Quercus pubescens

Quercus pubescens in Europe: distribution, habitat, usage and threats

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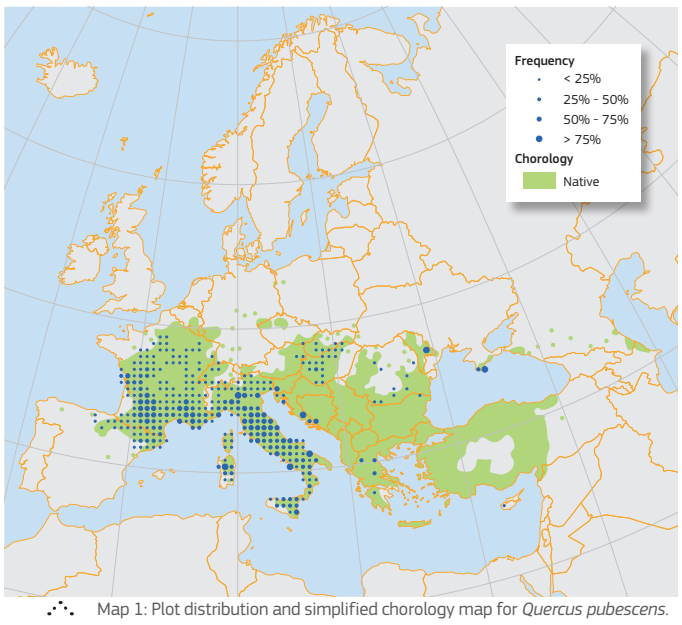
***Quercus pubescens* Willd., the downy or pubescent oak, is a middle-sized deciduous or semi-deciduous tree. Frequent hybridisation with other oaks, the complex sequence of survival and migration events during Pleistocene glaciations and the fragmentation of its populations due to long-lasting human impact are responsible for the remarkable variability of downy oaks. They have a wide distribution range, occupying almost all of central and southern Europe from western Spain to Ukraine and Anatolia with some isolated populations in the Caucasian area. Downy oaks are able to stand both moderate summer drought stress and low winter temperatures. On the other hand, they are poor re-sprouters and fare badly after intense anthropogenic disturbance. Forests dominated by this oak are quite common in southern Europe, while they are confined to warm microclimatic conditions in central Europe. Its wood is mainly used as firewood. Downy oaks are among the most frequent hosts of all the economically important truffles.**

Quercus pubescens Willd., known as downy or pubescent oak, is a middle-sized (15-20 m, rarely 25 m tall) deciduous or semi-deciduous tree. Its alternate leaves are mostly ovate-oblongate, (3)5-10 cm long, bear a short **petiole** (5 to 20 mm), with 5-6 more or less deep lobes[1]. Leaves are densely **pubescent** (the reason for its common names) and green-greyish when they start developing; soon after all the hairs of their upper side fall down and leaves become leathery and dark green[2]. Male flowers have 6-10 stamens and are grouped to form **pubescent** catkins which grow up along with new leaves at the base of new shoots. The short stalked female flowers have greenish **stigmata** and develop on the **axil** of distal leaves. The fruits - often grouped in clusters of 3-4 acorns - have a short hairy **petiole**, are mostly elliptic (2-3.5 cm long) and enclosed for ¼ to ½ of their total length by cupules which are covered by **imbricate** triangular hairy scales. Flowering season (from March to May) varies along with altitude. The huge acorns ripen from September to November and are able to germinate immediately and to develop vigorous roots in very short time[3]. The bark of downy oaks is characterised by deep furrows and rough and thick plates which represent an effective protection against grazing fires.

