

Abies alba in Europe: distribution, habitat, usage and threats

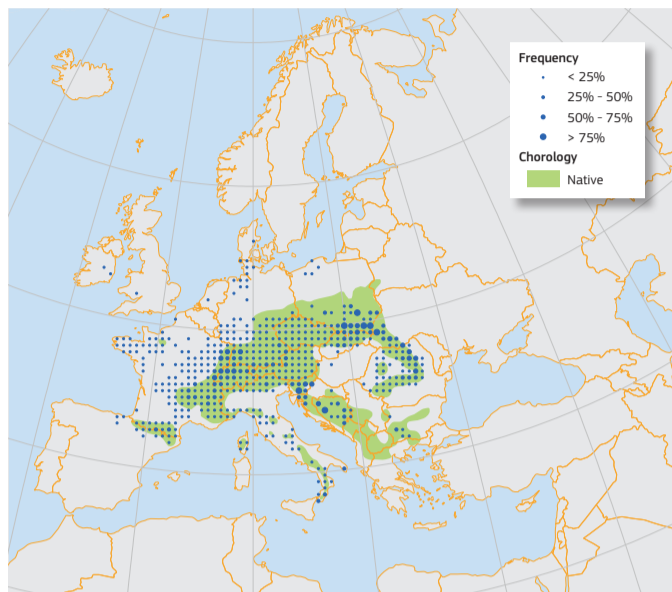
A. Mauri, D. de Rigo, G. Caudullo

Silver fir (*Abies alba* Mill.) is a large conifer that can be found in central Europe and some parts of Southern and Eastern Europe. It is one of the tallest tree species of the genus *Abies* in Europe. This tree is considered an important ecological and functional balancer of European forests and a fundamental species for maintaining high biodiversity in forested ecosystems. Its future distribution is subject of a debate between palaeoecologists and modellers, with contrasting climate-response forecasts.

Silver fir (*Abies alba* Mill.) is a large evergreen coniferous tree mainly distributed in montane areas in Central Europe, but is also present in Southern and Eastern Europe. It is a distinctive tree, straight-stemmed with a silver-grey trunk¹. Growth is very slow in early years, and then rapid as the tree matures. The uppermost part of young trees has a conical shape gradually changing to become a rounded dome as the tree grows older². The needles are dark green and glossy on their upper side while the lower side has two silver-green waxy bands of 6-8 rows of stomata, and can live for up to six or eight years. Flowers only appear after 30 to 40 years, generally in April or May, and the buds are red-brown and non-resinous. The fully developed seeds are mainly dispersed by wind. With particularly cool and moist habitats this tree can live up to 500-600 years^{3, 4} and reach heights above 60m⁴⁻⁷ making it among the tallest tree species of the genus *Abies* in Europe. This tree is also the most heavily browsed of the commercially important tree species in montane forests of central and southeastern Europe⁸.

Distribution

Silver fir is often distributed on relatively high elevated areas (500-2000 m a.s.l.). It requires relatively high moisture conditions throughout the year, with mean yearly precipitation between 700 and 1800mm⁹. Its main distribution is concentrated in Central Europe, on the Suisse plateau and in South and Eastern Germany as well as in the Czech Republic and Austria. There are conspicuous numbers in the Pyrenees, Southern Alps of Northern Italy and Ticino and the Eastern Alps, the Carpathians and Albania. It is also found more sporadically in Eastern France, on the Massif Central, and in the Apennines. Stands of silver fir are present in the Dinaric Alps and are continuously connected towards the Rodopi mountains in Bulgaria and Greece, where it naturally hybridises with the Greek fir (*Abies cephalonica*) forming stable populations of intermediate forms described as Bulgarian firs (*Abies x borisii-regis*)². Plantations of silver fir are rare outside its natural range, possibly because of increased potential for insect damage in monocultures¹.



Map 1: Plot distribution and simplified chorology map for *Abies alba*. Frequency of *Abies alba* occurrences within the field observations as reported by the National Forest Inventories. The chorology of the native spatial range for *A. alba* is derived after several sources²⁹⁻³¹.

Concerning its past distribution palaeo evidence suggests different ice-age refugia of silver fir in northern, central and southern Italy, the Balkans, the Pyrenees and potentially France, which is in agreement with results obtained using biochemical and molecular markers¹⁰. During the past decades silver fir was positively responding to climate warming in Central Europe and adjacent areas, as documented in many tree ring series¹¹. However, in Switzerland, silver fir is decreasing as a result of animal browsing and replacement by Norway spruce (*Picea abies*), a more economically valuable species¹². The future distribution of Silver Fir is subject of a debate. Some studies suggest a reduction in response to future expected warming^{13, 14}, while others suggest stable conditions or expansions^{15, 16}.



