

Pseudotsuga menziesii in Europe: distribution, habitat, usage and threats

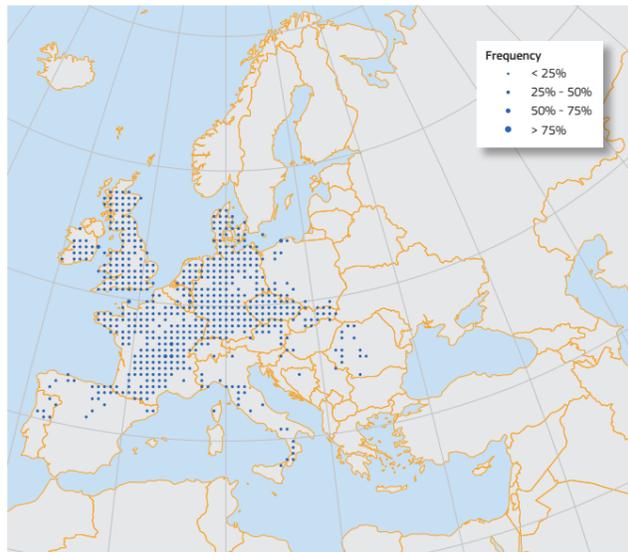
F. Da Ronch, G. Caudullo, D. de Rigo

Douglas fir (*Pseudotsuga menziesii* (Mirb.) Franco) is a large conifer from North America that was brought to Europe by David Douglas in the nineteenth century. Although it was initially planted as an ornamental tree it became a major economic species because of its fast growth rate and good quality timber, and is now the most abundant non-native tree species cultivated in Central European forests.

Douglas fir (*Pseudotsuga menziesii* (Mirb.) Franco) is a large evergreen coniferous tree up to 60-80m tall and with a trunk of up to 2m in diameter¹. Currently the second-tallest in the world after the coast redwood (*Sequoia sempervirens*), and in its natural and optimal habitat in North western America can grow exceptionally over 100m in height and with a trunk up to 4m in diameter, living more than 1300 years¹⁻³. The bark is coloured from reddish brown to greyish brown or even blackish, thick, breaking up with age into scaly, broad, interlacing ridges separated by deep furrows⁴. The trunk is cylindrical, with short, flat-topped crown, giving it a columnar shape¹. The leaves are needle-like, 2-3.5 cm long, dark-bluish green above and with two white-green stomatal bands below, spirally arranged around the twigs, twisted to face the upper side⁵. Douglas fir is a **monoecious unisexual** species, commonly starting to produce cones at 12 to 15 years of age⁶. Pollen cones are 10-20mm long, yellowish brown, and seeds cones are 4-9cm long, green and erect before maturity, yellowish brown to purplish brown and pendent when ripening. The seed scales are flexible with a bract longer than scales, pointed forward or sticking out. The seeds are 5-7mm with a 10-12mm wing⁴.

Distribution

Douglas fir is a native from North America with two subspecies: the coastal Douglas fir (*Pseudotsuga menziesii* var. *menziesii*) occurs from British Columbia southward along the Pacific Coast to central California; and the Rocky Mountain Douglas fir (*Pseudotsuga menziesii* var. *glauca*) occurs from central British Columbia along the Rocky Mountains into the mountains of central Mexico^{4,6}. The first seeds were introduced in Europe by David Douglas in 1827 and then planted at Dropmore Park (Buckinghamshire, UK), where there is a tree which is usually considered the oldest Douglas fir of Europe⁷. Initially planted as ornamental, Douglas fir started to be used as a forest species by the end of the nineteenth century. This fir became a major reforestation species in Western Europe after the Second World War, mainly with the support of national or regional forest grants.

