Maritime pine

Pinus pinaster

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

Maritime pine (*Pinus pinaster* Aiton) morphologically is similar to other species of the genera. The species display several adaptations to forest fires: early flowering (in some populations cones can be observed in 4-year-old seedlings), presence of serotinous cones, and a thick bark. Compared with other Mediterranean pines, Maritime pine has large cones (8-22 cm long) usually in groups of 2 or 3, and long needles (10-25 cm). Clear morphological differences exist among the different populations, resulting in the subdivision of the species into two subspecies (*atlantica* and *pinaster*), and into several geographical races (atlantica, mesogeensis, corteensis, maghrebiana, renoui, etc.), but a complete revision of the species does not exist.

The species can be found in quite different environments: from sea level to 2100 m elevation in the High Atlas (Morocco); from areas with more than 1400 mm of annual rainfall and no dry season, to others with 350 mm and more than 4 dry months. The soil conditions are variable; mainly in acid soils, but also in basic soils and even in sandy and poor soils, where not many commercial species can grow.

Distribution

Maritime pine is a broadly distributed conifer in the western Mediterranean Basin, in Southern Europe and Africa, and the Atlantic coast in Portugal, Spain and France. The island distribution of the species is limited to Corsica, and to a very limited extent, northern Sardinia. There is a marginal stand in Pantelleria island, close to the Tunisian shore. Two main factors have affected the present natural distribution of the species, resulting in a high degree of fragmentation: the discontinuity and altitude of the mountain ranges causes isolation of even close populations, and the human impact.

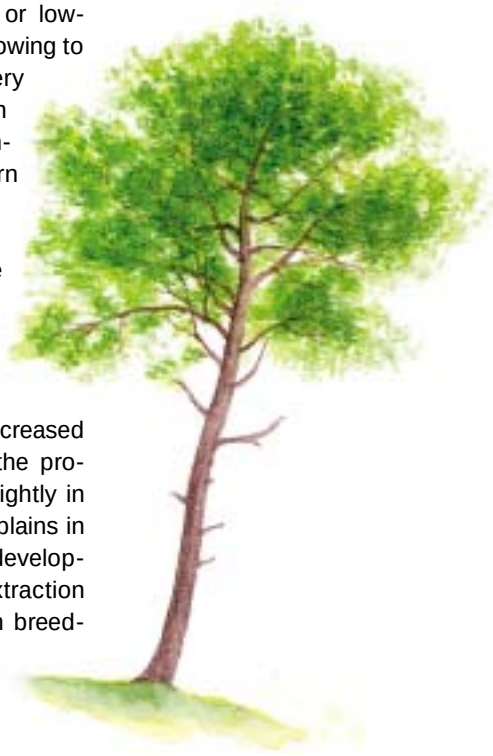
At present, the species is broadly distributed by forestation in different countries (within and outside the natural range). The differentiation of autochthonous and non-autochthonous stands is, in many cases, controversial. We can find regions with either a large or a limited human impact. This combination presents a unique opportunity to understand some aspects of forest management and its impact on the genetic resource conservation of broadly distributed conifers.

Importance and use

Maritime pine is one of the most important forest species in France, Portugal and Spain. The main uses of the species are related to wood and resin production, recreation and soil protection. It can be considered a fast-growing species (especially in the Atlantic region where rotation ages of 40-50 years are common). The main uses in these regions are pulp and paper production, construction, chipboards, floor boards and palettes. In the other regions, the rotation ages vary from 80 to 120 years, and trees produce either high-quality (Corsica, some mountains areas in Central Spain), or low-quality timber, especially owing to the existence of very crooked trees (Castillian plains and several southern populations in southern Spain).

One of the most traditional uses of the species is resin tapping. Maritime pines produce resin of high quality. The importance of this product has decreased over time, but recently the production has increased slightly in some regions (Castillian plains in Spain, Portugal). The development of new tools and extraction methods, combined with breeding programmes, could be of importance for this product.

The ability of the species to grow in very poor soils, and under prolonged drought, is one of the reasons for its use in afforestation programmes for wood production or soil protection.

