Pinus mugo and *Pinus uncinata*

Pinus mugo in Europe: distribution, habitat, usage and threats

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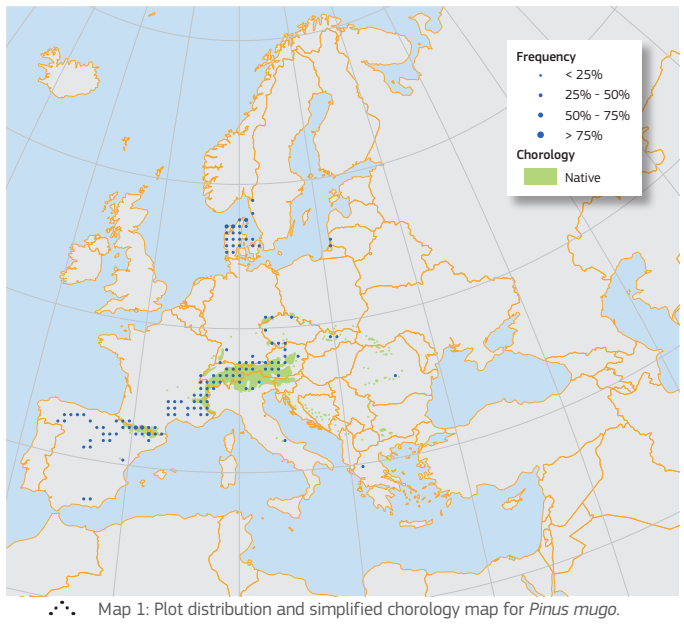
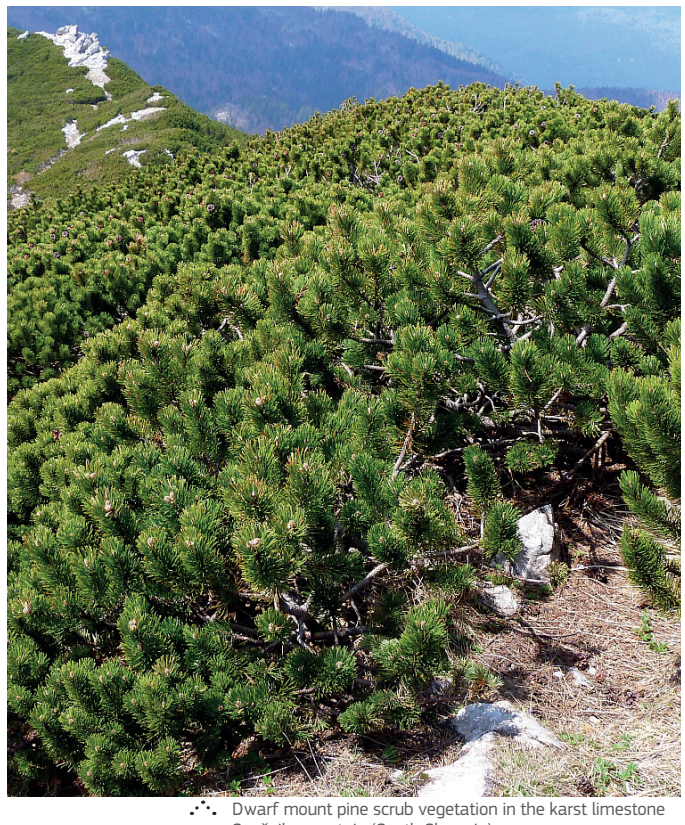
***Pinus mugo* Turra, the dwarf mountain pine, is a small tree, or, more typically, a shrub with many spreading stems, and dense, two-needled shoots. Among European pines, it is the most tolerant to cold climates and to bedrock lithology, adapted to any rocky habitat in the high-altitude mountains of Central and Eastern Europe, while merging with the closely related species *Pinus uncinata* on its western range. It forms widespread, pure scrubland communities over the tree limit, but also occupies avalanche tracks and rocks in the middle altitudes. It plays a major role defending mountain soils from erosion.**