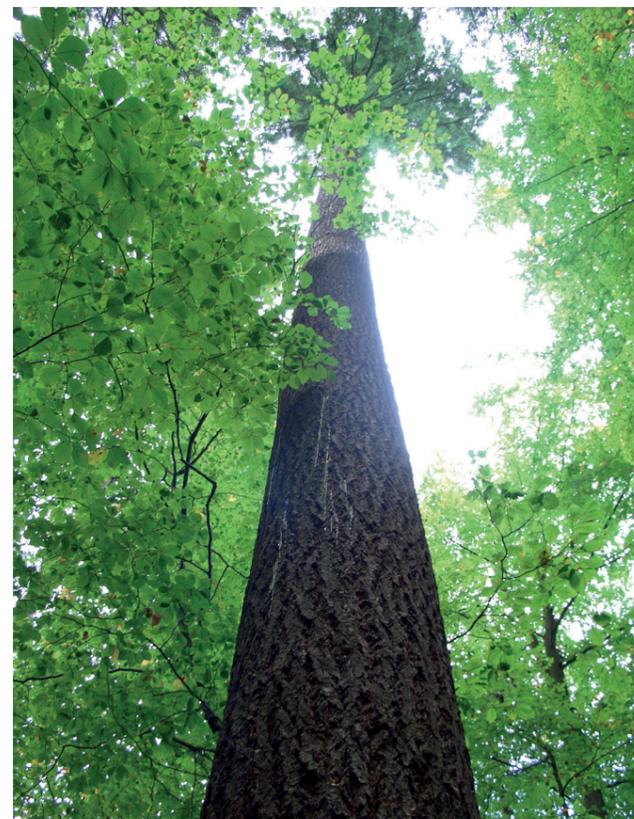


Map 1: Plot distribution and simplified chorology map for *Pseudotsuga menziesii*. Frequency of *Pseudotsuga menziesii* occurrences within the field observations as reported by the National Forest Inventories.

In Europe, 80% of the total Douglas fir area is to be found in three countries: France (half of the European area), Germany and United Kingdom. Outside Europe, Douglas fir has also been introduced in several countries of the southern hemisphere (South Africa, South America, New Zealand and Australia)⁸.

Habitat and Ecology

Douglas fir in its native habitat occurs from 0 to 3200 m, altitudinal distribution increases from north to south, reflecting the effect of climate on distribution of the species. It grows under a wide variety of climatic conditions. The coastal region of the Pacific Northwest has a maritime climate characterised by wet winters and cool, relatively dry summers, while in the central Rocky Mountains, the climate is continental, with long and severe winters and hot and dry summers⁹. This fir competes well on