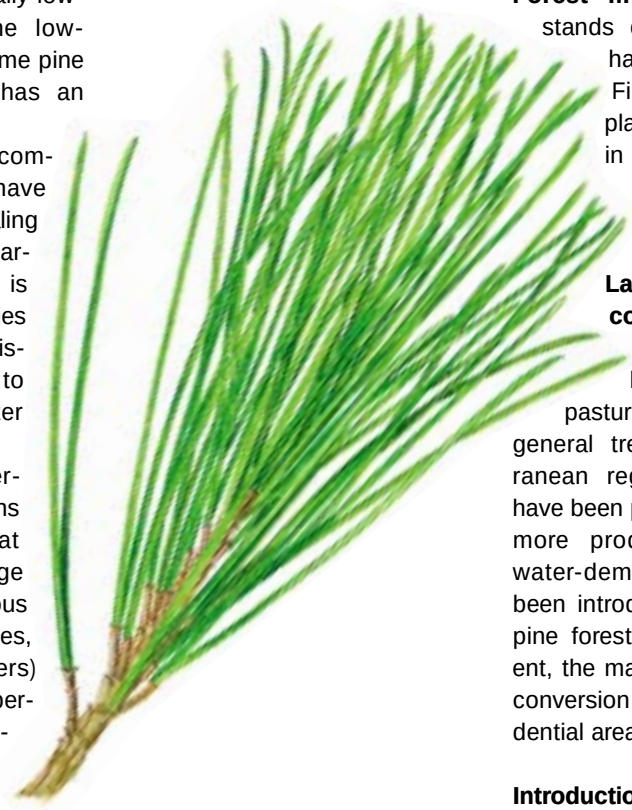


Genetic knowledge

Coniferous forest trees are wind-pollinated and typically have high proportions of outcrossed progeny (>0.80). In Mediterranean forests, pollen gene flow could be great owing to generally low-density stands and the low-fertility soils where Maritime pine grows. Maritime pine has an important genetic load.

Because of its high commercial value, there have been many studies dealing with the genetics of Maritime pine. This species is one of the model species used worldwide for the discovery of genes related to wood quality and water stress resistance.

Large genetic differences among populations have been reported at regional and wide-range spatial scales using various genetic markers (terpenes, isozymes, DNA markers) and common garden experiments. Especially important is the large genetic variation found between provenances in traits of importance for the adaptation of the species (drought and frost tolerance, insect resistance) and others of large importance for the use of the species (growth, stem form, polycyclism, branching habit). In general, clear geographic areas can be defined in terms of genetic diversity using different types of genetic markers, and within these areas, different adaptations are found. A clear geographic structuration of the diversity is found with the different genetic markers and adaptive traits.



Threats to genetic diversity

The main threats to the genetic diversity in maritime pine are similar to those of other Mediterranean species.

Forest fires. Mainly isolated stands or small populations have been affected. Fires have traditionally played an important role in modeling the genetic architecture of the species.

Land uses and plant cover changes. Transformation of forest land to agricultural or pasture areas has been a general trend in the Mediterranean region. Forest stands have been ploughed to introduce more productive species, or water-demanding crops have been introduced close to some pine forests. However, at present, the main threat comes from conversion of forested to residential areas.

Introduction of exotic species or genomes. Hybridization of maritime pine with other species is quite limited. The main threat is the introduction of material from exotic provenances close to natural populations. Because of advanced breeding programmes, selected material is widely planted in some countries (e.g. France).

Pollen flow in this species is quite extensive and could impact local resources, leading to loss of local adaptivity, for example in sand dune areas where *P. pinaster* has a very important ecological role against habitat destruction by wind and waves.

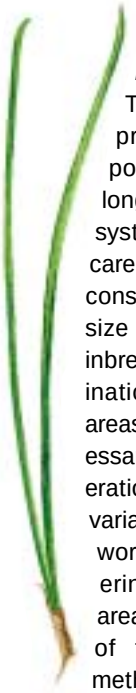
Overexploitation. There is little information on the effect of silvicultural practices on the genetic resources of the forest species. In conifers, the effect seems to be of scant importance under normal forestry practices. The adoption of criteria and indicators of sustainable forest management in most European countries would diminish the importance of this factor in the near future.

Global climatic change. Most of the models predict a reduction and changes in the pattern of rainfall in the Mediterranean area, where *P. pinaster* is mainly found. We can expect a shift northward in its range, leading to changes in pollen flow, seed dispersal, recolonization dynamics and new possibilities for gene exchange with resources from breeding programmes.

