European larch

Larix decidua

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

European larch (*Larix decidua* Mill.) is one of the few deciduous conifers. It is monoecious and wind pollinated. Larch pollen is small and round without air bags. As a result it is transported by the wind over only relatively short distances of up to 300 m.

Larch trees reach sexual maturity at the age of 15 years in open stands but at the age of 35–40 years in closed stands. Larch produces seeds every 3–4 years on average. Over 50% of larch seed may be 'empty'. *Larix decidua* can easily cross with some other larch species, such as Japanese larch (*Larix kaempferi (Lamb.) Carr.* with which it produces very valuable hybrids.

Larch is a typical pioneer, colonizing open land on freshly disturbed soils. As a light demanding species, larch does not compete well with other trees. Larch species establish enduring and close stands only when climatic conditions eliminate their competitors, such as in the mountains. In the Alps, European larch grows best at an altitude of 1400–1500 m, but faces strong competition from other species that also grow well at this altitude, e.g. silver fir (*Abies alba* Mill.)and Norway spruce (*Picea abies* (L.) Karst). At higher altitudes larch grows less vigorously but faces less competition from other species. At elevations above 1500m, up to more than 2000 m, larch forms closed pure stands. In the Tatra Mountains, larch does not form extensive pure stands but grows in compact clumps where local conditions do not favour the growth of Norway spruce.

Larch grows on a wide range of soils. It grows best on deep, well-structured and aerated soils, but can also grow on shallow stony soils, including calcareous soils, with a medium ground water level.

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Distribution

European larch is a central European species occurring mostly in mountainous regions (Alps, Sudetes and Carpathians). It is found on lowlands only in South Poland (Świętokrzyskie Mountains). Its natural range extends to about 500 000 ha and its distribution is fragmented.

People have planted European larch well beyond its native range, particularly in Western Europe. Together with the Japanese and hybrid larches, plantations of European larch cover over 500 000 ha.

Importance and use

European larch is economically important at regional level, especially in mountainous areas such as the Alps. It has long been valued for its wood and resin. It was already used as a construction material in ancient Rome.

Larch is one of the fastest-growing conifer species in Western and Central Europe, producing more than 10 m^3 of wood per ha annually under optimal conditions. Because of its fast juvenile growth and its pioneer character, larch has found numerous applications in forestry and agroforestry. It is used as a 'preparatory species' to afforest open land, abandoned farmland or disturbed land and as a 'nurse species' prior to the introduction of more demanding species. There is growing interest in its amenity value for forest landscaping.

Larch wood is dense, strong and durable. It is used extensively in the building industry (houses, roof constructions, bridges, flooring, etc) and in furniture making.

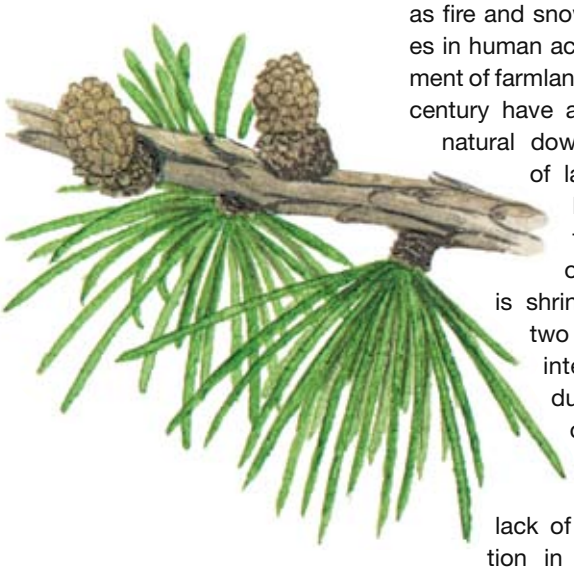
Genetic knowledge

European is one of the most researched tree species in Europe. This is due to both its economic importance and social and cultural values. For example, in ancient times, larch, lime and oak were considered sacred.

European larch has a high level of genetic variability for most silvicultural traits both between and within populations. International provenance experiments have indicated the best larch populations in terms of silvicultural quality. The fastest growing populations were found among the Sudetes and Central Polish larch; Alpine populations were slowest growing. The populations from Central Europe (Sudetes and Central Poland) showed also the highest stability across environments (low GxE), even across ecologically contrasting conditions, while southwestern alpine larch populations performed well only at high elevation sites.