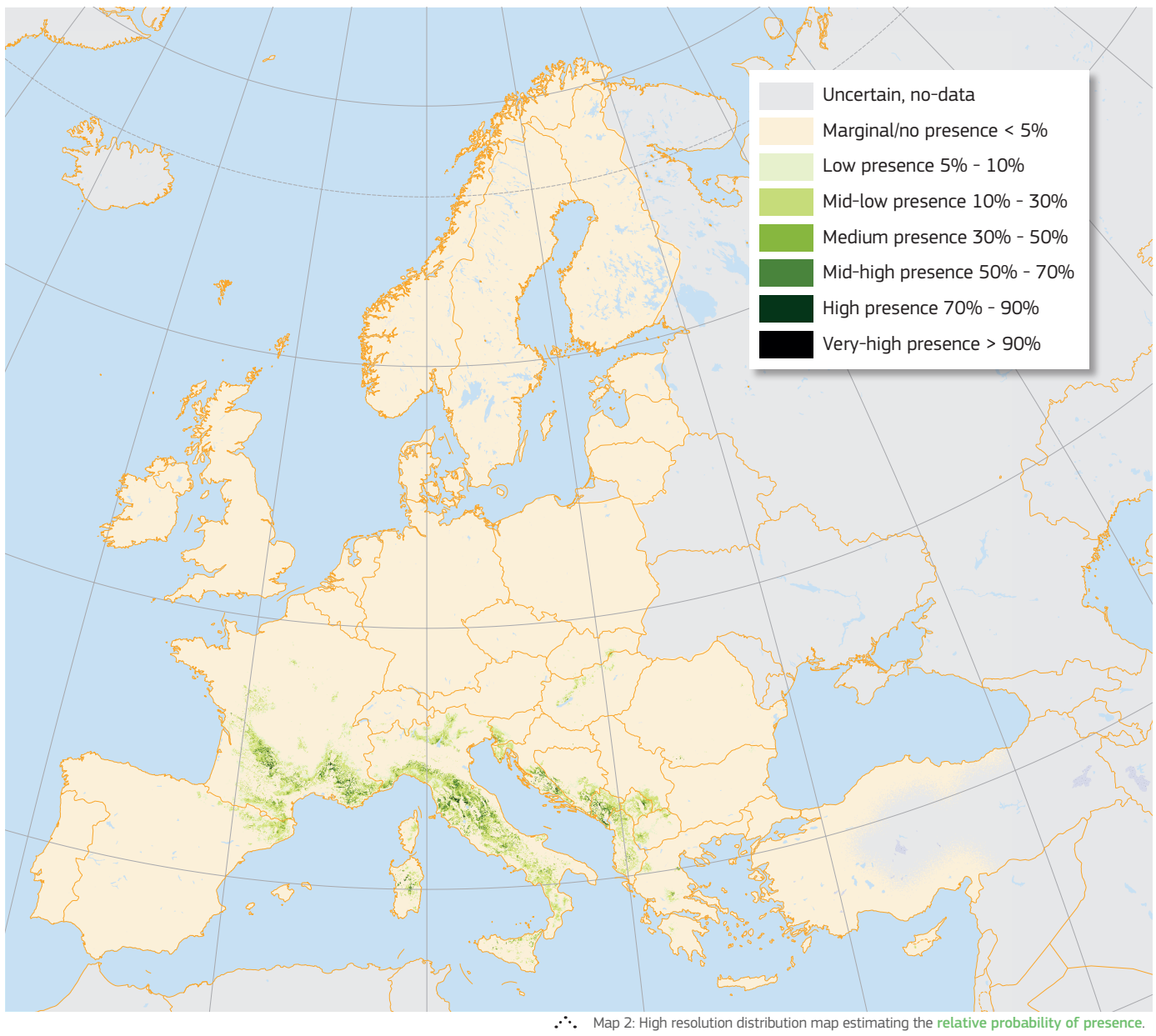


Map 1: Plot distribution and simplified chorology map for *Quercus pubescens*. Frequency of *Quercus pubescens* occurrences within the field observations as reported by the National Forest Inventories. The chorology of the native spatial range for *Q. pubescens* is derived after Wellstein and Spada[58].