Young tree near Zwardoń village (South Poland). (Copyright Crusier, commons.wikimedia.org: CC-BY)

Habitat and Ecology

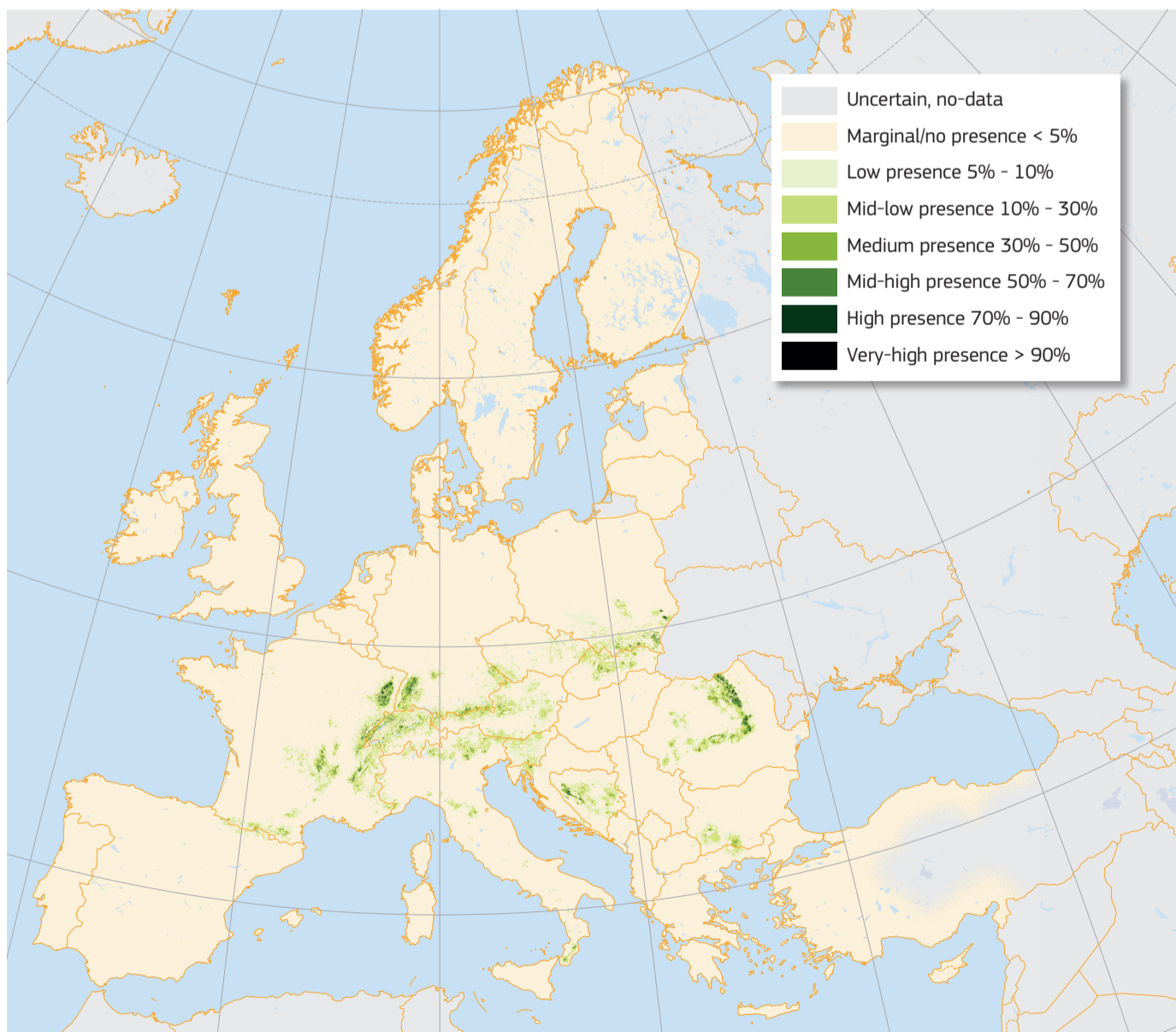
Silver fir tolerates a wide variety of soil types with different nutrient content and alkalinity conditions except compact and hydromorphic soils. Deep and moist but not too wet soils are preferred with a pH from acid to neutral. Silver fir shows a noticeable soil-acidifying ability¹⁵. Unlike the other European and Mediterranean *Abies* species, it prefers cooler and moister conditions, favouring summer temperatures ranging from approximately 14°C to 19°C⁹. The main limiting factors are a lack of summer heat and adequate moisture during the growing season, while new seedlings are extremely sensitive to frost damage. This tree is mostly found mixed with Norway spruce (*Picea abies*) or Scots pine (*Pinus sylvestris*) at the upper tree limit^{1, 4, 18}. At lower altitudes it competes with beech (*Fagus sylvatica*), being the first conifer species to appear among them⁴. It is very shade tolerant and can remain as a "seedling bank" under the canopy of older dominant trees for decades. It often invades deciduous forests due to its easy natural regeneration.