Pests and diseases. A good example is the reduction in the natural area of Maritime pine in the Southern French Maures and Esterel mountain regions, caused by *Matsococcus feytaudy*. This insect caused the destruction of approx. 200 000 ha of *P. pinaster* forests in the 1960s. Resistant material, both local and from Spain and Morocco, is currently tested to understand the genetic determinism of the resistance and to reintroduce the resource. The presence of a nematode (*Bursaphelenchus xylophilus*) in Portugal is a risk not completely evaluated until now.

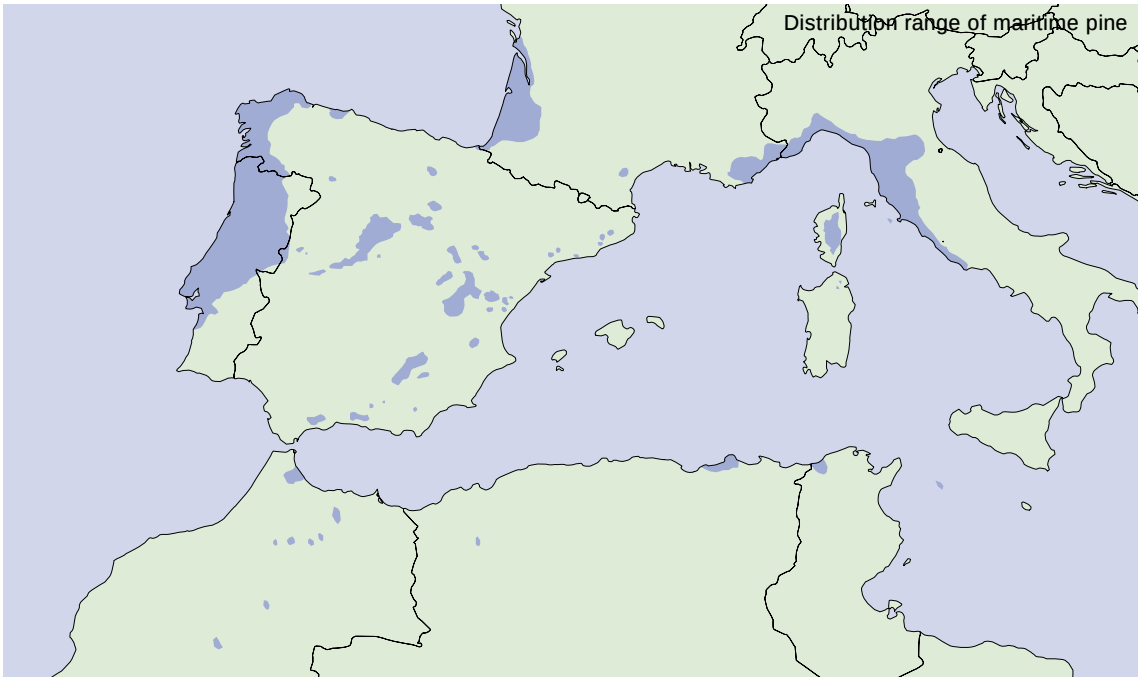
Guidelines for genetic conservation and use

Seed source selection. Taking into consideration the important differences in growth, stem form and adaptation of the different populations, seed source selection has to be carefully analyzed based on the results of provenance trials. Selection is dependent on the main objective of the plantation (protection, wood production, etc.), and in most countries descriptions of the base material are available to assist in selecting the most suitable for afforestation.



***In situ* conservation areas.** These are the best means of preserving the adaptive potential of the species in the long term. Given the breeding system of the species, special care has to be taken to establish conservation stands of sufficient size to reduce the effect of inbreeding and external contamination. As in other conifers, areas greater than 20 ha are necessary to ensure enough regeneration to maintain the genetic variability of the species. A network of conservation areas covering the most contrasting areas in the distribution range of the species would be a method to preserve the natural stands of the species.

***Ex situ* conservation.** This form of conservation is based on different activities, such as clonal



banks, seed banks and plantations using seeds from the threatened populations. Clonal banks are mainly used in populations with large economic (or ecological) value. Seed banks are very effective methods of preserving the adaptiveness of the target populations, because of the heavy seed production in Maritime pine, and the possibility of conserving the seed (or pollen) for a prolonged period of time.

At present there are many activities in different countries that could be considered as a starting point for the conservation of the species.

EUFORGEN

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.

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