The dwarf mountain pine (*Pinus mugo* Turra) is a shrub, erect bush or small tree showing very large variability in morphological and anatomical characters and including many distinct subspecies and varieties[1-3]. *Pinus uncinata*, the Pyrenean pine, is a big tree closely related to *Pinus mugo*, as shown by molecular markers which indicate the absence of species differentiation[4, 5]; nevertheless they will be treated here as independent species[1, 6-8]. Intermediate forms between *Pinus mugo* and *Pinus uncinata* are *Pinus mugo* subsp. *rotundata*, *Pinus mugo* subsp. *pumilio*, and others, and they all grow together in Central European mountains[1]. All of these pines are also able to hybridise with Scots pine (*Pinus sylvestris*) where they co-occur[9]. Most often the dwarf pine is a shrub growing up to 5 m, sometimes with ascending (**decumbent**) branches which can spread up to 10 m from the tree[1, 2], but there is also an erect form which grows as small tree up to 20 m in height[9, 10]. The needles are **acuminate** and pungent, 2 to 5 cm long, borne in **fascicles** of 2, and they persist on the tree up to 6 years. Physiologically the branches mature when they are 10 years old and start producing female cones in groups of 1-4, close to shoot tops. Unripe cones start diverging from the shoot, soon becoming horizontal or even reflexed; once ripe they are 2 to 5 cm long and 1.5 to 3 cm wide. The seed ripens during the second year after blossoming and is up to 5 mm long. At the outer end of cone scales a is shield (apophysis), which is of significant taxonomic value to distinguish subspecies as its size and shape are very variable[6, 9, 11, 12]. In the typical form (*Pinus mugo* subsp. *mugo*) cone scales are ended by a flat **apophysis** and are born on ascending branches. Two other subspecies have relatively larger and asymmetrical reflexed cones with protruding **apophysis**, which are born on erect branches (*Pinus mugo* subsp. *pumilio* and subsp. *rotundata*)[6, 9, 13, 14].



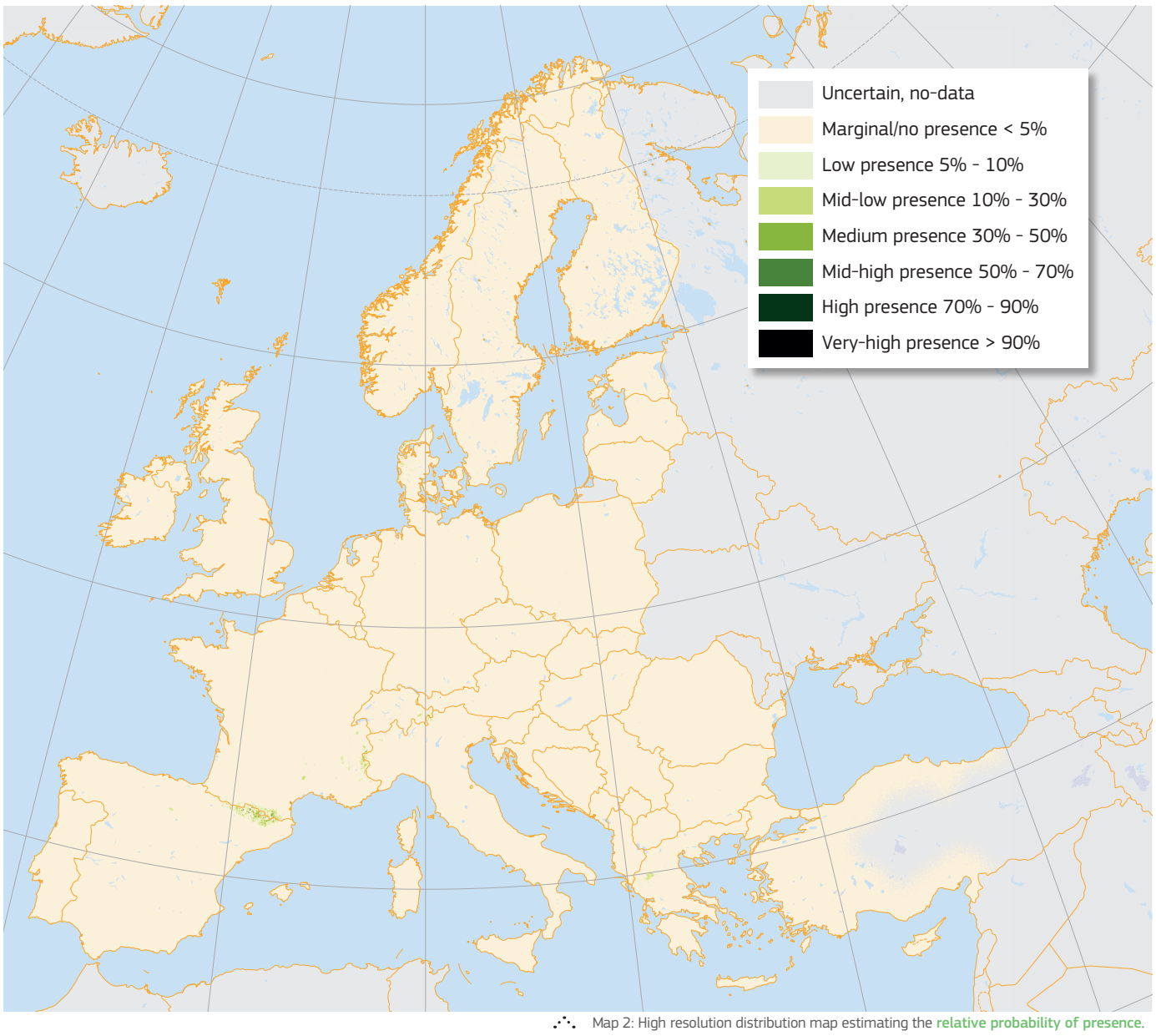
Map 1: Plot distribution and simplified chorology map for *Pinus mugo*.
Frequency of *Pinus mugo* occurrences within the field observations as reported by the National Forest Inventories. The chorology of the native spatial range for *P. mugo* is derived after Critchfield and Little, and Jalas and Suominen[31, 32].