Distribution

Species concept is particularly hard to be applied to downy oak, primarily because of frequent hybridisation with other **sympatric** deciduous oaks such as Pyrenean oak (*Quercus pyrenaica*) and Portuguese oak (*Quercus faginea*)[4, 5], sessile oak (*Quercus petraea*) and Hungarian oak (*Quercus frainetto*)[6-8]; secondly the complex history of its climate-driven survival and migration during Pleistocene glaciations[9-13]; and finally the fragmentation and isolation of its populations due to millennia of deforestation. These counteracting mechanisms (hybridisation vs. inbreeding and genetic drift due to habitat fragmentation) explain most of the high morphological variability of its populations. Hence, many eco-morphotypes living in South European peninsulas and/or in the main Mediterranean islands are treated as narrow **endemics**, like *Quercus virgiliana* (incl. *Quercus amplifolia*) reported for the Balkan-Pontian area, Sicily and South Italy[14-16], *Quercus brachyphylla* for South Greece, Crete and South-western Anatolia, *Quercus pubescens* subsp. *crispata* (syn. subsp. *anatolica*) for central and Western Anatolia and with a few isolated populations in the Caucasian area (Daghestan, Georgia and Azerbaijan[17, 18]), *Quercus congesta* (incl. *Quercus leptobalanos*) for Sardinia, Sicily and South Italy[14], *Quercus dalechampii* for South Italy[19], and *Quercus ichnusae* for Sardinia[20]. Only rigorous statistical methods applied to morphological traits make it possible to distinguish some of these taxa[21, 22], while genetic analyses still fail to point out any clear differences among them[23, 24]. Supported also by the most authoritative key to European oaks[25], all the above mentioned species and sub-species are clumped within a single species. In this way *Quercus pubescens* ***sensu lato*** has a wide range occupying almost all central and southern Europe from Western Spain[26, 27] to the Balkan area, Black Sea and Caucasus. Considering its wide ecological niche it is possible that downy oak woods covered very extensive surfaces all over Europe before being destroyed to make room for cereal fields, vineyards and olive groves.

Acorns are covered up to half of their length by the hairy scaled cupule. (Copyright Stefano Zerauschek, www.flickr.com: AP)



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

Habitat and Ecology

Downy oaks show a very wide altitudinal range, especially in the southern countries. Although they are more common on hillsides between 200 and 800 m, they grow from coastal plains up to 1 200-1 300 m. Indifferent to pH, they prefer lime-rich and well drained soils in the northern part of their range, while they may also be common on acidic soils in the warmer countries (e.g. Sicily and Crete). It behaves as a **heliophilous** and **thermophilous** species and is perfectly adapted to stand both moderate summer drought stress and low winter temperatures, although avoiding continental locations subject to most frequent frost and/or drought events[28]. As this oak is a very poor re-sprouter[29], it may be outcompeted by more resilient tree species under intense and frequent anthropogenic disturbance regimes (e.g. cutting, wildfires, overgrazing, etc.). On the other hand, it may perform rapid colonisation through seed dispersal after disturbance removal[30, 31]. *Quercus pubescens*-dominated forests are quite common in South Europe, while they are confined to warm microclimatic conditions in central Europe. Vegetation surveys concerning these communities are available for Germany[32], Bulgaria[33], Czech Republic[34], Italy[35], Austria[36], Slovakia[37], Hungary[38], Greece[39] and former Yugoslavia[40]. Downy oaks often co-occur with other deciduous trees of South-Eastern Europe and South-Western Asia, such as Oriental hornbeam (*Carpinus orientalis*), nettle trees (*Celtis* spp.), manna ash (*Fraxinus ornus*) and hop hornbeam (*Ostrya carpinifolia*). A West-East gradient in the composition of species-assemblages has been recorded in the Balkan Peninsula[40], while evergreen species cover and diversity values increase significantly along a North-South gradient in the Italian Peninsula[41]. Several authors classify downy oak forests in the vegetation communities at the level of order (*Quercetalia pubescentis*) within the class

Leaves can persist on the tree during winter. (Copyright Stefano Zerauschek, www.flickr.com: AP)

Querco-Fagetea (European temperate summer-green deciduous forests)[42-44], while others[45, 46] prefer to treat them as a separate class (*Quercetea pubescentis*) and provide a list of species which actually put downy oak woods in sub-Mediterranean contexts. On Mediterranean islands the downy oak often co-occurs with holm oak (*Quercus ilex*) and cork oak (*Quercus suber*) (Corsica, Sardinia and Sicily) or even with kermes oak (*Quercus coccifera*) (Crete). As the undergrowth of insular downy oak woods is also poorly differentiated from that of evergreen forest communities, most of them have been included within the class *Quercetalia ilicis*[47-49]. On the other hand, ongoing monitoring activities on forest dynamics suggest that the ceasing or reduction of disturbance may allow downy oaks to become the dominant species of 'final' Northern Mediterranean forest communities, outcompeting *Quercus ilex*, which will be confined to more disturbed places on shallow and poor soils[50].