High variability was also found in resistance to canker disease (*Lachnellula willkommii* (R. Hartig.) Dennis), one of the most harmful diseases in larch. Resistance was highest in populations from the eastern Alps and lowest in populations from the southern Alps. Similar genetic differences were found in traits such as seed weight, taper, crown shape, branching, wood properties, resistance to insects, frost hardiness and drought tolerance.

Several countries have developed breeding populations of European larch through selection of plus trees in natural stands. Trees from Sudetan origins and central Poland have been widely used because of their favourable characteristics. Progeny testing is underway at the intra-specific (usually from open pollination) and inter-specific (from controlled pollination with Japanese larch) levels.



Threats to genetic diversity

The natural distribution of European larch is small and fragmented and the species is subject to two major threats: shrinkage of the native range and hybridisation with 'alien' germplasm.

1) Due to its pioneer and shade-intolerant character, natural occurrence and regeneration of European larch are favoured by frequent natural -events in the high mountains that either refresh the soil (such as land slides) or destroy competing vegetation (such as fire and snow slides). Changes in human activities (abandonment of farmlands) during the last century have also favoured the natural downward extension of larch in the Alps. Now, however, the native range of European larch is shrinking because of two factors: i) human intervention to reduce the incidence of **avalanche** and landslide and fire, and ii) the lack of human intervention in newly colonised lands with intense competition by shade-tolerant species.

2) European larch has a long history of cultivation across Europe, dating from at least the 18th century. Many extant larch stands, especially in lowland areas, have been established from imported seeds. It is thus likely that natural populations have been crossed with introduced material.

The species belonging to the section of European larch have separated quite recently and have not yet established barriers to crossing. Widespread introduction of Japanese larch in Western and Central Europe at the turn of the 20th century led to possible crossing of these two species. As a result of further crossings, pure populations of European larch in these areas have been or may soon be completely eliminated.

Finally, climate change is projected to lead to a migration of European larch populations towards higher elevations, which in some areas could seriously limit their occurrence.

Guidelines for genetic conservation and use

The lack of natural regeneration can be favoured at high elevation (e.g. over 1500 m in the Alps), with protection against farm animals, soil scraping and complementary plantation; at lower elevation the competition with shade-tolerant tree species should be controlled by thinning to favour larch growth, flowering, fructification and establishment of seedlings. Protection against game animals is often necessary.

At all elevations, crossing with other European larch populations and species should be avoided by prohibiting their introduction in close contact with native populations. Several national seed transfer regulations have defined provenance regions where only local populations of European larch are recommended for establishment but elsewhere there are no rules preventing the use of alien material except in natural parks or reserves.

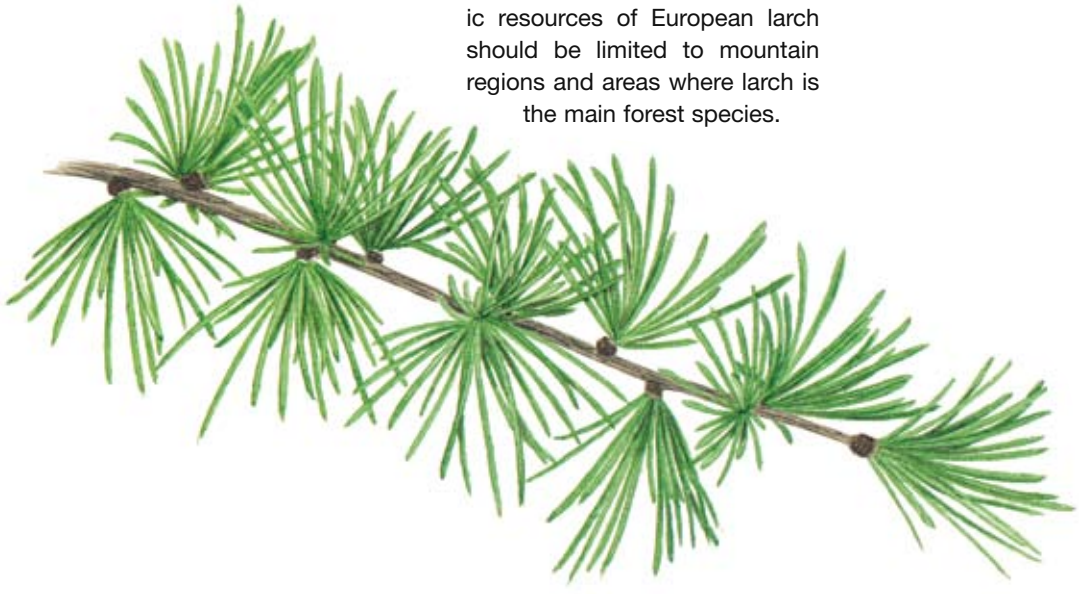
European larch requires special management if it is to survive and flourish, especially in mixed forests. For example cutting, in which trees from the upper storey are left as shelter precludes natural regeneration of larch. Thus, the drawing up of general rules of silviculture (felling systems, silvicultural measures, etc.) is necessary to ensure the establishment of progenies from the natural populations of larch and maintenance of larch stands. Assistance to natural regeneration can be provided through weed control, opening of stand canopy, complementary planting and other management efforts.