Dwarf mount pine scrub vegetation in the karst limestone Snežnik mountain (South Slovenia).
(Copyright Stefano Zerauschek, www.flickr.com: AP)

Distribution

The typical dwarf pine scrub (*Pinus mugo* subsp. *mugo*) occurs in the mountains of Central and Eastern Europe, from 200 to 2 700 m, but is especially abundant in the subalpine belt of the Eastern Alps and the Carpathians between 1 600 to 2 200 m. Disjunct ranges occur in the lower mountains of the Jura and the Vosges, and at high altitude in the Mediterranean and Balkan mountains, such as the Apennines, the Albanian Alps, and the Rila-Pirin-Rhodopes in Bulgaria[9, 12]. The southernmost reliefs in Southern Italy, Greece and Crete do not have a dwarf pine belt. *Pinus uncinata* occurs in the Pyrenees, Western Alps and there are also scattered populations in the North-East Spain, with an altitude range from 600 to 2 400 m[14, 15]. The intermediate form *Pinus mugo* subsp. *rotundata* is present in the Alps and Central European mountains (Bavarian Forest Mountains, Sudetes Mountains, North-West Carpathians)[3, 16] from 180 m (Poland) up to 1 800 m[10, 11]. The genetic diversity reveals a strong geographic differentiation that retains ancient imprints reflecting multiple survival areas during the last glaciation[4]. According to palaeobotanical evidence, the dwarf pine experienced a successful expansion during the Last Glacial Maximum at the border of glaciated areas both south and north of the Alpine ice sheets[17-19].



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

Habitat and Ecology

The dwarf mountain pine is a **xerophyte** fully adapted to **petrophytic** habitats, and requires a lot of light[2, 10]. It spreads over poor substrata, which lack nitrogen and are free-drained. Its main habitat is in massive fissured bedrock and blockfields, and even alluvial fans and sand dunes. It tolerates many types of bedrock, such as limestone, dolomites, sandstone, gneiss and granite, hence these communities spread irrespective of lithological composition[10, 20]. It may also withstand **anoxic** peatlands due to its adaptation to low nutrients and light availability in raised bog habitats[21]. It can endure low temperatures, with mean annual values down to 5 °C and 200 to 3 000 mm of precipitation[22, 23]. Given its cold-tolerance, it is most successful in a subalpine belt over the treeline, developing extensive scrublands with hairy alpenrose (*Rhododendron hirsutum*) forming the association *Mugo-Rhododendretum hirsuti*. On high altitude limestone sites it can be found with spring heath (*Erica carnea*) in the *Erico-Pinetum mugi* communities mainly on warmer slopes[10, 23]. The competition with other woody species may be lower at high elevations, but, most frequently soil acidification, due to needle littering triggers, leads to a long-term succession towards conifer forests of the *Vaccinio-Piceetalia* communities.