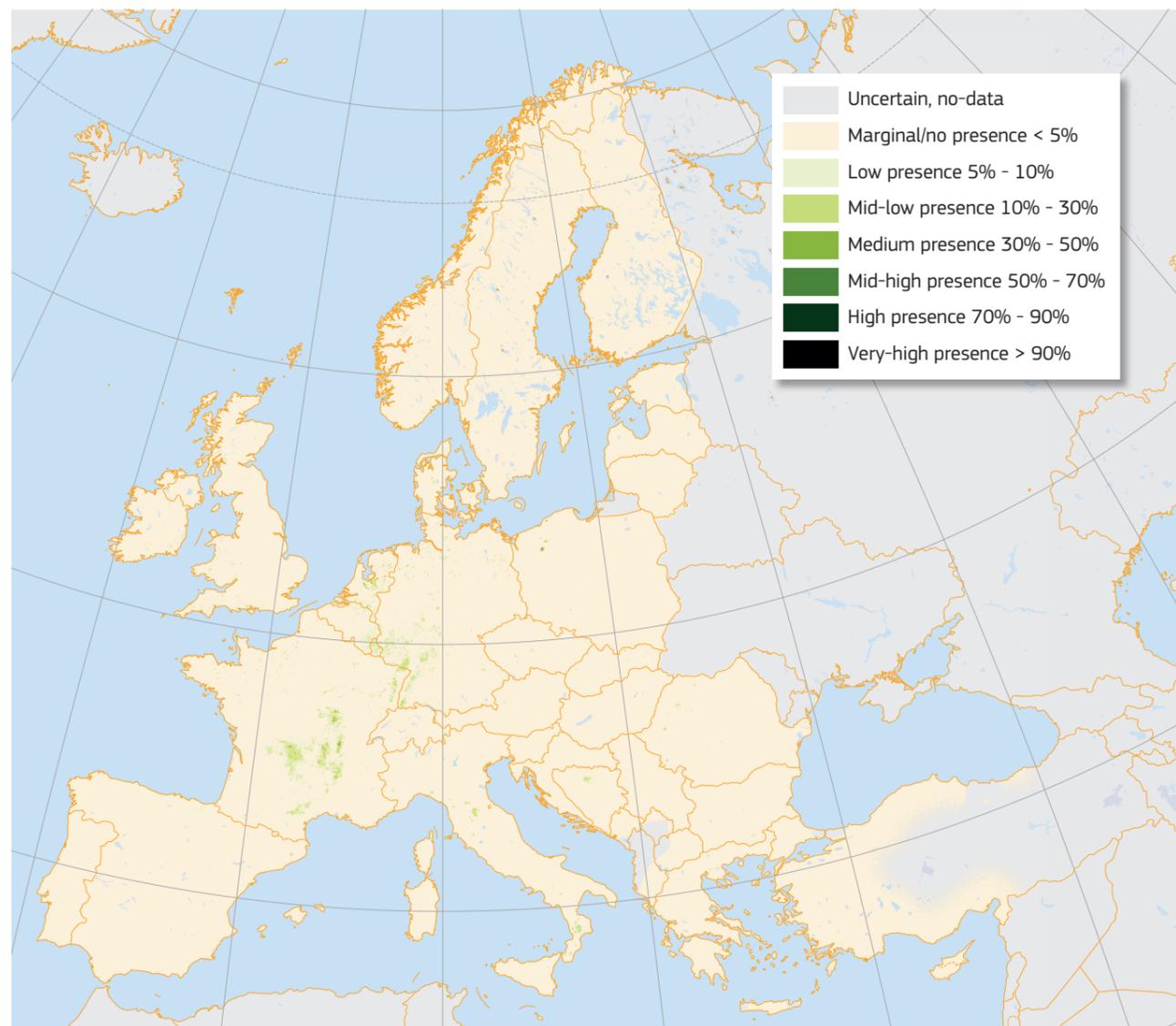


Straight columnar trunk of a Douglas fir reaching over 63 m in height in Freiburg: the tallest tree in Germany. (Copyright Manfred Gut, commons.wikimedia.org: PD)

most parent materials, aspects and slopes⁹. It also thrives on a wide variety of soil textures, but best on well-aerated, deep soils with a pH between 5 and 6⁶. In its natural range Douglas fir grows in pure or mixed-species stands. It is a fast-growing, pioneering tree species following fire, but also shade-tolerant in secondary successions, so that it may be present in early, mid and late forest stages as a major or minor component¹. In Europe, Douglas fir is one of the fastest growing trees, thriving on a wide range of soils, best when deep, moist, well-drained, at mid-elevations and with an annual rainfall over 800mm⁸. It shows a noticeable soil-acidifying ability¹⁰.



Cone with trifurcate seed bract longer than the scale. (Copyright benet2005, www.flickr.com: CC-BY)



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

Importance and Usage

Douglas fir is the most abundant non-native tree species cultivated in Central European forests¹¹. High growth rates, high reproduction capacity, great adaptation, good wood properties and a low number of pests and diseases are factors that have contributed to its success and spread in Europe, performing much better than Norway spruce (*Picea abies*) on similar sites¹². The wood is moderately heavy, hard and exceptionally strong, with a marked contrast between **sapwood** (yellowish-white) and **heartwood** (reddish-brown)¹. **Heartwood** is generally not sensitive to insect damage. Douglas fir wood is suitable for many uses. Its excellent mechanical properties make it very suitable for wooden structures. It is increasingly used outside for wood covering (**heartwood** only) and in joinery. It is also used for veneer, fibres or particle panels and by the pulpwood industry⁸. Recently there has been growing economic interest in Douglas fir, which is less vulnerable to drought than Norway spruce, becoming a valid alternative on plantations at lower altitudes or in response to climate change¹³⁻¹⁵.