Importance and Usage

Silver fir is considered an important ecological and functional balancer of European forests and can serve as a keystone species for maintaining high biodiversity in forested ecosystems⁹. The wood is non-resinous, light and fine-grained and also easy to work, which makes it a good material for carpentry and furniture. During the seventeenth century, its wood was used to produce ships' masts. The essential oils obtained from the leaves were also used in the past to heal bruises as well as for treating coughs and colds¹. Along with Norway spruce (*Picea abies*), silver fir is also used for paper production. During the 19th century it was popular as a Christmas tree, although it has lately been replaced by the cheaper Norway spruce¹.

Threats and Diseases

Silver fir is particularly susceptible to frost desiccation due to late spring frosts. It is also very sensitive to fire^{19, 20}, insects, fungi and industrial emissions, in particular to sulphur dioxide SO₂ exposure during winter¹⁹. In the next decades the climate of central and southern Europe is predicted to become warmer and somewhat drier²², favouring diseases and plant pests. Insect pests such as mistletoe and bark beetles have already been responsible for a reduction of silver fir in the Mediterranean, especially in those areas where drought stress is more frequent²¹. The fungi *Armillaria mellea* agg. and *Heterobasidion annosum* are responsible for butt rot and windthrow. Phytophagous insects such as *Mindarus abietinus* and *Dreyfusia normanniana* are often the cause of infections to needles and bark. Other insects



Map 2: High resolution distribution map estimating the relative probability of presence.

