

Bosnian pine

Pinus heldreichii syn. *Pinus leucodermis*

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These Technical Guidelines are intended to assist those who cherish the valuable Bosnian pine genepool and its inheritance, through conserving valuable seed sources or use in practical forestry. The focus is on conserving the genetic diversity of the species at the European scale. The recommendations provided in this module should be regarded as a commonly agreed basis to be complemented and further developed in local, national or regional conditions. The Guidelines are based on the available knowledge of the species and on widely accepted methods for the conservation of forest genetic resources.

Biology and ecology

Bosnian pine (*Pinus heldreichii* H. Christ. (1863) syn. *Pinus leucodermis* Ant. (1864)) is characterized by the colour and texture of its very thick bark: ash-grey in young trees, becoming ridged and furrowed with yellowish-brown flattened and angular patches in adult trees. The bark is white on twigs. Winter buds are non-resinous and ovoid or oblong in shape. The buds are reddish brown with silvery margins on the brown scales. Secondary leaves (needles) are borne in fascicles of two and persist for 5–6 years. Needles are denticulate, 6–9 cm long with acute apex and stomatal lines on both upper and lower sides.

Bosnian pine is monoecious; inconspicuous female and male flowers are borne in conelets on

the same tree. Male catkins are yellow-brown and female conelets reddish. Woody female cones mature in two years. They are sessile or on short peduncles, usually isolated but sometimes in groups of two or three. Catkins are 5–9 cm long and 2.5 cm wide, with soft and brittle flattened scales. Seeds are grey, 5–7 mm long with a 25–30 mm long wing. Seed production begins at 15–20 years of age, typical of pines.

Bosnian pine reaches a height of 30–35 m and a diameter of 150 cm. The tree is very frost-hardy.

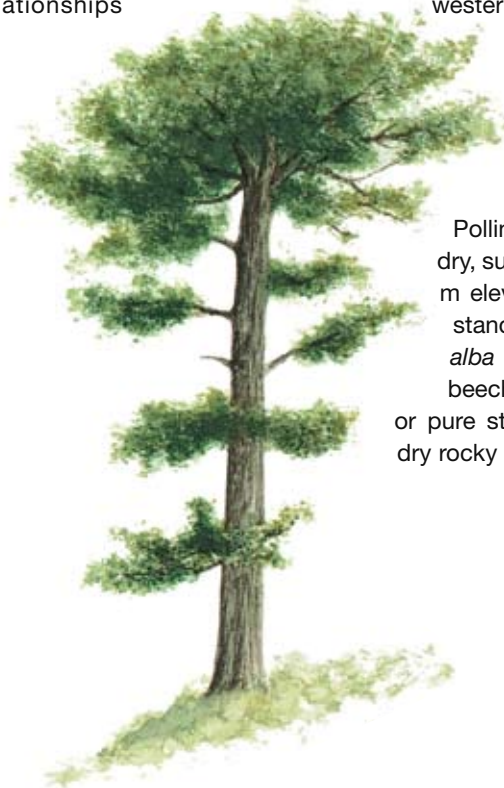
Bosnian pine has demonstrated low susceptibility to insect attacks. However, it can be seriously damaged by sawflies (Hymenopterae). Others include bark beetle (*Pityogenes bidentatus* Herbst.), European pine shoot moth (*Rhyacionia buoliana* Denis & Schiffmüller) and pine processionary caterpillar (*Thaumetopoea pityocampa* Schiff.). Fungal attacks by *Heterobasidion annosum* ((Fries) Brefeld) have also been observed to cause damage.



Pinus heldreichii

Distribution

Together with the mountain pines (*P. mugo* Turra and *P. uncinata* Mill. ex Mirb.), Bosnian pine is one of the high-elevation pines of the Mediterranean Basin. The systematic and phylogenetic relationships



between the Italian and Balkan populations are unclear. Some authors, on the basis of morphological traits (height, characteristics of the bark, twig and foliage colour), suggest that the populations represent two different species, *P. leucodermis* and *P. heldreichii*. Other authors consider all populations to be-

long to the same species or that *P. leucodermis* is a variety of *P. heldreichii*.

Pinus heldreichii is found only in the western Balkan peninsula (Albania and Greece) at 1000–2500 m elevation, reaching the Alpine timberline. *Pinus leucodermis* occurs in the central-western part of the Balkan peninsula (including Bosnia, Serbia, Montenegro and Bulgaria), and in the southern Italian Apennines (Monte Pollino), where it occupies dry, sunny sites at 900–2300 m elevation, forming mixed stands with silver fir (*Abies alba* Mill.) and European beech (*Fagus sylvatica* L.) or pure stands on steep and dry rocky southern slopes.