Japanese and hybrid larches should not be grown near European larch forests that are considered as gene conservation units.

In situ conservation of genetic resources of European larch should be limited to mountain regions and areas where larch is the main forest species.

Ex situ conservation can be carried out through establishment of artificial gene conservation units. These might include plantations as part of breeding programmes, such as clonal archives, clone banks, seed orchards and field trials as well as specifically designed conservation plots. Populations selected for *ex situ* conservation should be free from genetic 'pollution' with other populations of European larch or with other larch taxa.

Larch seed can be stored for at least 30 years in genebanks. Pollen can also be stored *ex situ*. Cryopreservation of somatic embryogenic lines is another possibility for conservation of larch genetic resources conservation since most technical problems have been solved recently.



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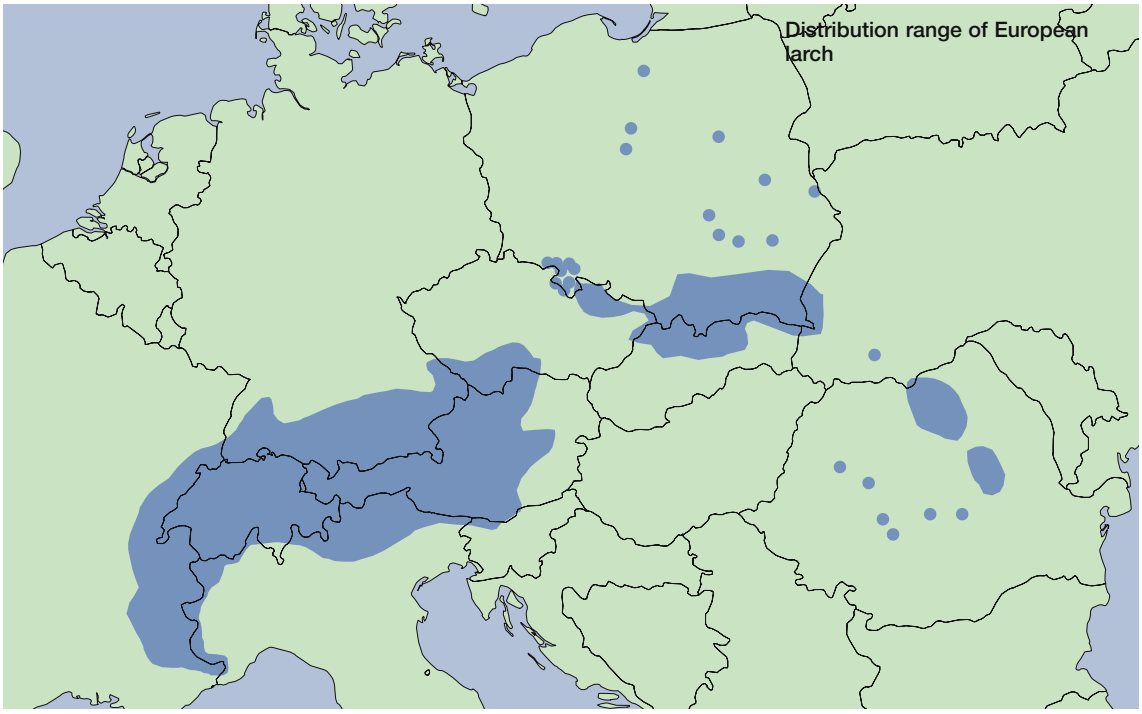

The series of these Technical Guidelines and the distribution maps were produced by members of the EUFORGEN Networks. The objective is to identify minimum genetic conservation requirements in the long term in Europe, in order to reduce the overall conservation cost and to improve the quality of standards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

*Citation: Matras J. and Pâques L. 2008. EUFORGEN Technical Guidelines for genetic conservation and use for European Larch (*Larix decidua*). Bioversity International, Rome, Italy. 6 pages.*

Drawings: Larix decidua*, Claudio Giordano. © 2003 Bioversity International.*

ISBN 978-92-9043-788-8

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