no systematic phytocenological research that would clearly position the phytocenological affiliation of the Bosnian pine forests on Lovćen has been carried out so far. Researches that were carried out during the drafting of this plan took place during fall (Researches had to be done during fall taking into consideration the defined pace of preparation of this plan (September-October) when the main growing season was already over. Accordingly, many types that form the first floor were missing or were in the developmental stage, meaning that it was not possible to determine them with certainty.

By comparing the phytosenological records and floristic data that we gathered during the research into stands with the available literature references on the synecology of Bosnian pine, we came to a conclusion that that there is a significant similarity to the community of Bosnian pine and Austrian pine that Fukarek (1966) described on Prenj. Fukarek provisionally named this association *Pinetum nigrae-leucodermis,* pointing out that the native Austrian pine covers almost the entire tree floor, which is same to what we noticed on Lovćen.

A common characteristic of the association on Prenj and the stand on Jezerski vrh is the presence of hybrid of Austrian pine and Bosnian pine. While describing the community, Fukarek stated that larger areas covered by *Globularia cordifolia* were recorded, as well as large groups of *Thymussp and Helianthemum sp*., which is same to what we recorded on Lovćen. Besides edifiers, there is also a significant number of species that we recorded in the stand on Lovćen, and Fukarek lists them as part of the *Pinetum nigrae-leucodermis* association: *Amphoricarpos neumayeri, Sesleria tenuifolia, Edraianthus tenuifolia, Scabiosa graminifolia, Dorycnium herbaceum, Brachypodium pinnatum, Teucrium chamaedrys, Teucrium montanum, Asperula aristatus subsp. longiflora, Hieracium waldsteinii subsp. plumulosum, Scabiosamontana subsp. subspicata*. However, in order to finally determine the phytocenological status of the Bosnian pine stands on Lovćen, it is necessary to carry out detailed phytocenological researches.

Due to the pace of preparation of the Conservation Plan, defined under the project, it was not possible to carry out thorough researches into the target stand of Bosnian pine.

As regards the Bosnian pine stand on Jezerski vrh, detailed information was gathered regarding each tree and sampling pertaining to tree growth, mortality, regeneration, and crown condition and damage was done. Position of individual trees was recorded and diameter at breast height (DBH) was measured on each Bosnian pine tree using standard forest diameters. Furthermore, tree height was measured on each Bosnian pine tree using vertex (Nikon Forestry 550). Trees with cones were recorded. Quantitative indicators of tree health used in this study consisted of standardized measures of crown loss and damage to tree stems and surface roots. Measurements of tree crowns included live crown ratio, and percentages of crown dieback, crown density, foliage transparency, foliage damage or discoloration, and broken branches. Measurements of stem and root damage included severity ratings (in percent) of decay, cankers, resinous, and wounds. Symptoms of decay were recorded in the field as present or absent and given corresponding severity ratings of 100 or 0 percent in this stand. The sampling period was 15 September – 30 October.

A total of 310 individual trees were noticed in this Bosnian pine stand, whereby the recorded average DHB of trees was 18.60cm, and the recorded average tree height was 6.4m. A relatively small number of representative trees were noticed in the stand (12). The average DHB of representative trees is 26.20 cm, and the average height is 8.80 m. A total of 185 trees with cones were recorded. Crown dieback was noticed on 30 trees, degree of dying ranges from 10 to 20 percent. *Sphaeropsis sapinea* was noticed on 7

trees, dying of branches from tops (the youngest sprout) as one of the symptoms of this fungus was noticed, but not to a great extent. This symptom is the result of the spread of the fungus in diseased bark. Hymenoptera caterpillars were noticed on only one Austrian pine tree, while no Hymenoptera caterpillars were noticed on *Pinus heldreichii*. Bark beetle was noticed on 11 *Pinus heldreichii* trees. No other harmful insects on the tree were noticed. But, it is important to point out that field researches were completed at the end of September, as well as that more accurate data should be obtained by means of continuous research.

Periodic monitoring of the stand down Jezerski vrh has been in place since 2010, and the monitoring results are given on the next page.

Table 4. *Phytocenological records (1 and 2)*

	1	**2**
X coordinate	42.397	
Y coordinate	18.837	
Altitude (m)	1543	1551
Slope angle (º)	32	33
Stone on the surface (%)	30	40
Floor of trees		
Surface cover (%)	60	40
Pinus heldreichii	3	2
Pinus nigra	1	2
Floor of shrubs		
Surface cover (%)	10	10
Juniperus communis	1	+
Pinus nigra	1	+
Acer pseudoplatanus	+	
Sorbus aria	+	
Rosa canina		+
First floor		
Surface cover (%)	70	60
Sesleria robusta	3	3
Bromus erectus	1	1
Hieracium waldsteinii subsp. plumulosum	1	2
Daphne alpine	1	1
Thymus longicaulis	1	1
Saturea montana subsp. subspicata	1	1
Galium lucidum	1	+
Festuca heterophylla	1	
Tanacetum cinerrariifolium	1	+
Echinops ritro	+	1
Dorycnium herbaceum	+	1
Silene italic	+	+
Teucrium montanum	+	+
Asperula rubia	+	+
Gymnadenia conopsea	+	+
Leucanthemum chloroticum	+	+
Orobauhe minor	+	+
Arabis spp.	+	
Linum spp.	+	
Teucrium chamaedrys	+	
Stachis erecta	+	
Edraianthus tenuifolius	+	
Sedum hispanicum	+	
Hieracium murorum		2
Campanula persicifolia		+
Sedum hispanicum		+
Cuscuta europea		+

5.2. Analysis of Bosnian pine reserves on the slopes of Jezerski vrh

The monitoring results are presented in whole, as well as conclusions submitted by associates from Public enterprise for National parks of Montenegro.

5.2.1. Basic information:

- The boundaries of the Bosnian pine reserve are not accurately defined on the map view due to the situation on the ground.
- Bosnian pine has been endangered by several factors and is likely to completely vanish.
- The area of the reserve covers around 15 hectares and is mostly overgrown with introduced Austrian pine in the habitat of Bosnian pine.
- The total volume of Austrian pine and Bosnian pine is 402 m3 and the average growth volume is 8m3.
- The average diameter breast height of tree is around 26cm at a height up to 15m, composition from 0.4 to 0.5
- Pathogenic species of fungi were recorded within in the reserve: *Sphaeropsis sapinea, Lofodermium seditiosum, and Cenangium ferruginosum*

5.2.2. Analysis of data during the monitoring

Monitoring of the Bosnian pine reserve during 2010, 2014 and 2017

Due to it smallness, data were collected from the entire area. The recorded data look at the health of the forest, defoliation, decorolisation, records of: diseased trees, dry trees, and progeny.

Table 5. Data on the state of health of Bosnian pine stand

Year	Defoliation (%)	Colorization (%)	Dry trees(no)	Diseased trees (no)	Bosnian pine progeny (no)
2010	5	5	2	4	/
2014	5	5	2	4	/
2017	5	6	3	5	/
2019					

5.3. Conservation status

As noted earlier (Chapter 4), Bosnian pine is protected by national law in Montenegro, but since the country does not have a Red List, there are no data that could indicate the level of threat and based on which it would be possible to accurately determine the IUCN category. Partial studies show a decline in population, but there are no accurate data on population decline at the country level, so it is not possible to determine the IUCN risk category by applying criterion A (population size reduction). The application of criterion B (Geographic range in the form of either B1 (extent of occurrence) and/or B2 (area of occupation) is also impossible since we do not have accurate data on the reduction of areas occupied by Bosnian pine stands, although the reduction is obvious. Unfortunately, at this point, the IUCN national category is DD (data deficient).

The Bosnian pine forests within the national parks are protected to a certain level. Under the Law on National Parks, forests in national parks have been identified as forests having special purpose. Forests and forestry land in national parks are managed by a company in accordance with the management plan and the annual management programme, which ensures the fulfilment of forests' functions established by law. Owners of forests and forestry lands in national parks must use forests and forestry lands in accordance with the management plan and the annual management programme. The level of protection depends on the zone of protection in which the forests are located. In strict reserves and in the first zone of protection, the use of natural resources is prohibited, while more liberal protection is present in the second and in the third zones of protection, and it is possible to control the use of natural resources up to the level that does not threaten functional and ecological importance of the habitats. There are no data on the size of the areas covered by Bosnian pine forests that are within national park. The reason for this probably lies in the fact that Bosnian pine forests are treated in the forestry sector as protective forests, not as economic. Hence, data of Montenegro's Forest Administration for Prokletije National Park, relating to the size of areas occupied by forests, as well as relating to the volume per hectare, do not include any data on the Bosnian pine forests, nor these forests are mentioned at all, although their presence within the National Park could not be brought into question. Of course, we can note that the areas covered by Bosnian pine forests in Montenegro account for less than 10 %.No stand has been granted status of a strict reserve, which implies the most strict regime of protection in the country.

The Bosnian pine stands on coastal Dinarids (Orjen, Lovćen, Rumija) are natural monuments for which the management plan is passed by the competent authority of the local self-government unit, with the consent of the Ministry. So far, no management plans are in place for Bosnian pine communities on these localities. The Bosnian pine stands on Lovćen mountain are enjoying the status of a special reserve in which, according to the Montenegrin Law on Nature Protection, it is prohibited to perform actions and activities that could adversely affect its characteristics for which it has been declared a protected area. This implies construction of facilities and road infrastructure, mining, plant harvesting, intentional introduction and spreading of non-indigenous species, starting

fires outside the places designated for this purpose, etc. Bosnian pine stands on the coastal Dinarides (Orjen, Lovćen, and Rumija) are natural monuments.

Bosnian pine habitats are listed in the Habitats Directive under code *95A0 High-oro Mediterranean pine forest*, together with habitats of the endemic Macedonian pine (*Pinus peuce*). The National catalogue of habitats (catalogue of habitat types of Montenegro relevant to the European Union) describes habitats, equivalent vegetation species, and characteristic species. Over the last three years, mapping of habitats has been carried out in selected localities (KBA-Key Biodiversity Areas) in the central and northern parts of the country, which will be featured in future NATURA, but for now, they do not enjoy any protection status.

5.4. Conclusion

Based on the collected data and analysis of the current state of play, it can be concluded that the stands stagnating in terms of development, or that Bosnian pine trees are extinguishing. Being a more durable species, Austrian pine is becoming dominant and is gradually taking over the habitat.

Rehabilitation and concrete measures on the ground need to be taken with a view to protecting Bosnian pine and to ensuring that its growth is unhindered. Restoration measures should imply stronger actions on the ground in order to ensure somehow good conditions for natural regeneration of Bosnian pine.

6. Carries out in progress conservation measures

The Municipality of Cetinje, within which Lovćen National Park is located, has so far prepared two documents regarding the protection of biodiversity in the municipality area, which also include the habitats of Bosnian pine on Lovćen: Local Action Plan for Biodiversity of the Old Royal Capital Cetinje for the period 2016-2020, and Local Plan for Protection of Environment of the Old Royal Capital Cetinje for the period 2017-2021.

As part of the Local Action Plan for Biodiversity of the Old Royal Capital Cetinje, an action plan has been proposed aimed at protecting the biodiversity of the Municipality of Cetinje in the period from 2016 to 2020. This Action Plan includes some general measures that need to be implemented, which also address the stands of Bosnian pine on Lovćen.