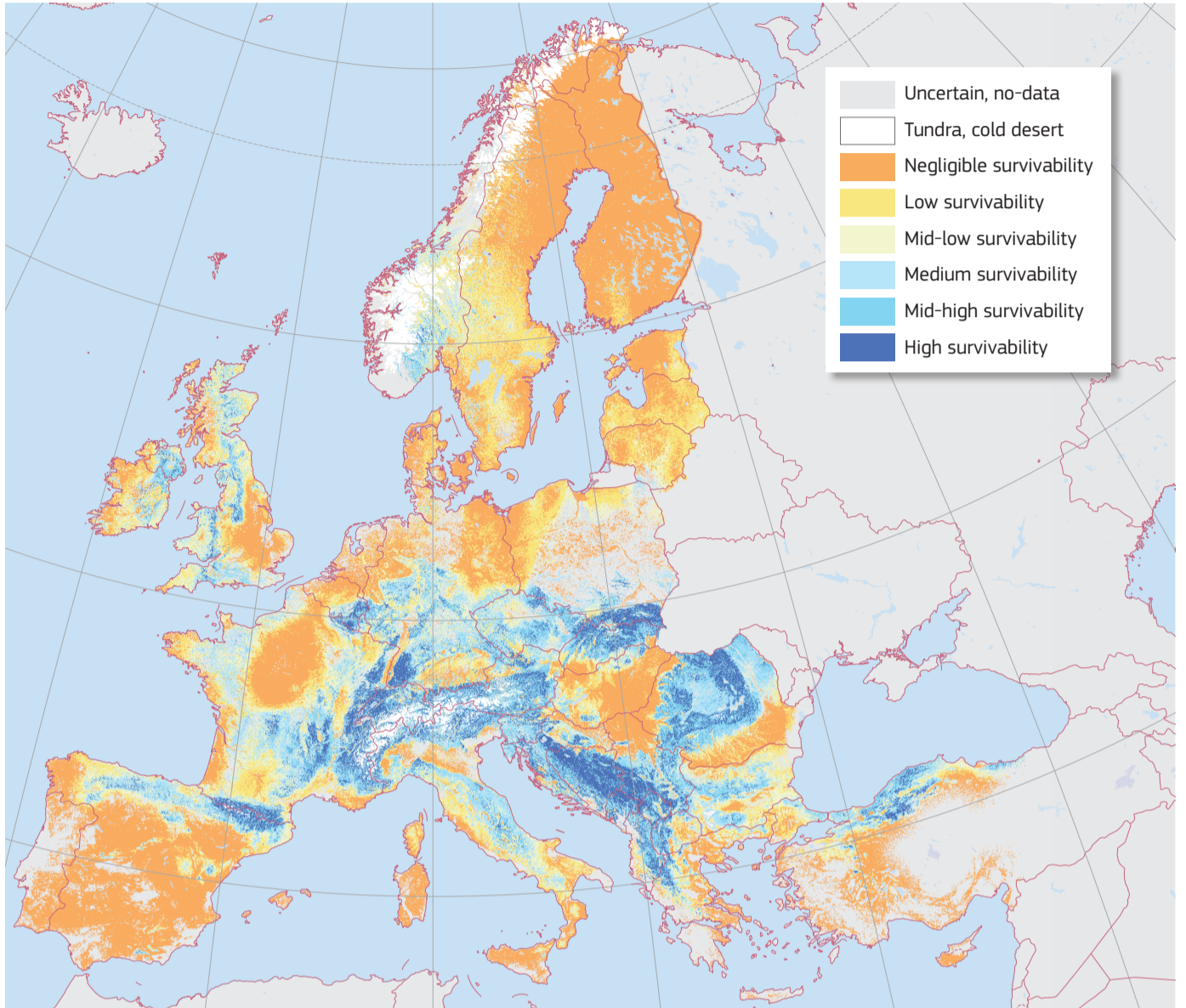


Branches with dark-green needles: leaves have an elliptical insertion but are positioned to avoid shading.
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such as *Cinaria pectinatae* and *Epinotia nigricana* are affecting bark and buds². Silver fir is vulnerable to *Ips typographus* which is also associated to potentially harmful fungal assemblages²⁴⁻²⁶. It is also a susceptible host to *Dothistroma septosporum* and vulnerable to *Gremmeniella abietina* and *Dothistroma septosporum*^{8, 25, 27, 28}.



Erect maturing seed cones on a branch. Old cones do not fall but remain and disintegrate on the tree.
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Map 3: High resolution map estimating the maximum habitat suitability.



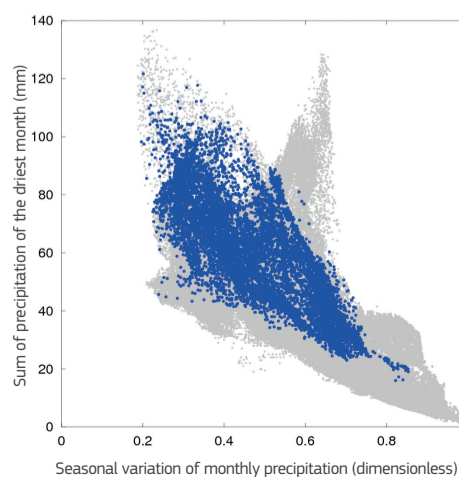
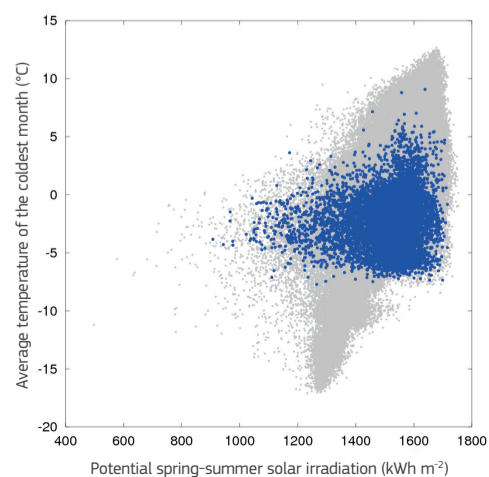
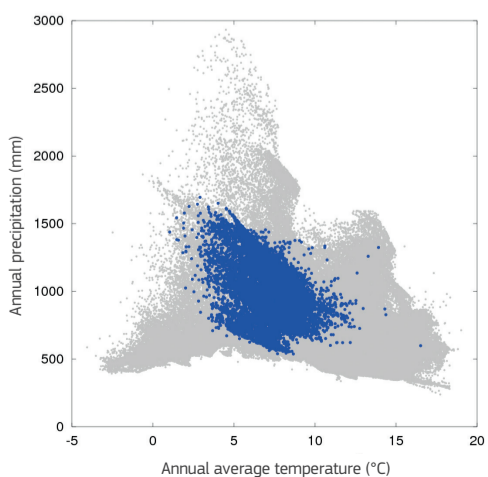
Dark-grey bark of a mature tree with fissured plates.
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Field data in Europe (including absences) ● Observed presences in Europe ●

Autoecology diagrams based on harmonised field observations from forest plots.



This is an extended summary of the chapter. The full version of this chapter (revised and peer-reviewed) will be published online at <https://w3id.org/mtv/FISE-Comm/v01/e01493b>. The purpose of this summary is to provide an accessible dissemination of the related main topics.

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