Importance and use

The main value of Bosnian pine is as an ornamental and landscape tree rather than as timber species. However, its wood can be used for general construction.

The species shows a great adaptability to extreme environmental conditions and a great colonising potential, making it suitable for reforestation of extensive dry areas. It is also resistant to sulphur dioxide, hydrogen fluoride, nitrogen dioxide and ozone pollution. Due to its ability to withstand wind, ice and heavy snow, the species is also used for high-altitude reforestation.

Planting is commonly carried out using 3-year-old seedlings. Bosnian pine is planted in the south of Italy not only because of its adaptability to high-altitude conditions, but also because it is less susceptible to pests than other pine species (e.g. it is resistant to the *Diplodia* tip blight that so seriously affects black pine (*Pinus nigra* Arnold)).



syn. *Pinus heldreichii* syn. *Pinus leucodermis* **Bosnian pine** *Pinus heldreichii* syn. *Pinus leucodermis*

Genetic knowledge

Genetic analyses using molecular markers have revealed that the Italian and Greek populations belong to the same genetic lineage. The divergence measured among Italian stands (peripheral populations) was as large as that measured between Italian and Greek stands, although they have been separated for more than 15 000 years. *Pinus leucodermis* and *P. heldreichii* should thus be considered as one species with populations that evolved separately.

The Italian populations were found to have lower levels of genetic diversity and a smaller effective population size than the Greek populations. In Italy, the stands are

small and isolated; this has probably promoted loss of diversity through random genetic drift and mating among relatives. Loss of diversity may have been further increased by a relatively high level of selfing (estimated to be 30% in some Italian populations). This high level of selfing was found to occur both in natural populations and in planted stands, where tree density is higher and neighbourhood structures less pronounced. Bosnian pine is a pioneer species; a relatively high level of self-fertilisation may represent a selective advantage, particularly when pollen is in short supply such as during the early stages of recolonisation when population size is small and density low. This strategy could be of particular importance after fires, which occur often in the Italian part of the distribution range.

Threats to genetic diversity

Bosnian pine is included in the IUCN Red List of threatened species, although as a low risk entry. However, the natural distribution of Bosnian pine is currently very limited and fragmented, mostly because of forest fires.

The Italian natural range is restricted to five small and separated stands. As a consequence of fragmentation and subsequent reduced gene flow and increased genetic drift leading to low effective population size, at least three of these populations are susceptible to losing a considerable amount of diversity over the coming generations.



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Guidelines for genetic conservation and use

The main strategy adopted so far for the conservation of this species is linked with national parks and other protected areas. In Bulgaria for example, Bosnian pine is conserved in the Pirin National Park (where a 1200-year-old tree has been recorded) and in the Slavyanka Biosphere Reserve which includes the largest Bosnian pine habitat on the Balkan Peninsula. In Albania, 159 ha of *P. heldreichii* are located within national parks and recently established integrated nature reserves. In Italy, Bosnian pine is conserved in the Pollino National Park and Serbia has three natural reserves for the species. Throughout the former Yugoslavian republics, Bosnian pine is a protected species.

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.

Designating *in situ* gene conservation units where appropriate forest management strategies are used is an efficient way

of conserving the genetic resources of a target species, while making evolutionary changes possible over time. Genetic diversity and adaptability can be conserved from one generation to the next by conserving sufficiently large populations of locally adapted trees and allowing natural regeneration from a large-enough number of parents. 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.

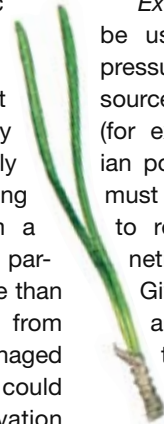
Exotic or unknown Bosnian pine material should not be grown within the remaining stands or in their vicinity. Natural regeneration should be closely monitored and assisted by sowing locally collected seeds if needed.