These general goals are as follows:

- Make institutional adaptation and create a mechanism for educating the public about sustainable use of biodiversity. This activity does not require special financial resources, but should be carried out as a regular practice in the work of all institutions and local government authorities that, as part of their work, make decisions regarding the abovementioned aspects of biodiversity;
- Intensify efforts to protect endangered species, habitants and landscapes, especially in areas that have not yet been included in nature-related researches;
- Put beech forests on Obzovica and Borovik under protection. This procedure will be carried out in line with the Law on Nature Protection, and implies preparation of a Protection Study and digitization GIS-compatible maps of its boundaries. As this activity, necessary funds, amounting EUR 13 000, will be provided under the budget of the Old Royal Capital.
- Ensure revision of category status, regime of protection and boundaries of the existing protected areas. During the process of a possible revision of category status, protection regime and boundaries of protected natural resources, belonging to the protection category "natural monument", drafting of a Protection Study will be initiated, as well as digitization of GIS-compatible maps of its boundaries.
- Define the entities that will be in charge of managing the protected natural resources.
- Draft management plans for the protected natural resources.

The ultimate goal in terms of protection of biodiversity (species, habitats and landscapes) is to conserve healthy habitats and forest habitats, with particular emphasis on habitats of importance for conservation of biodiversity. Furthermore, the Plan lists those activities that need to be carried out in order to conserve healthy forests with important biodiversity habitats. The proposed activities include monitoring of all important forest stands, removal of all diseased trees and prevention of disease spreading, as well as organisation of campaigns regarding protection of forests against fires.

As regards the Local Plan for Protection of Environment of the Old Royal Capital Cetinje for the period 2017-2021, the Bosnian pine stands, as well as forest habitats, have not been addressed in more details at all.

7. Analysis of threats and limitation factors for conservation

Bosnian pine has often been the subject of researches, and a significant number of articles have been published about it, yet many questions about the ecology and biology of this tertiary relic remain unanswered. There are no data available on how climate change affects the Bosnian pine forests, but we do expect that results of the project Adaptive responses to drought in *Pinus heldreichii* along altitudinal transects in the Apennines and the Balkans will make a significant contribution when it comes to getting an answer to this question.

7.1. Illegal logging

Because of its exceptional technical value, durability and great strength, Bosnian pine has been used in the past in the construction and carpentry industries. Given the history of Montenegro, the frequent occupation of its territory, its natural resources are uncontrollably used by the occupiers. As a result, large areas that Bosnian pine occupied were lost. Like in the past, uncontrolled and illegal logging is still affecting the distribution of Bosnian pine and the size of its stands, which also affects its ability to recover. Illegal logging most often involves quality trees, resulting in reduced quality of the stands, thus, at the same time, in reduced production of good genetic material and genetic diversity. Heavyweight of the tree and the terrain that Bosnian pine inhabits made the transportation of wood difficult. Thus, the exploitation of Bosnian pine was much more present on less steep and more accessible terrains. Evidence of this are Bosnian pine stumps in certain areas, which are now inhabited by some other species. Nowadays, illegal logging in forests and national parks are less present due to stricter controls and protection regimes. But, in Montenegro, there are Bosnian pine stands that are not within the protected areas, such as stands on Štitovo mountain (Municipality of Danilovgrad). In such places, uncontrolled logging of Bosnian pine is highly visible.

7.2. Fire

Due to the characteristics of the habitat inhabited by Bosnian pine, inaccessible steep landscapes, with *small* amount of wetness, high summer temperatures, etc., fires are posing a big threat to the Bosnian pine forests. For example, in 2017, a total of 124 forest fires were recorded in Montenegro, burning around 52,000 ha (EFFIS, 2017). Given the size of Montenegro, the burn area is extremely large. In the past, fires caused considerable damages to Bosnian pine forests, both in Montenegro and throughout its entire range.

It has been estimated that around 800 ha of forest, where Bosnian pine was the dominant specie, was burnt in 2013 on the territory of the Municipality of Danilovgrad– Štitovo. According to the studies conducted in 2015 and in 2016, restoration of these habitats after fires has not been carried out. A large number of trees damaged by fire are still in the stand, thus posing a big risk in terms of appearance of pests (fungi and insects) (unpublished data). Furthermore, the stand has not been replenished, so there is a threat that Bosnian pine will be replaced by a more competitive species (Austrian pine, spruce, beech).In addition, in 2018, a forest fire broke out near the Bosnian pine stand on Jezerski vrh in Lovćen National Park. Fortunately, Bosnian pine was saved. Fires have been recognised as the biggest threat to Bosnian pine forests, both in Montenegro (Lazarević et al., 2016b) and other parts of its range (Vendramin et al., 2008, Panayotov et al., 2010).Around 25 % of forest area covered by *Pinus heldreichii*in the south-eastern part of Montenegro was damaged by forest fires in the last 10-15 years (Lazarević, 2019).

The biggest cause of forest fires is human negligence. In late summer and early autumn, locals are cleaning up their estates using fire. At the same time, oddly enough, these fires get out of control and thus spread to forest areas.

7.3. Graze

In some areas, graze is what causes problems in natural rejuvenation of Bosnian pine forests. In the past, within the area of Lovćen Nation Park, as well as within other mountain areas, during warmer summer months, shepherds used to put cattle to graze. In that way, cattle caused damages by biting off grass shoots and by stripping the bark of the progeny, which resulted in its extinction. This obstructed natural regeneration of forests, after uncontrolled logging, removal of old trees, as well as biological extinction of old trees. According to Todaro et al. 2007, in Polino National Park (Italy), the development of Bosnian pine from progeny to young growth increased by 90% after a reduction in the number of population and activities in their vicinity, within a 50-year period. In the stages that follow, cattle and game animals do not cause serious damages to Bosnian pine due to its thick bark. Due to reduced graze, successful natural regeneration of Bosnian pine has been recently noticed in many localities in Montenegro (above altitude 1200-1400m).

7.4. Cattle breeding

The target stand within the boundaries of Lovćen National Park is not threatened by cattle breeding because cattle breeding on the mountain has been minimized, as well as because the stand is located on a very inaccessible terrain. Graze is what obstructs the restoration of the Bosnian pine stand within the boundaries of Prokletije National Park, due to the fact that graze is prohibited only in the first zone of protection. In this area, animal husbandry is traditionally a well-developed sector of the economy.

7.5. Regeneration

Multi-annual monitoring (Public Enterprise for National Parks of Montenegro) indicates that the Bosnian pine stand on Lovćen is not regenerating since no young tree have been recorded. *Pinus heldreichii* is usually propagated by seeds, since the rooting of cuttings has been only partially successful. However, seed production in natural stands is limited. Therefore, there is a need to develop an alternative propagation method (Stojičić et al., 1999). Due to the lack of reforestation practices, which is partially imposed by the difficulties producing *Pinus heldreichii* seedlings for reforestation, regeneration of *Pinus heldreichii* is mainly dependent on natural process (Lazarević, Menkis, 2017). The absence of successful propagation of Bosnian pine is the most important limiting factor when it comes to the stand of this species on Lovćen. So far, no detailed research has been conducted with a view to finding out the reason for this. One reason for this could be bad seed (Jelena Lazarević, personal communication). However, research into germination and growth of isolated embryos of *Pinus heldreichii* in vitro (cones were collected from open pollinated trees in a natural stand located on Lovćen Mountain), has shown that most isolated embryos of Bosnian pine germinates already during the first week after being transferred to a culture medium.

7.6. Climate

Bosnian pine is a species that very well tolerates frosty areas with very low temperatures, as well as very warm areas with high temperatures. It can withstand temperatures from -45 to +45 °C, but it has been reported that it sometimes suffers during long continuous cold periods with temperatures below -10 °C (Meštrović, 1999). But, during these long cold periods, damage incurs on the roots that have been developed on shallow terrains over the surface. This damage significantly slows the growth of Bosnian pine, which is fastest in the early growing season (Meštrović, 2007). Trees growing at higher altitudes are often damaged by lightning. Based on studies regarding the Bosnian pine stand on Lovćen that have been carried out so far, no damage caused by thunder has been reported on this steep terrain, but trees damaged by avalanches and rocks lining this steep terrain have been recorded on several locations.

7.7. Natural selection

One of the most significant natural factors affecting the spreading of Bosnian pine in Montenegro is natural succession. Bosnian pine is a species that most commonly inhabits steep and dry limestone slopes, most often in pure stands (Vidaković, 1982). Studies have shown that it can also thrive in wet habitats, but in such habitats, its most dangerous competitors (spruce, fir, and Macedonian pine), which needless sunlight (light shade) than Bosnian pine, are much easily developed.

Bosnian pine is a pioneer species, so the natural sequence of the Bosnian pine forest over time often progresses to another stage of development, where they are most often supplanted by forests of Austrian pine, spruce, beech or some other species. Bosnian pine is a species with high ecological amplitude; it tolerates large rainfall and high drought, high summer temperatures and very low winter temperatures, dry limestone and porous terrain, somewhat various kinds of geological substrate. Of all environmental factors, light has the most influence on the distribution of Bosnian pine, as it is an extremely halophytic species, and its distribution is strictly limited to conditions with abundant amounts of light. There has been a natural continuity in the Bosnian pine forests down Jezerski vrh, where the Austrian pine is slowly taking over Bosnian pine habitats. What causes a concern is the fact that no progeny of Bosnian pine has been found, which can be explained by the closure of the composition by Austrian pine, which reduces the intensity of light in the lower floor.

Given the mountain type of disjunction that characterizes its range, the global population of this species is fragmented and consists of fairly small stands.

7.8. Sphaeropsis fungi

As for natural pests and pathogens, studies have shown that Bosnian pine is quite resistant. On the territory of Serbia and Montenegro, the presence of the fungus *Sphaeropsis sapinea* on Bosnian pine has been noticed, which represents a significant pathogen for Austrian pine (Milijaševic, 2004). *Sphaeropsis sapinea* is a widespread parasitic fungus which most commonly causes harm to the Austrian and Aleppo pine crops and urban environments, and Bosnian pine is a relatively new host in Montenegro (Karadzić and Milijašević, 1998; Milijašević, 1994). The damage it causes has the consequences of reducing the production and quality of the wood. This species especially causes great damage in Lovćen National Park, as well as throughout the Adriatic. The critical period for infections is from mid-April to mid-May, it reaches infections through the buds in the spring before they open, and in the summer during their formation-through the bark of young plants and over its conifers (Milijašević, 2009). The main symptoms are wilting, atrophy, bud wilting, necrosis, deformity and atrophying of the conifers. According to Milijašević (2009), this type of fungus can infect both healthy and undamaged shoots. Also, Milijašević (2009) argues that the main cultivated measures are

the proper habitat choice for pines, so for example. Pines should not be planted in enclosed valleys or small groups protected by other trees. In crops and components, it is necessary to remove all trees with dry tops, as well as trees that have more than 80% of dry shoots. Chemical control measures are economically feasible in highly contaminated crops, hothouses and urban environments, and for this, the copper fungicides are used (Karađzić, 1986; Karađzić and Stojadinović, 1988).