Spring shoot with new growth of needles.
(Copyright Tom Brandt, www.flickr.com: CC-BY)



Pendent mature cones ripening.
(Copyright Andrey Zharkikh, www.flickr.com: CC-BY)

Threats and Diseases

Douglas fir hosts hundreds of fungi, but relatively few of these cause serious problems. This fir is less susceptible to the attacks of annosum root rot (*Heterobasidium annosum*) than many other conifers. The woolly aphid *Adelges cooleyi* causes yellowing and deformity of the needles and can severely check growth when the trees are young¹⁶. The large pine weevil (*Hylobius abietis* L.) is among the most serious pests affecting young coniferous forests in Europe¹⁷. Douglas fir coexists with the natural niche of the large pine weevil, to which it is highly susceptible¹⁷⁻¹⁹. From an ecological point of view, cultivation of Douglas fir in Europe is likely to have significant impacts on forest ecosystems, particularly in case of high density plantations over large areas. However, ecological impacts are generally not as severe as those of other exotic tree species: e.g. ailanthus (*Ailanthus altissima*), wild black cherry (*Prunus serotina*) and black locust (*Robinia pseudoacacia*)^{12, 20-22}. Further introduction of exotic organisms associated with Douglas fir in its native range may be more

problematic than the introduction of Douglas fir itself, in case of host jump affecting other native tree species¹². Douglas fir is reported as an invasive species in New Zealand, in Argentina and Chile in areas close to plantations. In Europe it also has the potential to become invasive in Germany, Austria, Bulgaria and Great Britain, given the right circumstances²³. For this reason silver fir (*Abies alba*) has been suggested as a sustainable European alternative to Douglas fir to substitute drought sensitive Norway spruce under global warming conditions²⁴.



Coastal Douglas fir (*Pseudotsuga menziesii* var. *menziesii*) forest in Mount Tamalpais State Park (Marin County, California).
(Copyright Miguel Vieira, www.flickr.com: CC-BY)

References

- [1] A. Praciak, et al., *The CABI encyclopedia of forest trees* (CABI, Oxfordshire, UK, 2013).
- [2] MonumentalTrees.com, Monumental trees (2015).
- [3] R. Stoltmann, *Guide to the Record Trees of British Columbia* (Western Canada Wilderness Committee, 1993).
- [4] A. Farjon, *A handbook of the world's conifers* (Brill, 2010).
- [5] J. E. Eckenwalder, *Conifers of the World: The Complete Reference* (Timber Press, 2009).
- [6] R. K. Hermann, D. P. Lavender, *Douglas-Fir, Agriculture Handbook 654* (U.S. Department of Agriculture, Forest Service, Washington, DC, 1990), pp. 527-540.
- [7] H. J. Elwes, A. Henry, *The Trees of Great Britain and Ireland Vol. 4* (Privately printed, Edinburgh, 1909).
- [8] J.-C. Bastien, L. Sanchez, D. Michaud, *Forest Tree Breeding in Europe*, L. E. Pâques, ed. (Springer Netherlands, 2013), vol. 25 of *Managing Forest Ecosystems*, pp. 325-369.
- [9] R. J. Uchytel, *Pseudotsuga menziesii* var. *menziesii*. Fire Effects Information System (1991). <http://www.feis-crs.org/feis>
- [10] L. Augusto, J. Ranger, D. Binkley, A. Rothe, *Annals of Forest Science* **59**, 233 (2002).
- [11] F. Essl, *Phyton - Annales Rei Botanicae* **45**, 117 (2005).
- [12] M. Schmid, M. Pautasso, O. Holdenrieder, *European Journal of Forest Research* **133**, 13 (2014).
- [13] M. Hanewinkel, D. A. Cullmann, M.-J. Schelhaas, G.-J. Nabuurs, N. E. Zimmermann, *Nature Climate Change* **3**, 203 (2012).
- [14] S. Hein, A. Weiskittel, U. Kohnle, *European Journal of Forest Research* **127**, 481 (2008).
- [15] N. Nadezhdina, J. Urban, J. Čermák, V. Nadezhdin, P. Kantor, *Journal of Hydrology and Hydromechanics* **62**, 1 (2014).
- [16] P. S. Savill, *The silviculture of trees used in British forestry* (CABI, 2013).
- [17] J. I. Barredo, et al., *EPPO Bulletin* **45**, 273 (2015).
- [18] CABI, *Hylobius abietis* (large pine weevil) (2015). Invasive Species Compendium. <http://www.cabi.org>
- [19] K. Wallertz, H. Nordenhem, G. Nordlander, *Silva Fennica* **48**, 1188+ (2014).
- [20] G. F. Peterken, *Forest Ecology and Management* **141**, 31 (2001).
- [21] A. Carrillo-Gavilán, J. Espelta, M. Vilà, *Biological Invasions* **14**, 1279 (2012).
- [22] A. Felton, J. Boberg, C. Björkman, O. Widenfalk, *Forest Ecology and Management* **307**, 165 (2013).
- [23] D. M. Richardson, M. Rejmánek, *Diversity and Distributions* **17**, 788 (2011).
- [24] W. Tinner, et al., *Ecological Monographs* **83**, 419 (2013).