Importance and Usage

Almost pure downy oak forests cover 8760 and 8500 km^2 in France and Italy, respectively[51, 52]. Notwithstanding the lack of quantitative data, pure and mixed stands are also very common in Balkan countries. Due to its irregular fibre distribution and the crookedness of the trunks, the wood of downy oak is scarcely considered as industrial lumber, and it is mainly used as firewood. In the past, it was largely employed for railway sleepers, while nowadays it is occasionally used for carpentry, boat-building, or packaging[53]. Downy oaks are among the most frequent hosts of all the economically important truffles (*Tuber aestivum, T. macrosporum, T. magnatum, T. melanosporum, T. uncinatum*). Considering the remarkable increase of tree ring size experienced by the downy oak in response to the augmentation of atmospheric CO_2 during the last century[54], its increased use in Southern European afforestations could be a very effective tool in order to combat the greenhouse effect.

Threats and Diseases

Several species of **Oomycetes** belonging to the genus *Phytophthora* are responsible for the so-called 'oak decline' which affects downy oak forests more and more frequently, especially those of the Mediterranean countries which are subject to more severe climatic stress and increasing frequency of climatic anomalies such as extreme drought events or strong shifts in seasonal rainfall distribution[55, 56]. In particular, downy oak is susceptlible to *Phytophthora cinnamomi, Phytophthora ramorum* and highly vulnerable to *Phytophthora quercina*[57]. This tree may also be attacked by the gypsy moth (*Lymantria dispar*) which has the potential to expand its virulence, due to climate change, in the European temperate oceanic ecological zone[57].