7.9. Dothistroma needle blight

Dothistroma needle blight (DNB) is one of the most serious and widespread needle diseases of pines and it is caused by two fungal species: *Dothistroma septosporum* and *Dothistroma pini* (Lazarević et al., 2017). The disease infects the needles and can result in needle defolation, reduction in stem diameter increment and height growth and, in severe cases the death of tree. The suspected symptoms of the disease are red bands and dying needle (Karadžić, 2004). The first finding of *Dothistroma septosporum* on *Pinus heldreichii* in Montenegro was published in 2014. (Lazarević et al., 2014). This was the first report on the mentioned species on *Pinus heldreichii* from the native forests stand. During later research, presence of *Dothistroma septosporum* was confirmed in four mountain massifs: Orjen, Prekornica, Žijevo, Prokletije (Lazarević et al., 2017). The disease intensity on stand level is currently low, but could vary depending on microclimate. It is sometimes also increased on skeletal soils or on tree line habitats that are nutrient poor, dry and exposed (Lazarević et al., 2017). The presence of the fungus has not been investigated in the Bosnian pine stand on Lovćen, but since its presence has been recorded throughout the range of *Pinus heldreichii* in Montenegro, there is a possibility that it could also be found on Lovćen, particularly due to the fact that *Dothistroma septosporum* was noticed on *Pinus mugo* species on Lovćen (Lazarević et al., 2017). The pathogenic fungus *Herpotrichia juniper* has been recognised as a particularly significant biotic factor that adversely affects natural regeneration of Bosnian pine in Montenegro. It has been recorded on Orjen, Prokletije, Žijev and Komovi, thus making forest regeneration difficult and sometimes even impossible (Lazarević, 2004).

In the area of the Bosnian pine reserve in Lovćen National Park, pathogenic fungal species have been recorded during long-term monitoring: *Sphaeropsis sapinea, Lofodermium seditiosum, Lofodermium pinastri* and *Cenangium ferruginosum. Certainly, it should be pointed out that no systematic research into pathogenic fungi has been carried out in the target stand. Thorough research into fungi by using modern molecular methods, since that is the only way to determine its presence.*

7.10. Insects

Bosnian pine has demonstrated low susceptibility to insect attacks. However, itcan be seriously damaged by saw flies (*Hymenopterae*). Others include bark beetle (*Pityogenes bidentatus*), European pine shoot moth (*Rhyacionia buoliana*) and pine processionary caterpillar (*Thaumetopoea pityocampa*) (Vendramin et al., 2008). Results of monitoring conducted by employees of the National Park have not indicated the presence of harmful insects in the Bosnian pine stand, but traces of bark beetle have been noticed on 11 trees in the course researches conducted during the preparation of this Plan.

7.11. Hybridisation

In the past, spontaneous hybridisation with Austrian pine was believed to pose significant threat to the conservation of genetic pool of Bosnian pine (Stefanović, 1986). However, recent investigations of genetic relationships found that *Pinus heldraichii*has a large distance from *Pinus nigra*and *Pinus sylvestris* (Kovačević et al., 2013). Despite the pronounced morphological similarity with *Pinus nigra*, research of phylogenetic relationships, based on plastid sequence data, include *Pinus heldreichii* into the group of Mediterranean pines (*Halepenses, Canarienses* and *Pinea* sub-sections) (Wang et al., 1999).

What could pose problem during reforestation (replenishment) of individual locations where Bosnian pine is present is the small size of the area occupied by these stands. In order for a stand to be self-sustaining and in order to ensure protection and conservation of species, it is necessary to provide sufficiently large population. According to Vendramin et al. 2008, forest stands covering more than 20 ha, which were created from local seed source, could conserve genetic pool of Bosnian pine The target stand of Bosnian pine on Lovćen does not meet this criterion, given that it only covers a 15 ha area.

Possible obstacles to the reintroduction or conservation of Bosnian pine habitat are strict regulations that apply to areas under a regime of strict protection, but that are inhabited by Bosnian pine species. To protect a species, some activities need to be carried out, such as: removing individual trees, expanding a habitat of a particular species to a size of a stand that ensures self-sustainability of that species, etc. Sometimes, regulations are making implementation of these activities difficult, so they should be adjusted.

8. Identification of Decisionmakers and Steakholders directly involved in the management of Bosnian pine

8.1. Decisionmakers and Stekaholders directly involved in the management of Bosnian pine

- Public Enterprise for National parks of Montenegro,
- Ministry of Agriculture and Rural Development,
- Ministry of Sustainable Development and Tourism,
- Environmental Protection Agency,
- Forest Administration,
- Non-governmental organisations dealing with environment-related issues,
- Faculty of Biotechnology,
- Faculty of Natural Sciences and Mathematics,
- Institute of Forestry,
- Municipality of Cetinje, Tivat, Budva, Plav, Bijelo Polje, Danilovgrad, Podgorica.

8.2. SWOT analysis

The following table shows the SWOT analysis when it comes to protection and conservation of *Pinus heldreichii* on Lovćen.

Table 6. SWOT analysis

S Strengths	W Weaknesses	O Opportunities	T Threats
➢ ***Pinus heldreichii*** **stand located within Lovćen National Park** ➢ **Presence of experts in forestry, habitat and plants within the Public Enterprise for National parks of Montenegro** ➢ **Relatively highinterest for nature protection of an average Montenegrin citizen** ➢ **High national symbolic importance of Lovćen** ➢ **Wide pool of experts among national stakeholders**	➢ Limited financial resources ➢ Limited expert capacity of the Lovćen NP employees ➢ Hard marketing utilisation of *Pinus heldreichii* ➢ Jurisdiction overlapping ➢ Rough terrain ➢ Low position on the NP Montenegro priority list	➢ **Low budget measures** ➢ **Easy to implement measures** ➢ **Good marketing opportunity for public and private companies** ➢ **Relatively easy fundraising** ➢ **Young specialists willing to work and learn** ➢ **Well-developed nature protection-oriented NGOs** ➢ **Good opportunity for public-private cooperation** ➢ **Opportunity for new working position and small company development**	➢ **Non-adequate population structure** ➢ **Ongoing hybridisation with Austrian pine** ➢ **Soil erosion** ➢ **Fire hazard** ➢ **Climate change**

9. Definition of general and specific objectives ensuring conservation of Bosnian pine in short, medium and long periods

9.1. General objectives

The primary goal of this Conservation Plan is permanent protection and conservation of Bosnian pine on Jezerskivrh in Lovćen National Park.

9.2. Specific objectives

In order to achieve this goal, a series of systematically planned activities must be performed within the three main fields of action. The first field of action would imply the conduct of scientific research aimed at increasing scientific knowledge, since a huge lack of Bosnian pine trees has been recorded in Lovćen National Park. The second field of action implies the application of protection and conservation measures, which will be implemented based on the ecological needs of species and habitats. These measures will also be of preventive nature in order to avoid degradation and endangering of Bosnian pine. The third field of action, after obtaining full details about the habitat, implies continuous monitoring of the effectiveness of implemented activities (defined in this Conservation Plan).

The conservation of Bosnian pine diversity should, in addition to environmental and genetic aspects at local and landscape level, include social, economic and legal issues as well (Vendramin et al. 2008).

In order to protect the habitat of Bosnian pine on the territory of Lovćen National Park, certain measures need to be taken. These measures can be divided into three categories, taking into account the goal to be achieved, and these are short-term, medium-term and long-term goals.

9.3. Recommendations needed to protect and preserve the habitat of Bosnian pine in National park Lovćen (Jezerski vrh)

9.3.1. Removal of certain Austrian pine trees

This measure is going to provide a larger area for the growth and development of Bosnian pine. One of the features of Bosnian pine tree is slow growth in at young stage. Studies have shown Bosnian pine trees grow noticeably slower than the Austrian pine trees in habitats where Bosnian pine has been introduced. The aggravating circumstance is the distinct heliophyte nature of Bosnian pine, so that the shadowing of Austrian pine trees prevents the growth of Bosnian pine progeny. The removal of Austrian pine trees should be done in several stages (in the course of several years). Logging trees and pulling trees out of the stands should be done in a manner that would not in any way lead to any kind of damage to the stand. The Bosnian pine stand on Jezerski vrh is located on a very sloping terrain (in some places, the slope of the terrain is over 45^{o}).Furthermore, the soil is very shallow, and rock creep has been noticed in several places, making the soil very unstable. Because of this, the intensity of logging should be taken into account, and the stand should in no case be discontinued due to the risk of erosion.

9.3.2. Drafting of a fire protection plan

Fires are one of the biggest threats to Bosnian pine trees in these areas. The protection plan provides for the following preventive measures against fires: fire hazard assessment; monitoring of climatic conditions and conditions of combustible materials in order to assess the current risk of fire breaking out; organised monitoring and dissemination of information about the breaking out of forest fires during fire seasons; active on-call hours in the National Park during periods of increased risk of fire; form and equip emergency response teams whose task is to extinguish fires at the initial stage; where possible, build observatories, fire-fighting facilities and reservoirs in highly risky areas; implement appropriate forest management measures aimed at reducing the risk of breaking out and spreading of fires; arrange excursion sites and control the lighting of fire in open air; educate local population and students about the need for protection against fires; print and distribute promotional material about risks and dangers of forest fires. One of the most important segments of this plan are fire risk models, which are created based on different scenarios. The basis for building such models are information and data on fires that broke out in the past: time when a fire broke out, cause, duration, climatic conditions (temperature, wind direction and speed, rainfall) at the time of the fire, area affected by the fire, as well as assessment of combustible materials on the ground. All this information is used to create various scenarios that are later used in the development of models. Greater number of different scenarios and more accurate past-related data give us a more accurate risk model.

This plan for conservation of Bosnian pine provides for fire risk models as well. A specially designed software FlamMap6 was used to create models, thanks to which it is possible to simulate a fire. Simulations of fires are carried out based on a large number of factors affecting the onset, spread and duration of the fire. Information about the terrain itself (height, exposure, slope of the terrain), vegetation and the purpose of the land (maps showing the purpose of the land-pastures; abandoned land; coniferous, deciduous and mixed forests; agricultural land; macchia; etc.) were used during simulation and creation of these models.. Simulation and fire risk models were prepared for the entire territory of Lovćen National Park.

9.3.3. Collecting Bosnian pine seeds

Collecting Bosnian pine seeds with a view to producing seedlings to be used for reforestation of the stand on Jezerski vrh. Since Bosnian pine on Lovćen does not regenerate naturally, there is a possibility that the seed is not of good quality. For this reason, as well as taking into consideration the fact that the Bosnian pine population on Lovćen is small (poor gene flow), the seed should be collected within a nearby location, where the species develops under as similar as possible environmental conditions. On the neighbouring mountain range, Orjen, there is a much larger population of naturally regenerating Bosnian pine. Hence, it is expected that seed of better quality than the seed of the population on Lovćen could be found here. Accordingly, we are recommending seeds to be collected on Orjen (Mičev, 1972; Kontić, 1962; Stojičić et al., 2007), in accordance with established standards (Isajev et al., 2010). Shortly after maturation of seeds, pine cones open and release their seeds. Due to this biological feature, the time for picking cones is short, only 10-15 days (Mičev, 1972).

