

Silver birch

Betula pendula

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These Technical Guidelines are intended to assist those who cherish the valuable silver birch gene pool 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



Silver birch (syn. European white birch (*Betula pendula* Roth)) is a fast growing, medium-sized deciduous tree with white bark, fairly narrow crown and drooping outer branchlets. Trees rarely exceed 30 m in height, even on the best sites in northern Europe, and the average height of pure stands is usually less than 25 m. The average maximum biological age of silver birch is approximately 100 years, although sometimes trees can survive up to the age of 150 years.

Silver birch is regenerated by seed, which are numerous, small

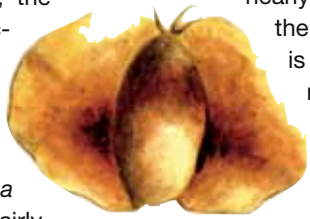
and efficiently wind-dispersed. The species is monoecious, male and female catkins are found in the same tree. Male catkins develop at the end of the previous summer and are visible during winter whereas female catkins overwinter in the shelter of buds and become visible at budburst in spring. Silver birch is self-incompatible, a chemical mechanism prevents the growth of pollen tubes on the stigmas of the same mother tree.

European birches are a species complex, where correct identification of silver birch may be a challenge. Silver birch is characterized by hairless leaves and young shoots and by very thick bark at the base of old trunks. Although quite similar, downy birch (*Betula pubescens*) has hairy leaves and shoots. Leaf shape of silver birch is most often triangular and the base of the leaf is at a right angle to the stalk, whereas the base of downy birch leaf is rounded. Chemical and molecular markers are presently available for more definitive identification.

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These two species can also be distinguished cytologically, silver birch has 28 chromosomes (a diploid species), whereas downy birch has 56 chromosomes (a tetraploid species). Despite this difference, the two species may occasionally hybridize.

Silver birch has soil requirements similar to those of Norway spruce (*Picea abies*); it thrives on fairly fertile and well-drained soils and does not survive on wet clay or peat soils.



Distribution

The distribution of silver birch covers almost all Europe from the Mediterranean in the south nearly to latitude 70° in the north. The species is most abundant in northern Europe, where the distribution is more or less continuous in mixed forests and also fairly large pure stands can be found. In the western and southern parts of the range the distribution is more patchy and in the south silver birch is found mostly at the higher altitudes. The species is missing from Iceland, and most of the Iberian peninsula and Greece.

Importance and use

Silver birch is among the most commercially important tree species in northern Europe. Its wood is used in plywood-making and carpentry as well as for pulpwood and fuel. The wood of silver birch is pale-colored and there are no differences of any importance between the spring- and summer wood or heart- and sapwood. The wood specific density is very high. The wood fibers are very short and birch pulp is mixed with conifer pulp to improve paper quality.

Curly birch (var. *carelica*), a special form of silver birch, is highly valued for the decorative colour pattern of the wood. There are several heritable pattern types and some of them can also be identified by visual inspection of the trunks. Curly birch is used in carpentry as veneer and for various small handicrafts.

Special forms of silver birch (f. *bircalensis*, f. *crispa*, 'Dalecarlica') are used in ornamental plantings because of their decorative leaf forms. In the southern fringe of the distribution silver birch is used for reforestation purposes and in some areas as fodder for cattle.

Silver birch (and birches in general) is an essential component of temperate and boreal forests and has positive effect on the diversity of ecosystems. A large number of herbivorous insects and symbiotic fungi are dependent on the presence of birches.



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Genetic knowledge

Genetic structure of silver birch in the main distribution area is shaped by the abundance (commonness) of the species and effective seed and pollen dispersal. Pollen can travel several hundreds of kilometers and birch seeds are very light and easily dispersed. Although the majority of the seeds fall down close to the mother tree, a smaller fraction will be dispersed over considerably longer distances.

As a result, the genetic pattern of silver birch is similar to common conifers (Scots pine (*Pinus silvestris*) and Norway spruce, (*Picea abies*)) and pedunculate oak (*Quercus robur*). Levels of adaptively neutral genetic variability are high within populations and local populations in northern Europe are very similar to each other, i.e. the differentiation among populations is very low. However, for adaptive traits a different pattern is observed.

