European black pine

Pinus nigra

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These Technical Guidelines are intended to assist those who cherish the valuable European black 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

The European black pine (*Pinus nigra* Arnold) grows up to 30 (rarely 40–50) m tall, with a trunk that is usually straight. The bark is light grey to dark grey-brown, deeply furrowed longitudinally on older trees. The crown is broadly conical on young trees, umbrella-shaped on older trees, especially in shallow soil on rocky terrain. Branch tips are slightly ascending on young trees; on older trees only branches at the top part of the crown have upturned tips. Needles are rather stiff, 8–16 cm long, 1–2 mm in diameter, straight or curved, finely serrated. Resin ducts are median. Leaf sheath is persistent, 10–12 mm long.

Black pine is a monoecious wind-pollinated conifer, and its seeds are wind dispersed. Flowering occurs every year, although seed yield is abundant only every 2–4 years. Trees reach sexual maturity at 15–20 years in their natural habitat. Flowers appear in May. Female inflorescences are reddish, and male catkins are yellow. Fecundation occurs 13 months after pollination. Cones are sessile and horizontally spreading, 4–8 cm long, 2–4 cm wide, yellow-brown or light yellow and glossy. They ripen from September to October of the second year, and open in the third year after pollination. Cones contain 30–40 seeds, of which half can germinate. Seeds are grey, 5–7 mm long, with a wing 19–26 mm long. Germination can occur without stratification although this technique is often used in forest nurseries (30–60 day moist +5°C treatment). Black pine is an obligate seeder under natural conditions.

Most black pine subspecies (see Distribution) grow in a Mediterranean-type climate, except *P.n. nigra* which is more typically temperate. Bioclimatic conditions range from humid (800–1000 mm annual rainfall) as

in *P.n. mauretanica* or *P.n. laricio*, to subhumid (600–800 mm) as in *P.n. pallasiana* in Cyprus, to semi-arid (400–600 mm) as in *P.n. pallasiana* in Anatolia.

The optimal altitudinal range of black pine is between 800 to 1500 m. However, a considerable altitudinal variation can be observed: from 350 to 1000 m in Italy (*P.n. nigra*) and on the Croatian coast (*P.n. dalmatica*), from 500 to 900 m in the French Pyrenees and 1600 to 2000 m in Spain (*P.n. salzmannii*), from 1000 to 1600 m in Corsica (*P.n. laricio*), from 1000 to 2200 m in the Taurus mountains and 1400 to 1800 m in Cyprus (*P.n. pallasiana*) and from 1600 to 1800 m in North Africa (*P.n. mauretanica*).

Black pine can grow on a variety of substrates: limestone (e.g. *P.n. mauretanica*, *P.n. dalmatica*, *P.n. pallasiana* in Central Greece), dolomites (e.g. *P.n. nigra* in northern Italy and Austria, *P.n. salzmanni* in the Cévennes, France), acidic soils (*P. n. laricio*, *P.n. pallasiana* in Anatolia, *P. n. salzmanni* in the French Pyrenees) or volcanic soils (*P.n. laricio* in Sicily).

Black pine is a light-demanding species, intolerant of shade but resistant to wind and drought. It grows in pure stands or more rarely in association with other pines such as *P. sylvestris* or *P. uncinata.*

Distribution

Black pine extends over more than 3.5 million hectares from western North Africa through southern Europe to Asia Minor. Owing to this large albeit discontinuous range and its large genetic and phenotypic variability, it is regarded as a collective species. Although there is no definite consensus on its taxonomy, six main subspecies can be recognized from North Africa to the Crimea.

Pinus nigra mauretanica (Maire et Peyerimh.) Heywood covers only a few hectares in the Rif mountains of Morocco and the Djurdjura mountains of Algeria.

Pinus nigra salzmannii (Dunal) Franco (syn: *P. n. clusiana*, *P. n. pyrenaica*) covers extensive areas in Spain (over 350 000 ha from Andalucia to Catalunia and on the southern slopes of the Pyrenees) and is found in a few isolated populations in the Pyrenees and Cévennes in France. It is sometimes referred to as the Pyrenean pine.

Pinus nigra laricio (Poiret) is found in Corsica (Corsican pine) over 22 000 ha, in Calabria (where it is also recognized as *P. n. l. calabrica*, the Calabrian pine) and in Sicily.