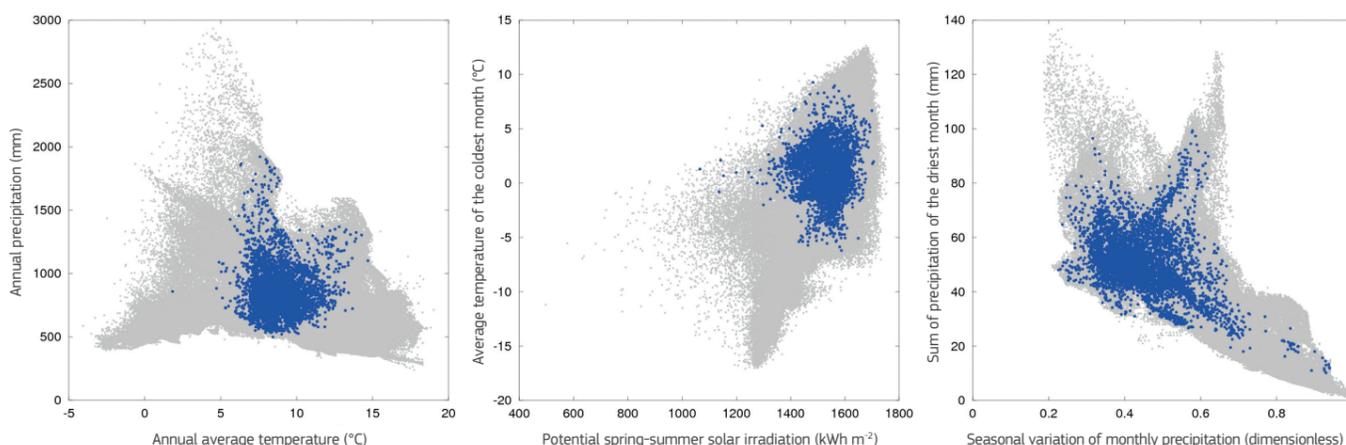


Greyish-brown bark in a young tree.
(Copyright Vito Buono, www.actaplantarum.org: AP)

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/e01a4f5>. The purpose of this summary is to provide an accessible dissemination of the related main topics.

This QR code points to the full online version, where the most updated content may be freely accessed.

Please, cite as:

Da Ronch, F., Caudullo, G., de Rigo, D., 2016. *Pseudotsuga menziesii* in Europe: distribution, habitat, usage and threats. In: San-Miguel-Ayaz, J., de Rigo, D., Caudullo, G., Houston Durrant, T., Mauri, A. (Eds.), *European Atlas of Forest Tree Species*. Publ. Off. EU, Luxembourg, pp. e01a4f5+