Importance and Usage

Pinus mugo, in contrast to other pines, has an extensive root system with many branches consolidating loose soils. It also bears long stems lying on the ground. Thanks to these properties,

Cluster of male pollen cones at the top of the shoot.
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Open forest of Pyrenean pine (*Pinus uncinata*) in the karst Larra-Belagua massif (Navarra, North Spain).

this plant has a great role in preventing torrents and avalanche erosions on high mountains.

The wood is elastic but hard, suitable for manufacturing small items and valuable as fuel. There is a large number of cultivars used in horticulture and it is grown in gardens for decorative planting[2, 6, 9, 24]. Pine needles are filled with vitamin C and carotene. Beverages made out of them are recommended to reinforce the immune system, if one has a cold, and to cure scurvy. Needles should be used fresh, if possible moments after collecting, because they can completely lose their healing properties after a year[2, 12]. Syrups and liquors are commonly obtained with cones and buds. Essential oil distilled from the leaves exhibits good antioxidative activity in **lipophilic** media[25].

Threats and Diseases

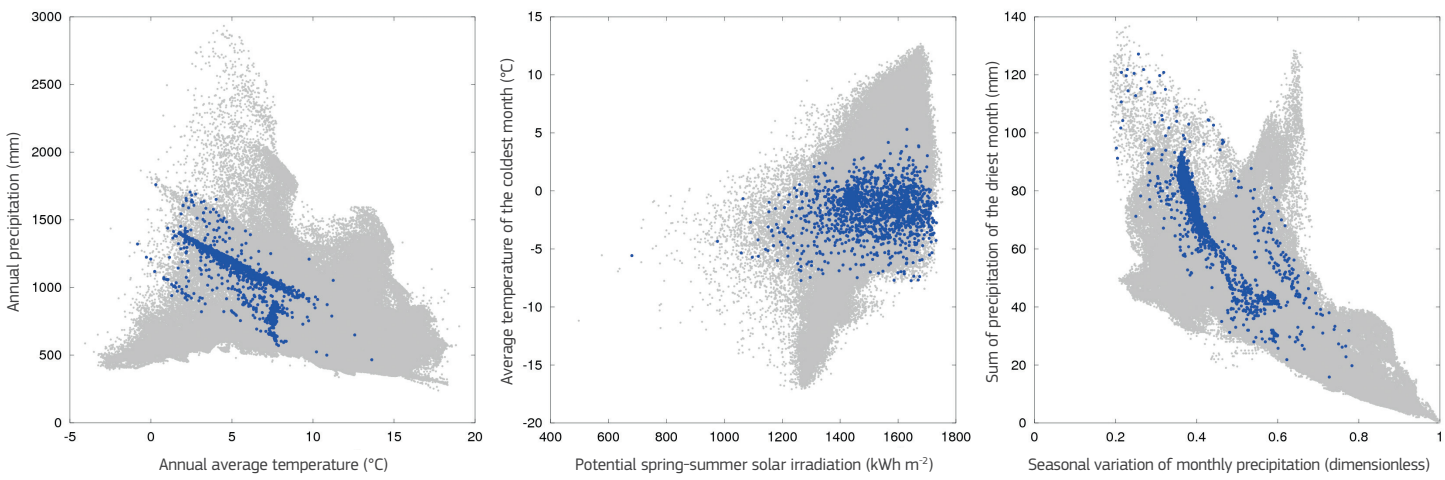
Even though it grows at high altitudes, the dwarf mountain pine is threatened by some pathogenic fungi associated with root-rot, but significantly affecting the living trees in adjacent forests[26]. Other fungi colonise the needles, the bark and needles[27]. Insect pests are not dangerous. But actually the biggest threat for *Pinus mugo* is humans. Pine scrublands were cut and burnt in order to enlarge pastures, especially since the Middle Ages expansion of mountain animal husbandry. Given its low stature and scrubland density, dwarf pine habitus may favour the spread of fires; hence, frequent human-caused fires may eliminate them[28]. This is why the dwarf pine has become extinct on several mountains in Central Europe and the Balkan Peninsula, although in recent decades land use changes have allowed the reversed process of invasion by dwarf pine in abandoned grasslands[29, 30].

Scrubland of dwarf mountain pines in the karstic Valley of Five Polish Lakes (Dolina Pięciu Stawów Polskich) in Tatra National Park (Gmina Bukowina Tatrzańska, South Poland).

Terminal shoots with 2 maturing seed cones.

Field data in Europe (including absences) ● Observed presences in Europe ●

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



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