Providing quality seed material and seedlings of high-value autochthonous species is one of the priorities determined in the Montenegro's Forestry Development Strategy, with Bosnian pine and Macedonian pine being identified as priority species (Anonymous, 2014). Prior to seed collecting, research needs to be done in cooperation with relevant research institutes in Montenegro (Faculty of Biotechnology), the results of which would show which trees are best to collect seeds from. Some Bosnian pine trees produce a large number of cones from year to year, while other trees produce a small number of cones. Furthermore, a significant variability is noticed when it comes to the number of seeds in cones. While collecting seeds to be used for seedling production, account should be taken of these genetically determined characteristics of the trees from which the seeds are harvested, since by doing this, seedlings that will "produce" more cones/seeds per hectare may be provided (Lazarević, 2013).

In cooperation with relevant research institutions in Montenegro (Faculty of Biotechnology), an analysis of collected seeds should be done to show whether the seed is of good quality, i.e. good for production of seedlings. This is also important due to the fact that parthenospermia (empty seed formation) is a common occurrence in Bosnian pine and sometimes reaches up to 75% (Mičev, 1972). Although the seeds of Bosnian

pine are generally characterised by high germination (Kontić, 1962; Mičev, 1972), the percentage of germination of seeds collected significantly varies, from 80% (Kontić, 1962) to only 32% (Mičev, 1972). If the results show that germination of seeds collected on Orjen is poor, then it is necessary to collect seeds in other stands for which good natural regeneration has been recorded (e.g. mountains of Kuči area).

Exotic or unknown Bosnian pine material should not be grown within the remaining stands, nor in their vicinity. Natural regeneration should be closely monitored and assisted by sowing locally collected seeds if needed (Vendramin, 2008).

9.3.4. Production of plant promotional material

Production of plant promotional material to be used to replenish (reforest) the stand. Seedlings can be produced from seed collected on Orjen, in cooperation with the Forest Administration, in the existing plant nurseries. Plant nurseries in Kolašin and Rožaje have sufficient capacities (Zehra Demić, personal communication) for implementation of this activity. Production of seedlings could also be done in collaboration with other (private) plant nurseries.

In the Mediterranean region, there are three main groups of activities falling within the forest growing area: afforestation on bare lands, tending of existing forests and natural reforestation (Matić et al. 1997). Natural regeneration of forests or some species is very often disabled due to the impact of various factors. Bosnian pine has limited capacity when it comes to natural rejuvenation. Hence, it is necessary to find a way to conserve and regenerate this species (Jovanović, 1971). Successful natural regeneration of many Bosnian pine stands in Montenegro has been noticed (Lazarević, 2013, Bulić, 2008), but the regeneration the stand on Lovćen is not natural and therefore, reforestation needs to be done.

Reforestation is carried out in two ways: sowing seeds and planting seedlings. Which of these two methods will be used depends solely on the biological properties and environmental requirements of species, climatic conditions, physical and chemical characteristics of soil, the purpose of production and purpose of the stand, as well as the possibility of acquiring seeds and planting material. As regards the Mediterranean region, Matić et al. (1997), besides seedling, also recommends the planting of seedlings. Planting is done with seedlings with coated root and with bare rooted seedlings. Planting of bare-root plants can be done only during the dormant season, while the planting with coated root can be done throughout the growing season. In the Mediterranean, planting should be done in autumn and winter due to greater amount of rainfall. If we decide to sow seeds, this is done during autumn. Moreover, it should be noted that sowing seeds is cheaper, but that planting seedlings is much more effective.

We are recommending seedlings to be used for reforestation of the stand on Lovćen. Planting is usually done using 3-year-old seedlings (Vendramin et al., 2008).

The practice so far has shown that Bosnian pine seedlings are difficult to produce (Lazarević, Menkis, 2017; Zehra Demić, personal communication). It has still not been definitely explained why, but mycorrhizal fungi could be one of the reasons. Survival, establishment and growth of pine trees may often depend on associated ectomycorrhizal fungi (Lazarević, Menkis, 2017). Mycorrhiza improves the mineral nutrition, growth and adaptation of forest trees. According to this, seedling mycorrhization is thought to be among the most important tools for achieving higher seedling quality. However, in Montenegrin nurseries controlled mycorrhizal inoculation of seedlings has yet to become common practice, and the fungi and fungal isolates from this region have not been examined previously as the material for mycorrhization (Lazarević et al., 2012).

When it comes to reforestation, the main question asked relates to the number of plants that need to be used for reforestation in order to provide a good-quality, stable and productive stand. A wrong idea about the forest as a community was present in the past, which was dominated by economic indicators for which bad arguments were put forward most often, while the bio-environmental indicators were most often ignored. The aim of reforestation should be to quickly form a stable young stand that would stop the process of degradation. In this process, several plants of the main species should play a dominant role, and this number should not be too large or too low, but optimal (Matić, 1994). When deciding about the optimal number of plants that will be used in the reforestation process, we must generally consider the role and purpose of the forest that we are about to form. The following is very important: examine the state of the forest land; pace and the time needed for forming a high-quality forest land; the possibility of growth of weed specie; dynamics of growth in terms of height, thickness and volume; the formation of horizontal and apical structure; competition and natural dying of trees; length of patrolling; possibility of natural regeneration in the future.

The hitherto studies regarding habitats where Bosnian pine has been artificially raised show that Bosnian pine grows noticeably slower than Austrian pine, suggesting that slow growth in youth is an attribute of this tree species (Meštrović, 1999). It should be noted that the positioning area occupied by one plant or one tree during regeneration and reforestation works is equally accessible to the target and non-target species. So, the rule is that the species that comes first has more chance to survive in that area for a longer period or, perhaps, to remain there for good.

According to Meštrovic (2007), who worked on the study of the natural spread of Bosnian pine and the formation of pioneer stands on Čvrsnica Mountain in Herzegovina, 8.600 PCs/ha in older stands is a sufficient quantity in terms of natural rejuvenation. Furthermore, these studies have been done in stands of different ages, so it has been determined that the quantity of natural Bosnian pine progeny in Bosnian pine stands was around 6,500 PCs/ha. Matić et al. (1997) claimed that during the formation of new stands, 1000-2000 seedlings per hectare are needed for planting Aleppo pine, Turkish pine,

Maritime pine, stone pine, and Cypress, requires, and 2000-2500 seedlings per hectare for planting Austrian pine. Researches into Bosnian pine in the surrounding of Nikšić (Kontić, 1962) have shown that there were over 2200 trees per hectare in stands with excellent natural progeny. It should be noted that a larger number of seedlings per unit area accelerates the stabilisation of the habitat, creates more favourable microclimate, and reduces the competitiveness of weed species, which, altogether, ensures better growth and development of a stand. In accordance with the aforementioned, we are suggesting 2000-2500 units per hectare to be used for reforestation of the target stand.

9.3.5. Preparation of the land for restoration

Before the planting, it is necessary to prepare the land for reforestation. In this way, we are helping a plant to fight weed species and competitive ones, both above the surface and in the root area. What method will be used for preparing a land depends on environmental conditions, methods of reforestation, the availability of a particular mechanization.

9.3.6. Research

Detailed researches need to be done in order to determine the health status of the Bosnian pine population, primarily the presence of pathogenic fungi and harmful insects. Based on the results of these researches, plans for the protection of the stand should be made. Continuous monitoring of the health status of the stand will allow timely and preventive application of protection measures.

Besides pathogenic fungi, it would be very useful to investigate mycorrhizal fungi. Ectomycorrhizal fungi may provide nutritional benefits to their host trees through increased supply of nutrients and water, and biotic stress factors. Such positive effects are likely to be most pronounced on marginal habitats under harsh environmental conditions (Lazarević, Menkis, 2017) such is habitat of *P. heldreichii*in the Lovćen national park. Therefore, information about ectomycorrhizal fungal communities associated with *Pinus heldreichii*is of great importance regarding the restoration of *Pinus heldreichii*forests (Lazarević, Menkis, 2017).

9.3.7. Detailed description of the habitat and floristic composition of the stand

Knowledge of the floristic composition of the stand is a basis for developing protection plans, studying the dynamics of the stand, monitoring the stand, etc. Accordingly, it is necessary to have a detailed overview of the floristic composition of the Bosnian pine stand in a given location. During the preparation of this Conservation Plan, an overview of vegetation composition was presented along with two phytocenological records made on Jezerski vrh. The first phytocenological footage was made on the part of the stand where Bosnian pine is more dominant than Austrian pine, the second one was made on the part where the shares of Bosnian pine and Austrian pine are equal. We would like to point out that the Conservation Plan was made in autumn, when many types that form the first floor were missing or were in the developmental stage, meaning that it was not possible to determine them with certainty. Accordingly, the floristic composition in the phytocenological recordings is incomplete.

9.3.8. Complete stand surveying

It is necessary to provide a detailed overview of the number of trees, the diameter and height of the trees, the volume and volume increment, thickness structure and other parameters. Stand surveying is carried out periodically by collecting data about the condition and changes in forests and forest land. Stand surveying is conducted for the purpose of preparing planning documents. The application of complete surveying in this case is justified because of the small size of the stand and its great value. During the preparation of this this Conservation Plan, a survey was made of all the Bosnian pine trees in the stand underwent surveying. The diameters of all trees and the heights of the most dominant ones were recorded.

9.3.9. Education of locals and visitors of Lovćen National Park

This implies getting the local population and tourists acquainted with the importance of conservation of biodiversity, especially rare and endemic species. Furthermore, student traineeship in the National Park is recommended, as well as schools in nature, because these would give pupils and students a chance to get familiar with the importance of nature conservation and species conversion in practice. The target groups of students in Montenegro are students of the Faculty of Natural Sciences and Mathematics (Study Programme - Biology), Faculty of Metallurgy and Technology (Study Programme - Environmental Protection), Faculty of Architecture. In many Western and developed countries, conversation of species is treated as a separate science, thus showing the importance of these activities.

9.3.10. Removal of waste from the stand

In the area below the Mausoleum of Petar II Petrović- Njegoš and the local restaurant, a large amount of waste has been noticed and needs to be removed due to the high risk of fire.

9.4. Medium- term goals and recommendations to be implemented

9.4.1. Taking care of reforested stand

Reforestation is only a partially done job, as the ultimate goal is to raise a stable stand. To achieve this, care procedures must be performed. The care procedure refers to the protection against pathogenic fungi and other adverse environmental factors, as well as against fires. If the loss exceeds 15%, replenishing needs to be done. At a young forest stand, the most necessary care measures are cleaning and thinning (Matić and Skenderović, 1992). During the cleaning process, damage or overgrown Bosnian pine trees are removed. Taking care of a stand is carried out during the period of maximum growth of trees in height when dying off of the lower branches and drying of some trees takes place due to the lack of light. This is a way to help the quality trees. As already known, Bosnian pine is a pioneer species, and natural succession can lead to replacement of a species by another one. Since the goal implies conservation of species and creation of a stable and durable Bosnian pine stand, work needs to be done to remove the competitive tree species.

9.4.2. Setting pheromone traps to control and monitor potential pests

The recurring problem with bark beetles in Montenegro, as well as at the global level, brings up the question about how to suppress them. Protection of forests against bark beetles should be based on environmentally friendly methods, e.g. the setting of pheromone traps. Bark beetles outbreak after physiological stress caused by adverse exposure to a factor, e.g. drought or accumulation of a large amount of materials suitable for development of bark beetles (materials with bark), which accumulates after tree throws and breakage. In contrast to many negative factors that contribute to stress (climate, pollution), preventive and repressive protection measures can be taken against bark beetles, the main purpose of which is to maintain population at a low level. Pheromone traps are used to monitor pest populations worldwide.