Leaves are 5-10 cm long and densely pubescent when they start developing.
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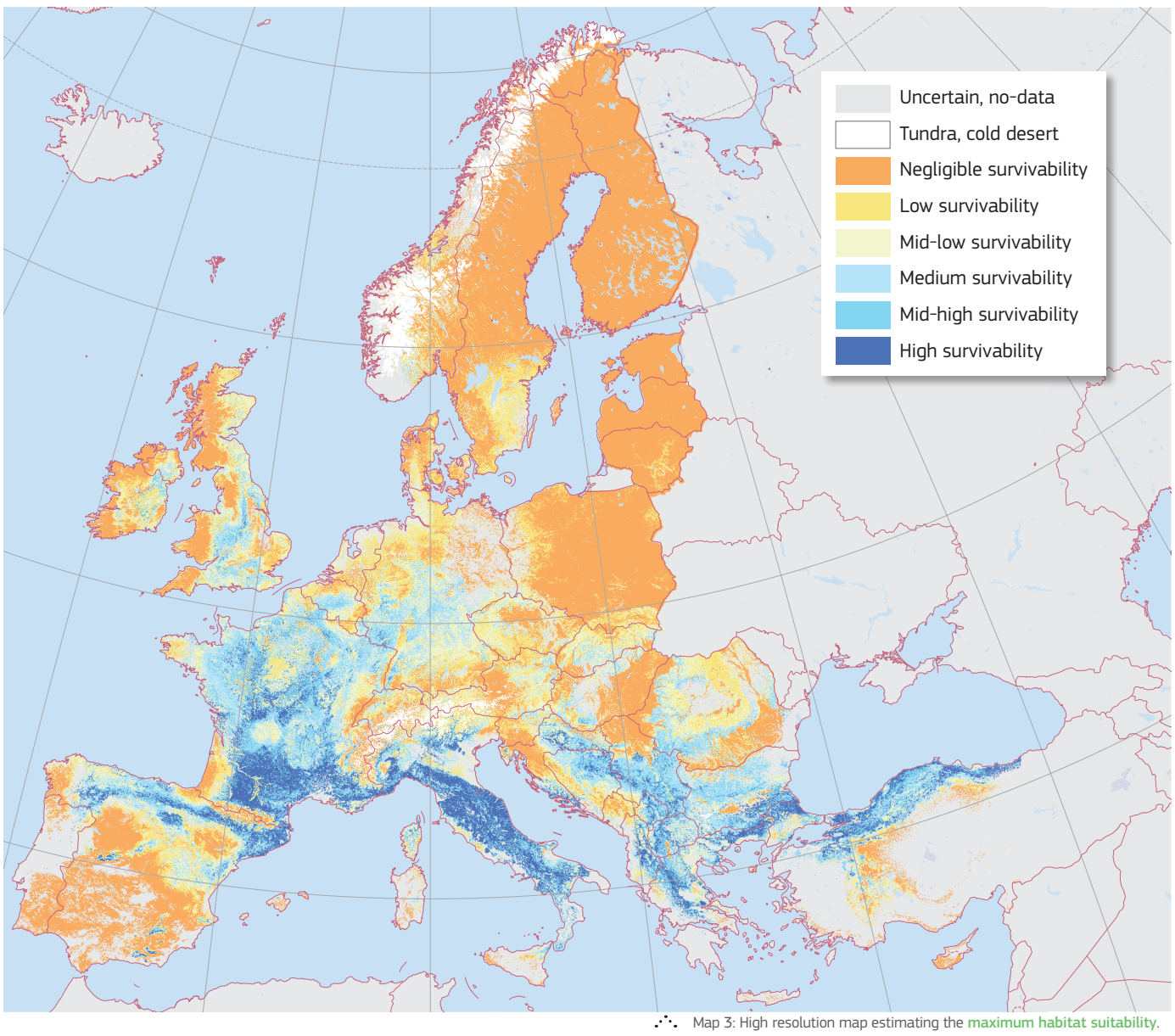
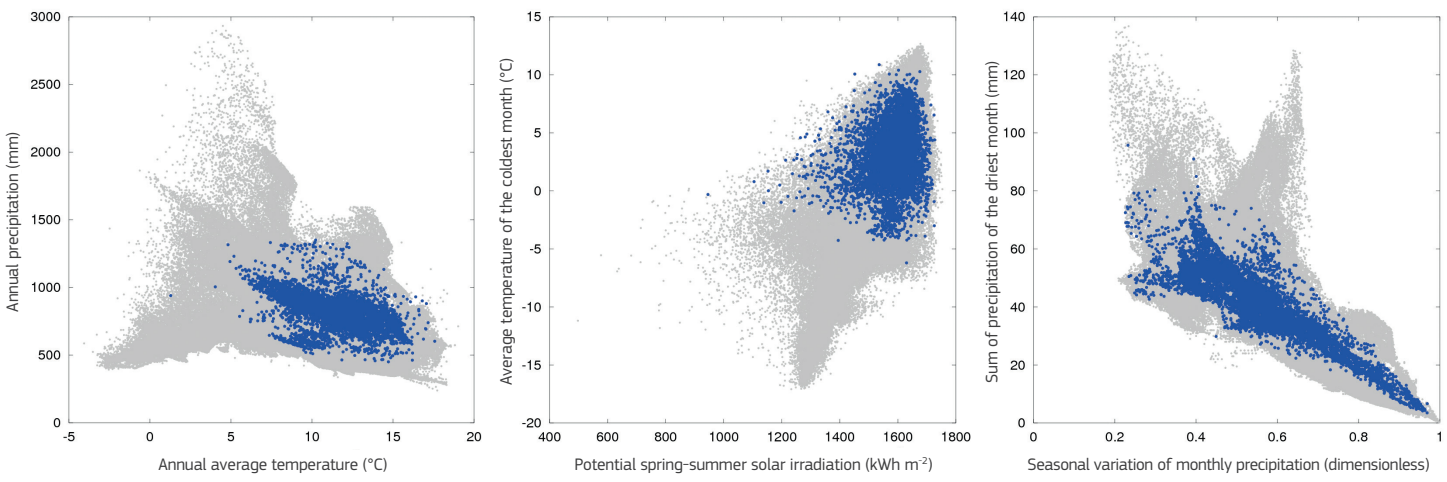


Map 3: High resolution map estimating the **maximum habitat suitability**.



Autoecology diagrams based on harmonised **field observations** from **forest plots**.

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