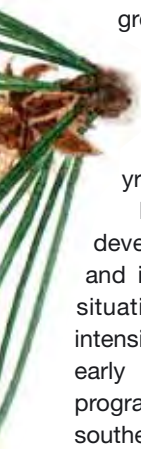
Pinus nigra nigra (syn: *P.n. austriaca* Höss, *P.n. nigricans* Host, the Austrian pine) is found from Italy in the Apennines to northern Greece through the Julian Alps and the Balkan mountains, covering more than 800 000 ha.

Pinus nigra dalmatica (Vis.) Franco, the Dalmatian pine, is found on a few islands off the coast of Croatia and on the southern slopes of the Dinaric Alps.

Pinus nigra pallasiana (Lamb.) Holmboe covers extensive areas, mostly in Greece and Turkey (2.5 million ha, 8% of total forest area) and possibly as far west as Bulgaria. It can also be found in Cyprus and the Crimea. It is sometimes referred to as the Crimean pine.

Importance and use

Black pine is one of the most economically important native conifers in southern Europe. Early growth is rather fast. It is widely planted outside its natural range. Wood is durable and rich in resin, easy to process. *P.n. laricio* is appreciated for building and roofing because of its straightness and thin branches. If properly thinned, its low amount of duramen makes it a fine carpentry and cabinetry wood. The same use can be made of Calabrian pine, although it is more branchy. Wood of *P.n. nigra* is of lower quality and thus restricted to lower-grade building wood and the making of crates. Black pine has a mean productivity of 8–20 m^3 ha^{-1} yr^{-1} when grown as a monoculture on fertile soils. In natural conditions, productivity is 6–10 m^3 ha^{-1} yr^{-1} and down to less then 3 m^3 ha^{-1} yr^{-1} on the driest sites.



Because of its ability to develop well on open lands and in ecologically demanding situations, Austrian pine was intensively used during 19th and early 20th century reforestation programmes, e.g. in the French southern Alps for landslide control and land rehabilitation and in England and the USA for sand-dune fixation and as a windbreak. Currently *P.n. laricio* is the most important reforestation species in southern England as well as in some French regions (e.g. Loire valley).

Black pine is also valued for landscaping, both in parks (isolated trees or in groups) and in urban and industrial contexts because of its tolerance to pollution. It is one of the most common introduced ornamentals in the USA. Other uses include Christmas trees, fuel wood and poles.

Black pine is included in the European Council Directive 1999/105/CE (December 22 1999) on the marketing of forest reproductive material. Minimum requirements have to be met before black pine seed can be sold for reforestation.

Genetic knowledge

The first black-pine-type fossils date to the Miocene, about 20 million years ago. The ice cycles that shaped the Quaternary period in Europe are believed to have been responsible for the currently very discontinuous range of black pine. This geographic separation did not result in mating barriers, and all subspecies are interfertile under experimental conditions. Studies using morphological and genetic markers have confirmed the common phylogenetic origin of all black pines. The most divergent and genetically original European groups are *P.n. salzmanii* and *P. n. laricio,* although *P.n. nigra, dalmatica* and *pallasiana* appear quite similar. The amount of genetic diversity is also high within populations. Experiments measuring adaptive traits have revealed strong within- and among-population variability for traits such as vigour, form and drought, frost and disease resistance. It is this huge adaptive plasticity that has made black pine such a favourite for reforestation projects over a wide range of environments.

In the middle of the 20th century, several provenance trials were established independently in Europe, the USA and New Zealand. The Corsican and Calabrian black pine provenances were found to be the best in almost every respect on siliceous soils. They had consistently

excellent stem form and branching habit, gave the greatest volume production and were hardy against winter and late frosts (except in north-central USA). The major defect reported is branch forking, which is both heritable and highly correlated with polycyclism and branch angle. On calcareous soils, *P.n. laricio* does not perform well and is to be replaced by the slower-growing but more Ca-tolerant *P.n. nigra*. In dry climates (as in inner Anatolia, Turkey), black pine is slow growing and breeding programmes for such zones are focused on improving growth rate and increasing drought and frost tolerance through within-population selection.