9.4.3. More scientific researches need to be done

More scientific researches need to be done with a view to providing a better overview of the dynamics of a Bosnian pine stand at a given location. During the drafting of this Conservation Plan, a big lack of scientific research into Bosnian pine has been noticed, not only when it comes to Lovćen National Park, but also when it comes to the entire territory of Montenegro. Researches and their findings represent a basis for development of species protection plans, as well as area management projects. During the preparation of this plan, the project team gathered basic information about the stand and provided an overview. The data can serve as a basis for further research. We are recommending detailed researches into flora, fungi and fauna, environmental characteristics and limitations of Bosnian pine, genetic studies of Bosnian pine, etc. To be done within this stand.

9.4.4. Monitoring of microclimate in the stand

The recommendation is to place mini climatological stations within the Bosnian pine stand and Lovćen National Park. These stations would provide data that are important for climate change monitoring and for researches into how climate change affects Bosnian pine.

9.4.5. Monitoring of the state of health of the stand

This Conservation Plan gives an overview of the state of health the Bosnian pine stand. The recommendation to regularly (on annual basis) monitor and record the health of the stand.

9.4.6. Taking inventory on a periodic basis

Due to great importance of the stand and its small size, the recommendation is to take inventory in forests within every Bosnian pine stand every 5 years. Continuous monitoring of growth, development, forest structure, etc., gives us an insight into the dynamic processes that will take place in the stand, as well as into the performance of application of measures from this plan.

9.4.7. Gradual spreading of the Bosnian pine stand

Gradual spreading of the Bosnian pine stand by means of replenishment using plant promotional material derived from locally provided seed material. Like it has been already indicated, a stand should cover an area of at least 20 ha in order for a species to be permanently protected and in order for it to survive.

9.4.8. Controlling the growth and development of Austrian pine

It is necessary to gradually remove Austrian pine from this area. This activity must be carried out in parallel with the replenishing of the stand using Bosnian pine seedlings.

9.5. Ultimate golas

Goal 1

The primary ultimate goal of this plan for conservation of Bosnian pine (*Pinus heldreichii*) on Jezerski vrh in Lovćen National Park is to have a stable self-sustaining Bosnian pine stand. A stable stand means a stand within which natural reproduction is at satisfactory level. It has been determined that there is no natural regeneration of Bosnian pine in the Lovćen reserve, but we do believe that this stand will be a self-sustaining one after implementation of measures described above (removal of Austrian pine, preparation of the land for reforestation, reforestation, spreading of the stand). Forest stands of more than 20 hectares, established from local seed sources and managed for nature conservation, could qualify as gene conservation units for Bosnian pine (Vendramin, 2008).

Goal 2

Successful production of Bosnian pine seedlings from seed collected on Orjen, or from another stand in Montenegro that has proved to have good quality seed. This would be important not only from the aspect of protection of Bosnian pine stands on Lovćen, but also for the restoration of burned Bosnian pine forests in other localities in Montenegro (Prekornica, Štitovo), as well as for reforestation of areas with extreme ecological conditions (drought, high slope, skeletal soil), in which other species would hardly succeed. Although providing a good quality seed material and Bosnian pine seedlings has been defined as one of the priority goals in Montenegro's Forestry Development Strategy (Anonymous, 2014), not many actions have been taken so far in order for this goal to be achieved. Attempts to produce Bosnian pine seedlings in plant nurseries of the Forest Administration were unsuccessful (Zehra Demić, personal communication). A well-organised seedling production could be a significant basis for education and practical work of high school students, university students and other interested groups.

Goal 3

Protected Bosnian pine habitat, which will serve as a model in the process of protection of Bosnian pine habitats on the territory of Montenegro. On the territory of Montenegro, there are areas inhabited by this pine but that are not within some of the protected areas. These stands are much endangered and we must work on their protection and conservation. As it has been already indicated, one of the dangers posing a threat to Bosnian pine in Montenegro is fragmentation of the Bosnian pine habitats. There is a great number of small areas in Montenegro that are distant from each other. When it comes to their number, the downward trend is intensive. The Bosnian pine stand on Jezerski vrh could be used as a model for protection of other Bosnian pine habitats (of course, after making corrections to possible deficiencies).

Goal 4

Systematic monitoring of forests. As a basis for establishing long-term and short-term management plans in protected areas, it is necessary to systematically monitor the state of the forest in the reserve. In order to do this, it is necessary to monitor the state of health of forests, take inventory, and to measure microclimate conditions in the stand.

10. Defining of a Plan of integrated actions for the correct protection and managemant of Bosnian pine

During the drafting of this Conservation Plan, some basic researches were done and the results are presented in the plan. Furthermore, some of the activities proposed in the plan have already been carried out and it is now necessary to work on the monitoring. In order to protect the habitat of Bosnian pine located in Lovćen National Park, the following specific activities need to be implemented:

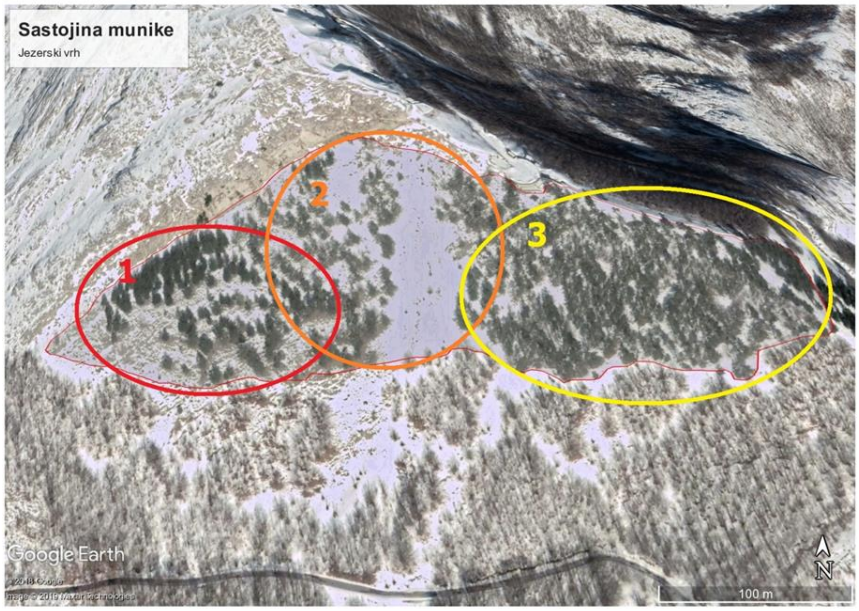

Figure 5. Bosnian pine stands on Jezerskivrh, Lovćen National Park

10.1. Removal of certain Austrian pine trees

By means of this measure, space will be provided for the growth and development of young Bosnian pine trees, characterised by slow growth in youth. In the course of preparation of this Conservation Plan, Austrian pine trees that need to be removed were selected on the ground. On Jezerski vrh, these activities would be carried out in three zones with different intensity in terms of logging. The first zone is located in the very core of Bosnian pine, located on the western side of the stand (image). This part is dominated by Bosnian pine trees that are of good quality, among which trees with cones can be found. Younger Bosnian pine trees are found in small groups of 5 to 10, and it has been noticed that in several cases these trees are obscured by Austrian pine trees, which prevent their growth and development. It is necessary to remove 80% of Austrian pine trees from this zone at the first stage. The second zone is in the central part of the stand, which is dominated by Austrian pine. Presence of rock creep is also characteristic for this zone. Rock creep can be seen along the entire zone and it separates the second zone from the third one. It is also necessary to remove some Austrian pine trees in this area, but this should be done during the first stage, even logging is less intensive. It is suggested 40% of Austrian pine trees to be removed. As for the third zone, it is characterised by the absolute dominance of Austrian pine trees. In this part, the first step is to cut down 20% of Austrian pine trees, while taking care that old trees that take up more space are removed, as well as trees that have been damaged or attacked by a pathogen. If it is not possible to export trees that have been cut down, bark should be removed from all trees, as well as from over 5cm-thick branches.

10.2. Drafting of a fire protection plan

For the preparation of fire protection plans, it is necessary to use fire risk models, which are presented in this Conservation Plan. The accuracy of the model is reflected in the fact that the model showed that the risk of fire break out was highest in places that had already been exposed to fires in the past. The model showed that there is a high risk (red color) of fire break out at the site covered by Bosnian pine on Jezerski vrh. This model clearly indicates risk points on the territory of the National Park, but also near the Park, i.e. within the boundary area. Accordingly, during fire season, special attention should be paid to these risk points. Some of these points are located near the estates of the local population, as well as near the campsite, where fires were frequently reported in the past. Therefore, special attention should be paid to education of residents and people visiting the Park. Publishing of brochures and training materials would be one of the activities to be carried out for this purpose. It is very important to educate residents and visitors about how an excursion site should be arranged (for this purpose, they should not use fire to clean the area, waste should be dumped in precisely designated places, etc.). In order to protect the Bosnian pine stand on Jezerski vrh, water sources (cistern, pool, etc.) should be provided in the immediate vicinity of the stand. This would ensure firefighting and fire

suppression at the very beginning. Illegal waste disposal sites must be controlled and removed from the National Park. One of the most important measures that should be taken when it comes to protection against fires implies, of course, active on-call hours and timely dissemination of information about fire break out. Because of this, it is necessary to build observatories, where possible, so that information could be provided in a timely manner. Well-trained and equipped fire services are, of course, an important segment when it comes to protection against fires. During fire season, such a service should be present in the National Park on day-to-day basis. Better keeping of records of possible fires should be ensured. These records must contain the exact time when a fire broke out, cause, direction of spreading, duration, precise information about climatic conditions at the time of the fire and during the fire, etc. In the future, these data will be useful for creating more accurate fire risk models, which will help creating better fire protection plans.