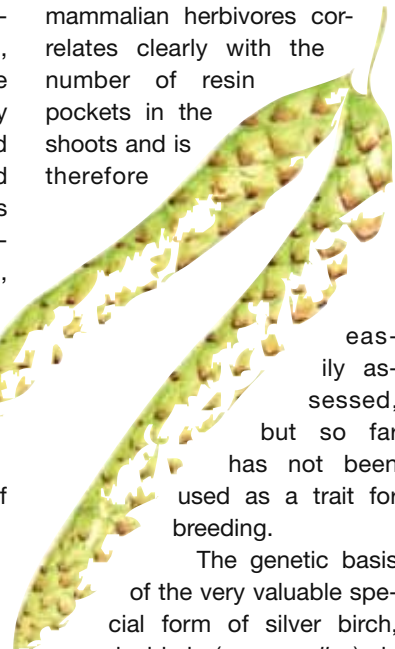
Strong genetic differentiation of local Scandinavian populations occurs along south - north axis in the case of phenological traits. This is evidently an adaptation to the local climate and to the timing and length of grow-

ing season. At the end of summer, cessation of height growth, which is the first step in the hardening process, is primarily controlled by photoperiod and modified by temperature and other factors. Birch populations from different latitudes differ regarding their critical night length, i.e. the shortest night length to trigger growth cessation. In the spring, bud burst and onset of new growth is primarily controlled by temperature.

A considerable amount of genetic variation has been detected in many economically important growth and quality characters. The provenances from Finland and Sweden (omitting the most northern marginal populations) usually have better stem form than provenances from Central Europe, but there is also genetic variation within populations. Conventional breeding has considerably improved both the volume growth and quality of planting material in Finland.

There is also considerable genetic variation in herbivore resistance, both against mammals and insects. The genetic variation in resistance is mostly within populations, there is no known differentiation among populations. Resistance against

mammalian herbivores correlates clearly with the number of resin pockets in the shoots and is therefore



easily assessed, but so far has not been used as a trait for breeding.

The genetic basis of the very valuable special form of silver birch, curly birch (var. *carelica*), is still not completely understood. The proportion of curly phenotype in the progenies is 60-70% if both parents are curly birches; in open-pollinated seedlots about 50% of progenies show curly phenotype. There is considerable amount of variation among mother trees regarding the proportion of curlyness in their progenies.



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Threats to genetic diversity

The main threats to the genetic diversity of silver birch are found at the margin of its distribution, where occurrence is discontinuous and consisting of isolated populations. In particular, southern (Spain, Italy, France) and, to a smaller extent, northern edges of the distribution area are subject to this fragmentation process. Very little is known about the amount and organization of genetic variation in the southern marginal areas.

Within the main distribution area there are no immediate threats to the genetic diversity of silver birch. Natural regeneration has prevailed and large-scale planting started only after the importance of genetic knowledge and the control of the origins of the planting material was realized. Special forms, however, need more attention and native curly birch genotypes may be at risk of extinction.

Unbalanced use of forest reproductive material can lead to loss of genetic variation. In the case of silver birch this possibility has to be considered seriously, because of the extremely high seed-producing capacity of birches. The production of clonal seed orchards in good conditions is so high that one orchard may produce enough seeds for extremely large areas and limitations to the usage of seed must be considered.

Guidelines for genetic conservation and use

Because silver birch is a widespread species, the environmental conditions and hence priority and methodology of genetic conservation are different in various parts of the distribution area. In northern Europe silver birch is common and has almost continuous distribution over large areas without any immediate threats to the amount of genetic diversity, hence the nature of the gene conservation measures in these areas is mostly precautionary. These measures include restrictions on the use of single seed sources or vegetatively reproduced clones and the selection of properly adapted forest reproductive material.

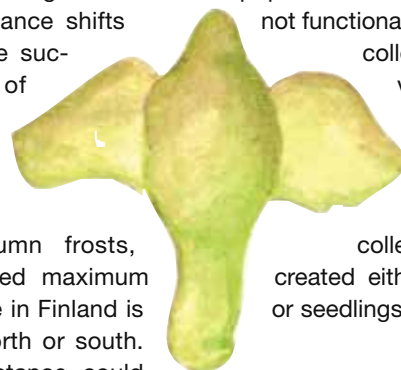
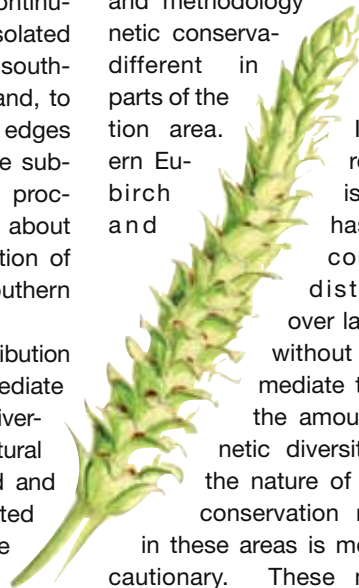
In the northern parts of the distribution area (Finland and Sweden), controlling the distance of provenance shifts is crucial for the successful use of planting material. In order to avoid the risk of late spring and early autumn frosts, the recommended maximum transfer distance in Finland is 150km either north or south. The transfer distance could

be larger at low elevations in Central European countries.