Intraspecific hybridization is easily performed among all black pine subspecies (a further proof of phylogenetic relatedness), but has not contributed any outstanding genotypes to breeding programmes so far. Interspecific crosses seem to be possible at a low survival rate with *P. sylvestris*.

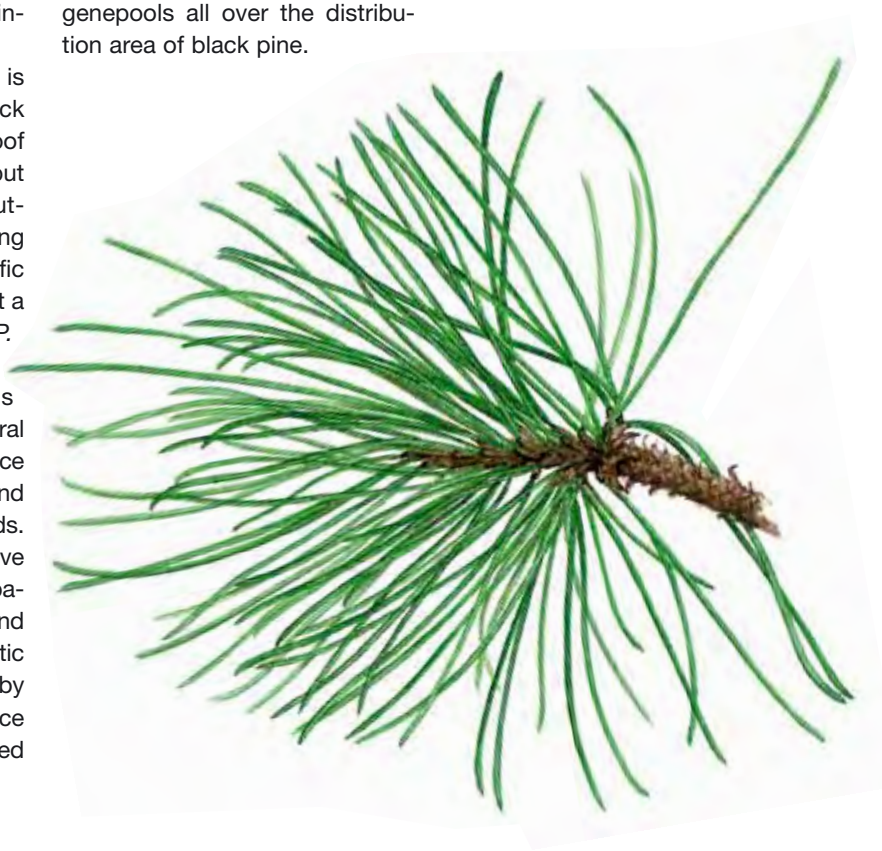
Black pine seed orchards have been established in several European countries, e.g. in France there are one Calabrian pine and two Corsican pine seed orchards. Current experiments in vegetative propagation include micropropagation of zygotic embryos and brachyblasts as well as somatic embryogenesis. Propagation by grafting has been known since 1820; the method generally used is lateral grafting.