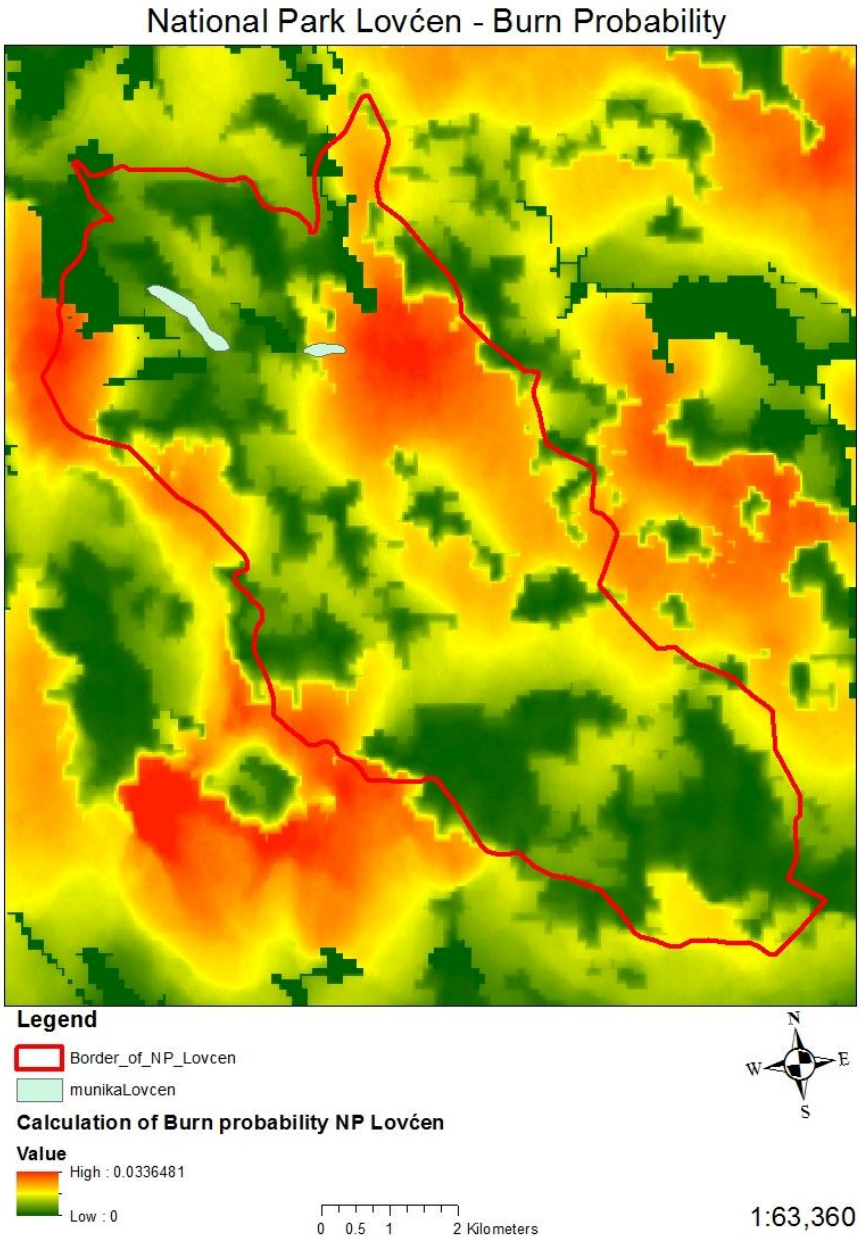

Figure 6. Burn probability on National park Lovćen

10.3. Conservation of genetic material

Since Bosnian pine on Lovćen does not regenerate naturally, as well as taking into consideration the fact that the Bosnian pine population on Lovćen is small (poor gene flow), we are recommending seeds to be collected on Orjen, or in some other stand in Montenegro.

Exotic or unknown Bosnian pine material should not be grown within the remaining stands, nor in their vicinity (Vendramin, 2008).

10.4. Reforestation of the stand

Reforestation must be done in parallel with the removal of Austrian pine trees from the stand. After removing the Austrian pine trees, it is necessary to replenish the stand. Due to great importance of the stand and its small size, the recommendation is to plant seedlings with coated root in autumn due to greater amount of rainfall. Before the planting, it is necessary to prepare the land for reforestation. Due to a very sloping terrain, smaller terraces need to be built in order to avoid erosion around trees. As for the number of seedlings, the recommended total number of plants to be introduced and of those already present in this habitat is at least 2000 per hectare. Large number of bare areas have been noticed on Jezerski vrh (down the very the stand, as well as by going west from the Bosnian pine stand). Reforestation is recommended to be done in these areas by using Bosnian pine seedlings. Furthermore, the success of the planting should be monitored every year. If more than 15% of seedlings fail to survive, additional replenishing needs to be performed.

10.5. Education of locals, visitors of Lovćen National Park, pupils and students

Special attention should be paid to the education of local population about the dangers of outdoor fires, as well as about their adverse effect on the environment. The recommendation is to get the local population and visitors acquainted with the *Pinus heldreichii* endemic type, as well as with the importance of biodiversity for humans. This would be done as part of campaigns, in which the whole public should be included. But, special emphasis should be placed on the inclusion of pupils and students. It is suggested that activities should be undertaken at the faculties of biology, ecology and similar scientific disciplines, where students would be directed to promote and develop species conservation in Montenegro as part of their graduate, master's or doctoral studies.

10.6. Placement of mini climatological stations

Placement of mini climatological stations that will serve to collect microclimate data. The recommendation is to place a smaller climatological station on Jezerski vrh that will record some basic data, such as daytime temperatures, precipitation, wind strength, etc. It is also necessary to place 2 or 3 more such stations on the territory of the National Park. Data from these stations would provide a more precise picture of climate change in the National Park.

10.7. Systematic monitoring of the state of the stand

Due to great importance of the stand and its small size, the recommendation is to annually analyse the state of health of the stand; control the number of barks (use of pheromone traps); determine the number of insects; monitoring of pathogenic fungi; control the successfulness of planting.

The primary attack of bark beetle can be easily detected. The outbreak of this beetle can be recognised by small round emergence holes visible on the tree trunks. The indications suggesting the existence of a bark beetle problem are as follows: change in colour of needles of infested trees (from bright green to yellow and, finally, to brownish-red); oozing of pine resin (often from boring holes); crevices in the bark; reddish-brown dust on crevices in the bark or around the base of the tree, as well as on lichens, leaves (this dust is the result of adult beetles boring through the outer bark of the tree); clearly seen trace of chewing (clearly visible tunnels under the bark); stripped bark (on some parts of the infested trees, birds remove the bark in search of food).

There are two ways to control the number of bark beetles: with the help of control trees and with the help of pheromone traps. As for the control trees, they should be cut down in at least two turns, since most bark beetles have two generations. The first turn takes place during winter and the second in late May. These trees are controlled every 7-10 days, and records of each control performed are kept in an orderly manner. As for pheromone traps, today we can find them for a large number of bark beetle species. They are placed on every 5ha of land so that the quantity could be determined. The traps are placed in two turns, before the beginning of swarming of bark beetle of the first and the second generation. They are controlled every 7-10 days and counted, and records of each control performed are kept. At the end of swarming of one generation, the numbers of bark beetle captured during every control are added together. The same is done for the second generation. The number of bark beetles captured in the trap is a great indicator for the future forecast. Suppression of bark beetles can be accomplished by placing trap trees or pheromone traps. Trap trees are planted in early spring and in June. Processing of trees is done after the appearance of first pupas under the removed bark. Pheromone traps are a much more effective and simple way to suppress bark beetles. A large number of these products can be found in the market.

The quantity of *Hymenoptera species (Neodiprion sertifer, Diprion pini*) can be determined by means of sampling of one of the developmental stages (egg, caterpillar or cocoons).In order to have a reliable forecast, it is sufficient to count 5% of evenly distributed trees. For each tree examined, the following data are recorded: the number of brood sand eggs in the brood, the number of colonies of pseudo-caterpillar sand the number of pseudo-caterpillars per colony or the number of cocoons within the crown projection area under the tree. As for suppression, in weaker attacks a mechanical-physical method may be employed, that is, cutting off and burning branches with colonies of pagans. For more severe attacks may be used as a chemical method, treatment of the infested surfaces drugs based on diflubenzuron method micronized substance from the air. But environmentally and economically, it is best to treat the attacked ingredients with a nuclear polyandries-based viral drug (closely specific to *Neodiprion sertifer*).

With regard to suppression, in case of weaker attacks, mechanical-physical method, i.e. the cutting off and burning of branches with the colonies of pseudo-caterpillars, may be applied. In case of severe attacks, a chemical method may be used, i.e. treating the infested areas with diflubenzuron-based products by means of air micronization. But, from the environmental and cost-efficiency point of view, the best thing to do is to treat the attacked stands with a *nuclear* polyandries *-based virus product* (specific for *Neodiprion sertifer*).

To control *Sphaeropsis sapinea*, it is best to apply breeding and preventive measures. As part of the cartridges at the top of the pond before planting, it is necessary to remove the infested, old Austrian pine trees. Measures to clear trees of lower branches during a critical period for infection should be avoided. All trees that are dry-leaved should be removed from the ingredient, should also be removed and burned by all the cones on which the pyncid fungi have been seen.

When it comes to the control of *Sphaeropsis sapinea*, it is best to apply breeding and prophylactic measures. Before planting, it is necessary to remove the attacked, old Austrian pine trees from the Bosnian pine stand on Jezeri vrh. Measures to clean the trees from the lower branches should be avoided during the critical period in terms of infection. All trees that are dry should be removed from the stand. Furthermore, all cones on which pycnidia have been found should be removed and burned.

11. Information and sensitization measures for Steakholders and local population

Despite the fact that locals are familiar with Bosnian pine due to the quality of this pine's forests, they do not know anything about the uniqueness of this species, nor about threats that Bosnian pine is facing. This does not seem surprising since only specialist are familiar with data regarding biology, endemism and threats to Bosnians pine, which possible to find only in highly specialised literature.

Taking in consideration Lovćen National Park and the site where Bosnian pine grows, due to protection and spatial position, this stand does not represent any kind of resource for the local population (there is no logging of Bosnian pine trees within the area of Lovćen National Park). Therefore, our stand point is that there is no need for organising any kind of awareness campaign aimed at educating the public about the uniqueness and importance of protection of *Pinus heldreichii*. Instead of such a campaign, we think that some public effort aimed at raising awareness of importance of prevention of fires should be made, with a focus on local population and tourists, since fires represents the biggest threats to this forest stand.

If we look at *Pinus heldreichii* in a wider context, then education of local communities, as well as of entrepreneurs and company owners utilizing the forests, is something that we have to work on. One of the ideas is to make some kind of documentary series about *Pinus heldreichii* that would be broadcasted on the national TV broadcaster or on some other channel with national coverage. Similar programmes have already been done in the past, and we do believe that broadcasting of this kind of documentaries would be the best way to bring this issue into focus and to educate the widest audience in Montenegro.

Furthermore, a national campaign oriented towards protection and conservation of this unique pine species would greatly help not only in raising the level of knowledge and in drawing attention to *Pinus heldreichii* , but also in pointing to the problem of decreased volume and forest area of this species.

All of the above-mentioned would be feasible only if the entire action would involve stakeholders who play a crucial role. Of course, not all of the stakeholders have the same institutional potential and the level of knowledge needed for protection of Bosnian pine. Accordingly, our suggestion is to start working at national level and creating a national plan aimed at protecting this pine and its stands first. Since this study refers mainly to the Bosnian pine stand on Lovćen, we will only focus on those suggestions that are in line with this geographical area.

The first activity would be to present the Conservation Plan and its contents to the representatives of the Ministry of Agriculture and Rural Development, Ministry of Sustainable Development and Tourism, and the Environmental Protection Agency. This would be best done by means of a one-day workshop organised by the Public Enterprise

for National Parks of Montenegro whose experts in dendroflora and forestry would present the attendants with identified problems, as well as with suggestions for resolving them. This workshop would result in drawing up of a plan with precisely defined responsibilities and duties of each stakeholder, and with a time frame for implementing them.

Subsequently, stakeholders would take on their obligations and begin working on fulfilling them, all with the common aim of protecting the remaining stands of Bosnian pine on Lovćen and increasing its volume.

The following diagram shows the hierarchy of stakeholders when it comes to the conservation of the Bosnian pine stands on Lovćen.