Bosnian pine also needs to be protected from two common man-made disturbances: forest fires and over-grazing. The Italian populations are under a particularly intense threat from both. Fires can cause rapid and drastic reduction of the population size by killing adult trees with consequent losses in seedling genetic diversity and adaptive potential. Intensive grazing prevents

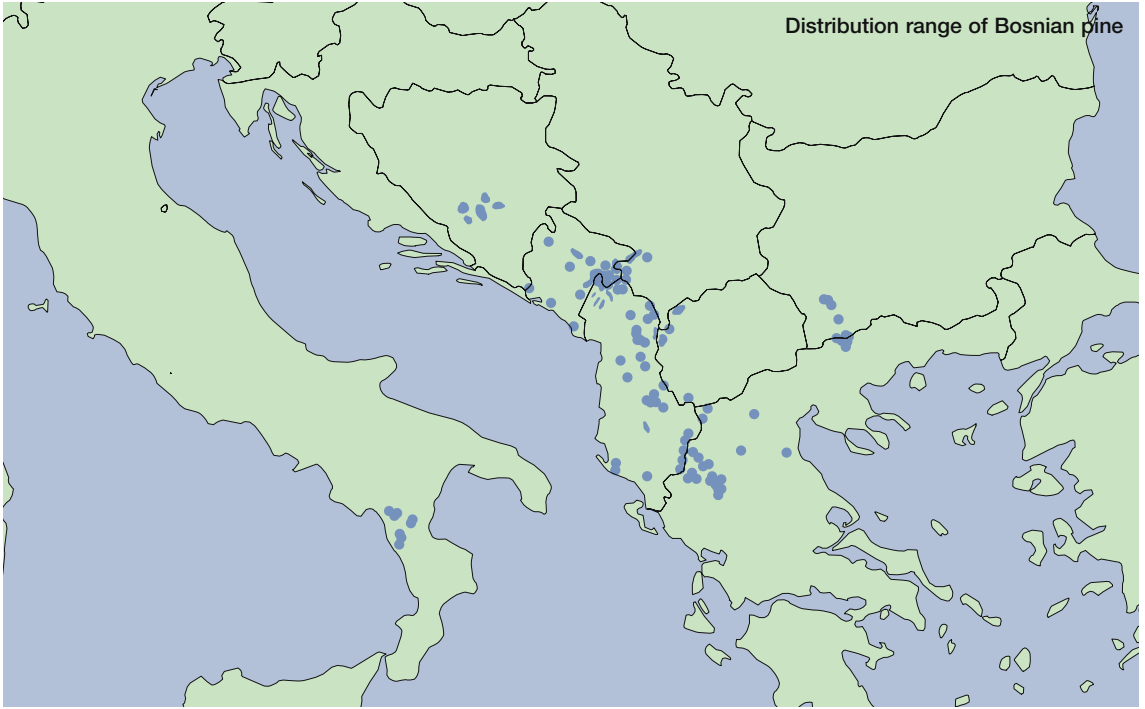
natural regeneration and may also lead to local extinction when adult trees die.

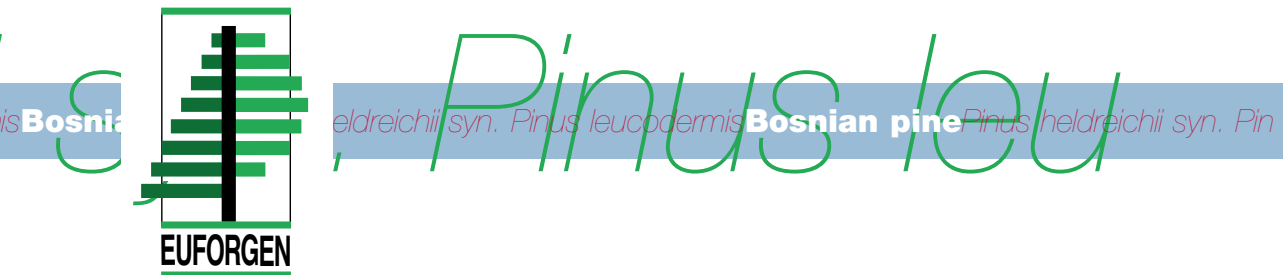
Ex situ conservation should be used if forests are under pressure or if their genetic resources are of particular interest (for example the marginal Italian populations). *Ex situ* stands must be established with care to represent the original genetic diversity of a population.

Given the high inbreeding and low outcrossing rates of this species, ideally seeds should be collected from a large number of trees (approx. 100) and from trees growing at least 100 meters apart. Ecological conditions of the *ex situ* conservation site should be comparable to those of the original sites, possibly with lower environmental stress. Such an *ex situ* collection exists in southern Italy (Pollino mountain, Calabria), covering approximately 60 hectares.



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The series of these Technical Guidelines and the distribution maps were produced by members of the EUFORGEN Networks. The objective is to identify minimum genetic conservation requirements in the long term in Europe, in order to reduce the overall conservation cost and to improve the quality of standards in each country.

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