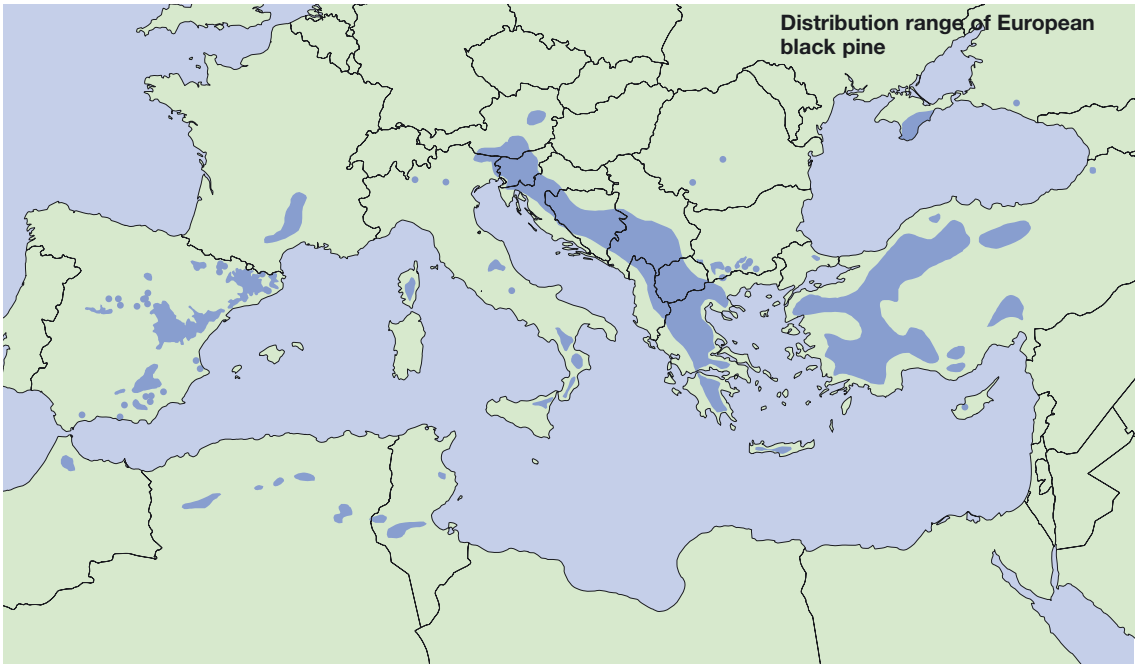
Threats to genetic diversity

Black pine is not recognized as a threatened species although some of its sub-Mediterranean endemic populations constitute priority habitats under the EU Natura 2000 directive (Habitat Directive n° 92/43/CEE, May 21 1992).

Extensive plantations were often made across Europe in the past two centuries with material from unknown and/or very distant sources for which no historical traces currently exist. This has probably resulted in extensive mixing of local and imported genepools all over the distribution area of black pine.

Damaging insects include European black pine shoot moth (*Rhyacionia buoliana*), pine processionary caterpillar (*Thaumetopoea pityocampa*), especially in warm and dry climates, and tip blight (*Sphaeropsis sapinea*), which has been particularly active in France and Turkey in 1990's. Other pests such as *Acantholyda hieroglyphica, Diprion pini*, *Pissodes validirostis* and *Monophlebus hellenicus* have been active in Turkey. Most recently, an increase in the impact of a needle blight known as the 'red band disease' (*Dothistroma septospora*) has been reported.





In areas where black pine is widespread and very important for forestry, factors such as forest fires and illegal cutting cause serious damage. In areas where it occurs in small isolated populations, major risks come from any factor that may provoke local extinction, either through illegal cutting and fires or through hybridization ('genetic pollution') from planted black pines belonging to other subspecies. Original and rare varieties such as *P. nigra* var. *pyramidalis* or *P. nigra* var. *sheneriana* in Turkey are under identical threats.

Guidelines for genetic conservation and use

Because black pine of different origins has been extensively planted, it is now important to identify authochthonous populations. This undertaking should be carried out at the international level. In each country, an inventory should be made to define the geographical distribution of the species, its conservation status, threats and potential uses. Breeding activities provide valuable information by defining potential plantation, seed collection and transfer zones. *In situ* conservation activities should be encouraged separately as seed stands and gene conservation forests. Those do not serve the same goal and should not always be identical, especially to make the conservation of marginal populations possible. An international *in situ* network of 100–120 stands would seem appropriate to represent the natural ecological and genetic variability of black pines.

As intraspecific hybridization is easy among black pines, exotic or improved black pines should not be planted in the vicinity of autochthonous and naturalized stands. This is particularly true for localized and fragmented sub-

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These Technical Guidelines were produced by members of the EUFORGEN Conifers Network. The objective of the Network 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.

species such as *P.n. laricio*, and is of extreme importance for subspecies that are threatened, such as *P.n. salzmanii* in France and *P.n. mauretanica* in North Africa. For these subspecies and other varieties of rare occurrence, *ex situ* conservation is appropriate and urgent. As a step in that direction, in 1999 a gene conservation forest was selected in Turkey for the rare *P. nigra* var. *pyramidalis*.

Information on the provenance and progeny trials established throughout Europe should be entered in a database. This network of experimental sites could be used for *ex situ* conservation of black pine. Marginal areas might need to be further sampled to strengthen this network and possibly planted as *ex situ* seed orchards to re-install depleted resources.

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