An additional measure to protect the natural genetic composition is to select *in situ* areas for genetic conservation either for birch alone or as mixed forest with other species. Such areas can be nature conservation areas or gene reserve forests under commercial forestry. In both cases natural regeneration should be favoured or, if artificial regeneration must be applied, the material originating from the same forest should be used.

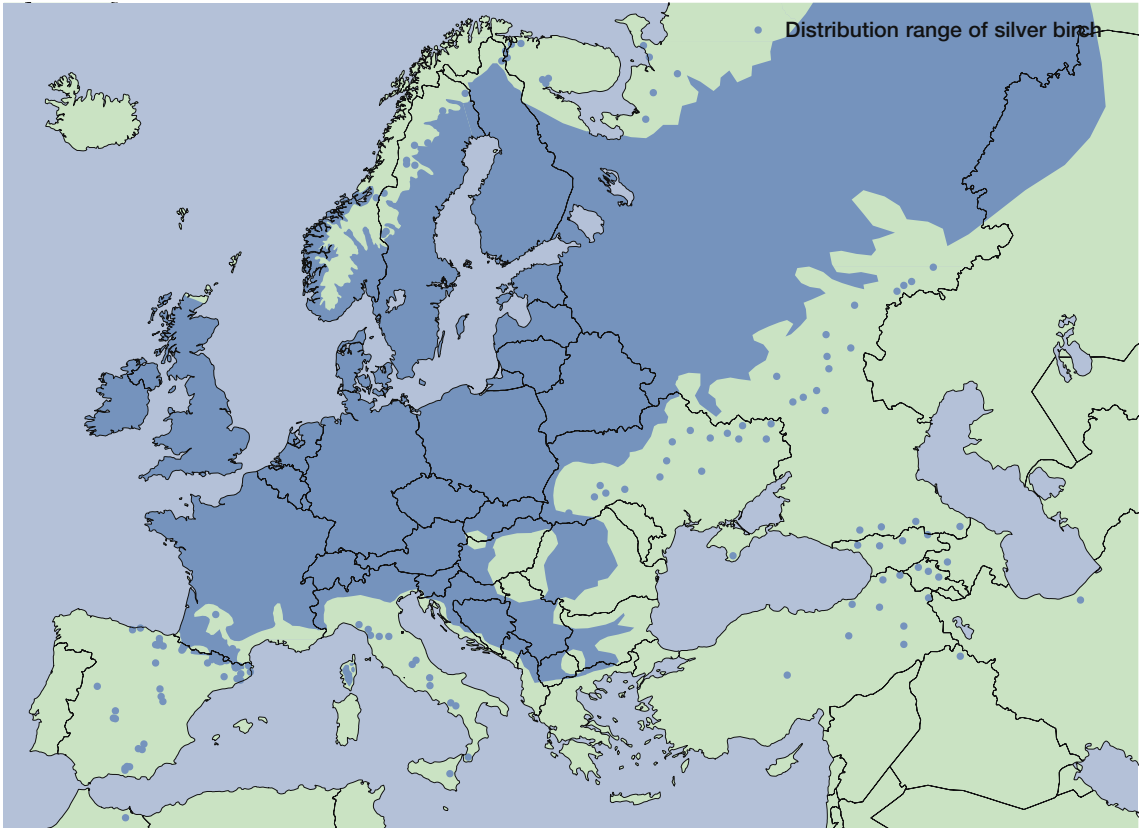
In the areas of scattered distribution the use of gene reserve forests may not be possible. The local stands may be too small and threatened by various environmental hazards to such a degree that an *ex situ* conservation strategy is more applicable. *Ex situ* collections may be based on either grafts or seedlings.

A special case for gene conservation is curly birch, which is usually found as single trees or as groups of a few trees in natural forests. In such cases a population-based approach is not functional and an *ex situ* collection of individual clones (genotypes) is a more appropriate approach. The collections can be created either by grafting or seedlings.



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

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