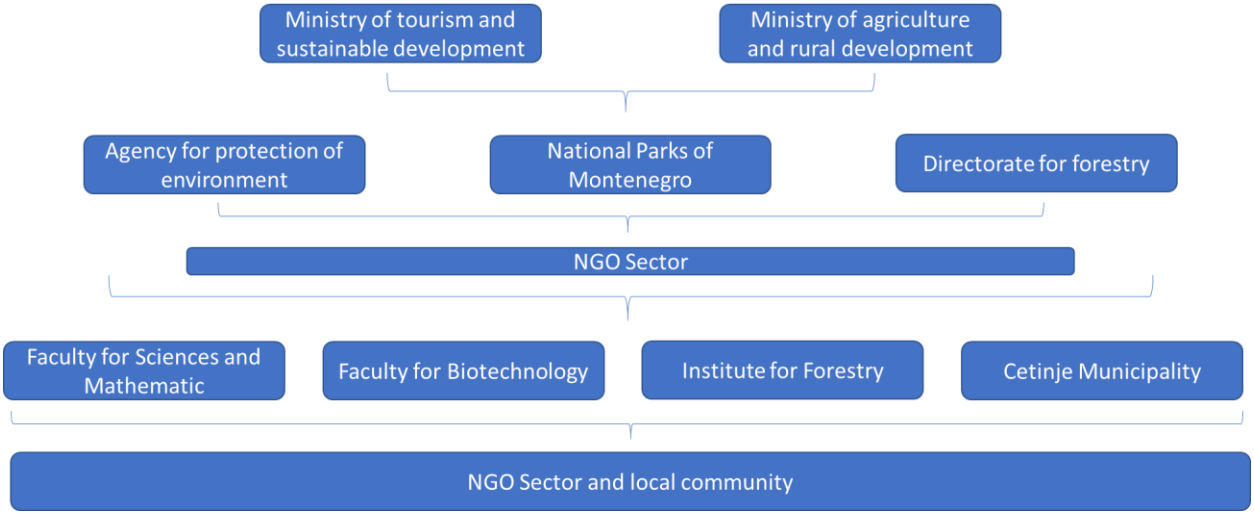

Figure 7. Hierarchy of Decisionmakers and Steakholders in Montenegro directly involved in management of Bosnian pine

12. Assesment of impact of the Action Plan for the correct protection and managemant of Bosnian pine habitat

This Action Plan contains a lot of information about *Pinus heldreichii* and particularly about its population on Lovćen. In the wider region, this population represents one isolated island – like are inhabits by this species and it is most probably remain of past much dens coverage. It has been concluded that this population records a downward trend, so there is significant likelihood that Bosnian pine could vanish form Lovćen National Park. Therefore, implementation of measures identified in this document should have great importance for protection, conservation and repopulation of this species within the area covered by National Park.

The Action Plan for Conservation of *Pinus heldreichii* in Lovćen National Park includes well defined measures and activities that need to be implemented in order to conserve and recover this species. Measures are well balanced and defined based on identified problems and causes of shrinking of *Pinus heldreichii* range. The main goal of those measures is conserve the *Pinus heldreichii* species on Jezerski vrh in Lovćen National Park in order to have a self-sustainable population. Bearing in mind the fact that it is impossible to implement conservation measures and to make conservation interventions within a short time period, and knowing that their effects would be visible only after certain period of time (particularly when it comes to measures and interventions referring to slow-growing species, such Bosnian pine), the conservation measures and activities defined in this Action Plan are methodologically well organised in three categories: protection of the habitat, mid-term measures, and long-term measures (ultimate goals).

The impact of this Action plan completely depends on its implementation. We are aware of the fact that we cannot expect all the measures and activities to be implemented, but we can single out those that, in our opinion, are the most crucial ones.

According to information presented in this Action Plan, it is urgent to stop the downward trend when it comes to the number of *Pinus heldreichii* trees on Lovćen. In this regard, the following measures need to be implemented urgently and they are the main indicators of this conservation plan implementation:

12.1. Removal of certain Austrian pine trees

Removal of certain Austrian pine trees in order to reduce competition and to provide wider area for the growth and development of Bosnian pine. The Bosnian pine stand on Jezerski vrh is located on a very sloping terrain having very shallow soil, so that possible cutting of Austrian pine could result in a great risk of erosion. In such situation, a detailed logging plan needs to be developed, and the stand should in no case be discontinued.

12.2. Drafting and implementation of a fire protection plan

Fires are one of the biggest threats to Bosnian pine trees in these areas, so everything possible needs to be done in order to prevent it. This measure, inter alia, implies: organised monitoring and dissemination of information about the breaking out of forest fires during fire seasons; active on-call hours in the National Park during periods of increased risk of fire; form and equip emergency response teams whose task is to extinguish fires at the initial stage; where possible, building of observatories, fire-fighting facilities and reservoirs in highly risky areas, etc. Fire risk models are one of the most important segments of this plan, and are created based on different scenarios. The basis for building such models are information and data on fires that broke out in the past: time when a fire broke out, cause, duration, climatic conditions (temperature, wind direction and speed, rainfall) at the time of the fire, area affected by the fire, as well as assessment of combustible materials on the ground.

12.3. Collecting and storage of Bosnian pine seeds

Seeds should be collected within the stand on Jezerski vrh, from trees that were marked during the drafting of this Conservation Plan. Collecting of seeds within the Bosnian pine stands should be done during the month of October (Isajev et al. 2010). Bosnian pine produces seed every second or third year. Seeds should be collected and stored according to the established standards (Ratknić, M., eds 2007).

12.4. Establishment of a seed source stand

Establishment of a seed source stand in order to preserve and to produce genetic material for the future generation, as well as for plant nurseries. A seed source stand should provide seeds that will be used in the production of promotional material in the reproductive centre, a plant nursery that will ensure the production of promotional material from locally provided seeds (Lovćen National Park). As for Europe, forest genetic resources are facing several threats: habitat destruction, fragmentation, pollution, poor forest management systems, or the use of reproductive material of poor quality or of reproductive material showing very poor adaptability. With regard to Bosnian pine, the greatest threat is fragmentation of its range or lack of reproduction.

The disappearance of these smaller fragmented surfaces reduces the likelihood of gene flow between populations and reduces genetic diversity at global level. Therefore, it is very important to use seeds from a local stand for the purpose of producing promotional material. Seedlings produced in this way have a significantly higher adaptive capacity.

12.5. Reforestation using promotional material

Planting of new seedlings should be carefully planned and carried out, pursuant to standards. After seedlings are selected, method of reforestation needs to be determined. Reforestation is carried out in two ways: sowing seeds and planting seedlings. Which of these two methods will be used depends solely on the biological properties and environmental requirements of species, climatic conditions, physical and chemical characteristics of soil, the purpose of production and purpose of the stand, as well as the possibility of acquiring seeds and planting material.

12.6. Detailed overview of the state of health of the stand

A detailed overview of the state of health of the stand needs to be provided. In addition, these data are very important for continuous monitoring of the state and the dynamics of the stand. During researches done in the course of preparation of the Conservation Plan, the state of health of the Bosnian pine stands has been recorded, showing that the state of health of the stand is at satisfactory level. During these researches, the percentage of fungi noticed was not high - they were noticed only on few trees. Presence of caterpillars was noticed on several Austrian pine trees. Continuous monitoring of the health status of the stand will allow timely and preventive application of protection measures.

All the aforementioned measures should ensure correct and direct positive impact of this Action Plan on *Pinus heldreichii* stand within Lovćen National Park, which is of essential importance. Of course, these measures require additional effort, financial and human resources, and the success of this Action Plan depends on their availability. Great responsibility falls on stakeholders, but primarily on the management staff of the Public Enterprise for National parks of Montenegro, whose readiness to carry out all the necessary activities, aimed at implementing this Action Plan, is one of the crucial preconditions. Fundraising activities are among the most important ones, and need to be carried out in close cooperation with stakeholders at national level, primarily with the Ministry of Sustainable Development and Tourism. Furthermore, this stakeholder needs to work on building its institutional capacities in terms of education of its employees, while during the transitional period, it could rely on experts employed in other stakeholder institutions.

13. Identification of human and financial resoruces which will be included into project through partnership with public and private authorities

Generally speaking, Montenegro, as small country with small population, is lacking both, but particularly financial resources. There are several experts working in the Public Enterprise for National parks of Montenegro, as well as in other institutions (e.g. Biotechnical faculty, Institute for Forestry, and Faculty of Sciences and Mathematics), who have skills to implement this Action Plan, but since implementation of this Conservation Plan is a long-term process, there is a strong need to educate younger experts to continue and finish the implementation of this Action Plan.

At present, major pair of human resources can be found in the following institution:

- Public Enterprise for National parks of Montenegro,
- Ministry of Sustainable Development and Tourism,
- Environmental Protection Agency,
- Forest Administration,
- Faculty of Biotechnology,
- Faculty of Natural Sciences and Mathematics,
- Institute of Forestry.

Providing financial resources will be the biggest problem since many of the suggested activities, particularly the major ones, demand significant funds and efforts. In situations when limited funds are available, the stakeholder (Public Enterprise for National parks of Montenegro) has to prioritize the suggested measures so that implementation of this Action Plan could start.

There are several options for provision of financial resources for implementation of the aforementioned measures. The first and the basic one implies relocation of some small part of national parks' annual budgets for a specific measure/s and proposing of a new budget line in order to cover the costs of field research (fuel, food and per diems) and material (some smaller pieces of equipment for some filed interventions). Since some of the available experts already work in the Public Enterprise for National parks of Montenegro, the management staff of this stakeholder has to worry about expert fees for implementation of certain measures. If measure implementation analysis shows that there is a need for engagement of external experts, Public Enterprise for National parks of Montenegro has to allocate some smaller amount of funds in their budget for that purpose.

The second option implies forming of kind of small consortium together with other national stakeholders with defined activities that have to be carried out and with precise budget sharing. In that manner, for instance, Public Enterprise for National parks of Montenegro and Ministry of Sustainable Development and Tourism (or the Environmental Protection Agency or the Municipality of Cetinje) should make a detailed plan and budget sharing in order to cover the costs of planned activities and implement the selected measures.

Cooperation of the Public Enterprise for National parks of Montenegro with some public or privet entities, which are socially responsible and environmentally sensitive, could be based on application of some of the suggested measures. This kind of cooperation, so called public-private cooperation, is well known and highly effective mechanism that, on one hand, could solve some environmental problems, and that, on the other hand, represents one of the best-known investments in company marketing. Bearing in mind the fact that this Bosnian pine stand is placed on Lovćen, which is the national symbol of Montenegro and towards which all Montenegrin citizens feel strong and positive emotions (similar to emotions that Greeks feel towards Olimp), brings huge marketing potential for companies that are willing to provide their help in the conservation of this forest.

Additional funding could be provided through a relatively strong and well-developed environmentally oriented NGO sector within Montenegro. These NGOs have good cooperation with big international donors and international environmental organisations and they could, together with national and local stakeholders, provide financial support for many of the presented activities and measures. Therefore, local and national stakeholders, primarily Public Enterprise for National parks of Montenegro, need to establish closer cooperation with those NGOs and try to develop a joint project proposal, which will imply launching of open calls for funding or lobbying big international donors in order to provide funds for implementation of the Action Plan.

Last but not least, we could use some of the EU accession funds, such as IPA funds, and some international funds that are unlocked for state stakeholders.

14. Monitoring plan for checking the effectiveness of actions

The only measurable and visible effect of this Action Plan is the number of measures implemented in the predefined time period. From the protection of Bosnian pine (the stand on Lovćen) point of view, the most important are the so-called “crucial” measures listed in Chapter 11 of this Action Plan. Considering the fact that *Pinus heldreichii* is a slow-growing species, the real effects on the abundance of the stand could be spotted only five to eight years after implementation of this Action Plan ends.

In order to monitor the process of *Pinus heldreichii* revitalisation on Lovćen, we are suggesting the following:

- Monitoring of the number of the measures proposed under this Action Plan that will become part of annual operational plans of the Public Enterprise for National parks of Montenegro, or that will be applied by other national or local stakeholders (institutions, public/private entities, NGOs),
- Precise GPS mapping of stand boundaries and counting of *Pinus heldreichii* trees in order to detect any changes in Bosnian pine population on Lovćen. This should be done during the first year of implementation of this Action Plan so as to produce the so-called “zero-point state”, and after that, every third year.
- Monitoring of the Austrian pine individual trees, particularly of those competing with *Pinus heldreichii* trees,
- Monitoring of new, young *Pinus heldreichii* trees, naturally regenerated or reforested, in order to detect population trend and effectiveness of applied measures.
- Monitoring of fires and potential fire break outs and real damages caused by fire in the wider region of the *Pinus heldreichii* stand on Lovćen.

The aforementioned monitoring will make it possible to us to measure the effectiveness of this Action Plan, but if implementation of the suggested measures does not occur, we cannot even think about its effectiveness.

In the course of implementation of this Action Plan, we may see and conclude that some of its parts are not feasible. No matter how hard we tried to make the Action Plan feasible as much as possible, we cannot foresee all the problems and obstacle that we may face during the operational stage. Therefore, a continuous review of data on the species on Lovćen should allow adjustments and adaptations in areas where the Plan is ineffective.

15. Conclusions

- The Bosnian pine stands on Lovćen mountain are enjoying the status of a special reserve in which, according to the Montenegrin Law on Nature Protection, it is prohibited to perform actions and activates hat could adversely affect its characteristics for which it has been declared a protected area.

- The Bosnian pine stands on the coastal Dinarides (Orjen, Lovćen, and Rumija) are protected as natural monuments.

- A downward trend has been recorded in the number of *Pinus heldreichii* trees in the Mediterranean and Balkan subalpine forests in Montenegro, while as for the quality, the trend is unknown (probably a downward trend).

- A common characteristic of the association on Prenj and the stand on Jezerski vrh is the presence of a hybrid of Austrian pine and Bosnian pine.

- Bosnian pine is protected by national law in Montenegro, but since the country does not have a Red List, there are no data that could indicate the level of threat and based on which it would be possible to accurately determine the IUCN category. Therefore, at this point, the IUCN national category is DD (data deficient).

- At present, the biggest threats to Bosnian pine on Lovćen are: fire, competition with Austrian pine, hybridisation with Austrian pine, lack of young trees.

- The most urgent measures aimed at stopping the downward trend when it comes to the number of *Pinus heldreichii* trees on Lovćen and at ensuring self-sustainability of this stand on Lovćen are as follows: a) removal of certain Austrian pine trees in order to prevent competition and hybridisation; b) drafting and implementation of a fire protection plan; c) collecting and storage of Bosnian pine seeds; d) establishment of reproductive centre for young Bosnian pine – plant nursery; e) reforestation using propagation material obtained from locally provided seed material; detailed overview of the state of health of the stand.

ANNEX I

Summary table of the results we collected during the research performed in order to prepare this conservation plan

No. Units	H (m)	R (cm)	Cones	Young tree trunks	Resin	Drying of confiders	*Sphaeropsis sapinea*	*Hymenoptera*	Bark beetle on the branches
1	8	23	yes						
2	8	26	yes			yes			
3	8	18	yes				yes		
4	10	24	yes						
5	11.5	29	yes						
6	10	28	yes				yes		
7	5	15	no	yes					
8	5	16	no	yes					
9	8	23	yes						
10	7	25	yes						
11	7	19	yes						
12	6	15	yes						
13	6	13	yes	yes					
14	6	13	yes	yes					
15	5	13	no	yes					
16	6	14	yes	yes					
17	6	19	yes						
18	5	15	no	yes					
19	5	16	no	yes					
20	5	13	no	yes					
21	6	19	no		yes				
22	6	19	yes						
23	5	13	yes	yes					
24	5	12	yes	yes					
25	8	25	yes						
26	7	25	yes			yes			
27	6	14	no	yes		yes			
28	8	22	no						
29	7	20	no						
30	9	24	no						
31	11	31	yes						

32	7	22	yes						
33	7	21	yes						
34	7	22	yes						
35	6	20	yes						
36	6	19	yes						
37	6	18	yes						
38	6	17	yes						
39	6	18	yes						
40	6	18	yes						
41	5	16	yes						
42	5	16	yes						
43	6	17	no						
44	7	20	no						
45	6	19	no						
46	6	18	no			yes			
47	7	22	no			yes			
48	7	20	no						
49	6	19	no						
50	5	17	no						
51	9	28	yes			yes	yes		
52	8	26	yes			yes	yes		
53	9	31	yes				yes		
54	8	27	yes				yes		
55	6	16	no			yes	yes		
56	7	19	no			yes			yes
57	6	17	no			yes			yes
58	8	23	yes			yes			yes
59	7	19	yes			yes			yes
60	7	21	yes			yes			yes
61	6	18	yes			yes			yes
62	7	21	yes						
63	7	19	yes						
64	6	18	yes						
65	6	11	yes	yes					
66	6	16	yes						
67	7	16	yes						
68	7	23	yes			yes			
69	6	17	no			yes			
70	6	17	yes			yes			
71	5	14	yes	yes		yes			
72	6	18	yes			yes			

73	6	17	yes			yes			
74	8	32	no						
75	7	24	no						
76	5	14	no	yes					
77	5	17	no	yes					
78	5	18	no	yes					
79	5	18	no	yes					
80	6	26	no	yes					
81	5	15	no	yes					
82	6	16	no	yes					
83	6	18	no	yes					
84	5	16	no	yes					yes
85	6	15	no	yes					
86	6	17	no	yes					
87	6	16	no	yes					yes
88	6	17	no	yes					
89	5	15	no	yes					
90	6	17	no	yes					
91	5	16	no	yes					
92	6	16	no	yes					
93	6	15	no	yes					
94	6	16	no	yes					
95	8	27	yes						
96	8	15	no	yes					
97	8	18	no						
98	8	14	no	yes					
99	8	14	no	yes					
100	8	11	no	yes					
101	8	20	yes						
102	8	17	no						
103	8	16	no	yes					
104	8	16	no	yes					
105	8	17	no						yes
106	8	16	no	yes					yes
107	8	16	no	yes					
108	8	16	no						
109	8	15	no	yes					
110	8	14	no	yes					
111	8	17	no						
112	8	16	no						
113	8	15	no	yes					

114	8	17	no						yes
115	8	17	no						
116	8	16	no						
117	8	16	no						
118	8	16	no						
119	5	16	no						
120	6	18	no						
121	6	24	no						
122	6	19	no						
123	5	15	no						
124	5	16	no						
125	5	14	no	yes					
126	5	15	no	yes					
127	5	14	no	yes					
128	6	14	no	yes					
129	6	15	no	yes					
130	6	14	no	yes					
131	7	25	no						
132	7	25	no						
133	6	20	yes						
134	6	19	yes						
135	6	19	yes						
136	6	18	yes						
137	6	20	yes						
138	6	21	yes						
139	5	16	yes						
140	6	22	yes						
141	5	19	yes						
142	5	18	yes						
143	6	22	yes						
144	6	21	yes						
145	6	21	yes						
146	6	20	yes						
147	6	19	yes						
148	5	18	yes						
149	5	18	yes						
150	6	19	yes						
151	6	20	yes						
152	6	21	yes						
153	6	20	yes						
154	6	20	yes						

155	5	19	yes						
156	5	18	yes						
157	5	17	yes						
158	5	17	yes						
159	6	18	yes						
160	6	19	yes						
161	7	22	yes						
162	7	21	yes						
163	7	23	yes						
164	7	21	yes						
165	6	20	yes						
166	6	19	yes						
167	6	18	yes						
168	6	18	yes						
169	6	18	yes						
170	6	18	yes						
171	6	19	yes						
172	6	20	yes						
173	6	17	yes						
174	6	17	yes						
175	5	16	no						
176	5	15	no						
177	5	16	no						
178	7	20	yes						
179	7	19	yes						
180	7	19	yes						
181	7	22	yes						
182	6	17	no						
183	5	16	no						
184	7	23	yes						
185	7	19	yes						
186	7	19	yes						
187	7	20	yes						
188	7	21	yes						
189	7	20	yes						
190	7	18	yes						
191	7	17	yes						
192	7	18	yes						
193	7	19	yes						
194	7	20	yes						
195	7	20	yes						

196	7	20	yes						
197	6	21	yes						
198	6	17	yes						
199	7	22	yes						
200	6	16	yes						
201	6	19	yes						
202	6	17	no						
203	7	23	yes						
204	6	14	no						
205	7	24	yes						
206	6	17	no						
207	6	18	no						
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227	6	17	no						
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229	6	14	no						
230	6	14	no						
231	6	16	no						
232	6	17	no						
233	6	16	no						
234	6	18	yes						
235	6	16	no						
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237	6	17	no						
238	6	19	yes						
239	6	16	no						
240	6	16	no						
241	5	15	no						
242	5	17	yes						
243	5	18	yes						
244	6	18	yes						
245	5	16	yes						
246	5	15	no						
247	6	15	no						
248	5	16	no						
249	6	19	yes						
250	6	20	yes						
251	6	21	yes						
252	5	13	no	yes					
253	8	28	yes						
254	6	17	yes						
255	7	24	yes						
256	6	17	yes			yes			
257	6	20	yes			yes			
258	6	19	yes			yes			
259	7	22	yes						
260	7	24	yes						
261	7	23	yes						
262	7	18	yes						
263	7	18	yes						
264	7	19	yes						
265	7	20	yes						
266	7	21	yes						
267	6	17	yes						
268	6	15	no						
269	6	18	yes						
270	6	19	yes						
271	7	21	yes						
272	7	22	yes						
273	7	23	yes						
274	6	19	yes			yes			
275	6	18	yes			yes			
276	7	19	yes			yes			
277	7	19	yes			yes			

278	6	20	yes			yes			
279	6	21	yes						
280	6	20	yes						
281	5	19	yes						
282	5	18	yes						
283	6	18	yes						
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285	6	20	yes						
286	6	20	yes						
287	6	21	yes						
288	6	23	yes						
289	6	20	yes						
290	6	20	yes						
291	6	20	yes						
292	6	19	yes						
293	6	19	yes						
294	6	18	yes						
295	6	20	yes						
296	6	20	yes						
297	6	20	yes						
298	6	19	yes						
299	8	29	yes						
300	6	16	yes						
301	7	19	yes						
302	6	18	yes						
303	6	18	yes						
304	7	20	yes						
305	7	21	yes						
306	7	18	yes						
307	7	22	yes						
308	7	21	yes			yes			
309	7	22	yes			yes			
310	7	29	yes						

Annex II

Pictures taken during the research in order to prepare this conservation plan

16. Literature

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