

Betula pendula, Betula pubescens and other birches in Europe: distribution, habitat, usage and threats

P. Beck, G. Caudullo, D. de Rigo, W. Tinner

Silver birch (*Betula pendula* Roth) and downy birch (*Betula pubescens* Ehrh.) are short-lived, relatively small broadleaved trees that occur throughout most of Europe, particularly in northern regions. In southern Europe, birch trees are confined to mountainous areas, as they do not tolerate prolonged summer drought. Birch has a light canopy of small serrated leaves, and characteristic smooth, white to grey bark. In northern regions, birch trees can dominate the landscape up to the tree-line, whereas in the centre of their range they often occur early in secondary succession because of their abundant seed production, low demands on soil quality, and intolerance of shade. Birch trees provide the predominant hard wood source in northern Europe, and some varieties of *Betula pendula* produce highly priced veneers, while *Betula pubescens* is mostly used for pulp and fire wood. Other rarer species of birch are endemic to Europe contributing to the continental biodiversity even at high elevations and latitudes.



Isolated silver birches (*Betula pendula*) at the forest edge in Brkini Hills (South-West Slovenia).
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Betula pendula Roth is a medium-sized tree, growing up to 30 m, while *Betula pubescens* Ehrh. is relatively shorter, rarely growing beyond 20m and also less towards its northern range limits, up to dwarf trees in extreme habitats in the northern tundra and on mountains^{1,2}. The bark of young trees is brown in colour; when mature it turns silvery-white, with horizontal dark grey lenticels, that with age darkens and develops fissures. The bark of the *Betula pendula* is a brighter white and shinier than that of *Betula pubescens*, and its branches characteristically droop, whereas those of *Betula pubescens* grow upwards or horizontally. In addition, *Betula pubescens* shoots are covered with a smooth fine down, as opposed to the hairless shoots of *Betula pendula*. *Betula pendula* leaves are coarsely and unequally double-serrated, larger than those of *Betula pubescens* (3-7 cm vs. 2-5 cm), and end in a fine point. *Betula pubescens* leaves are egg shaped, with a finely serrated margin and end in a shorter point³. Both species are **monoecious** with male and female



Female catkin of silver birch (*Betula pendula*) in spring.
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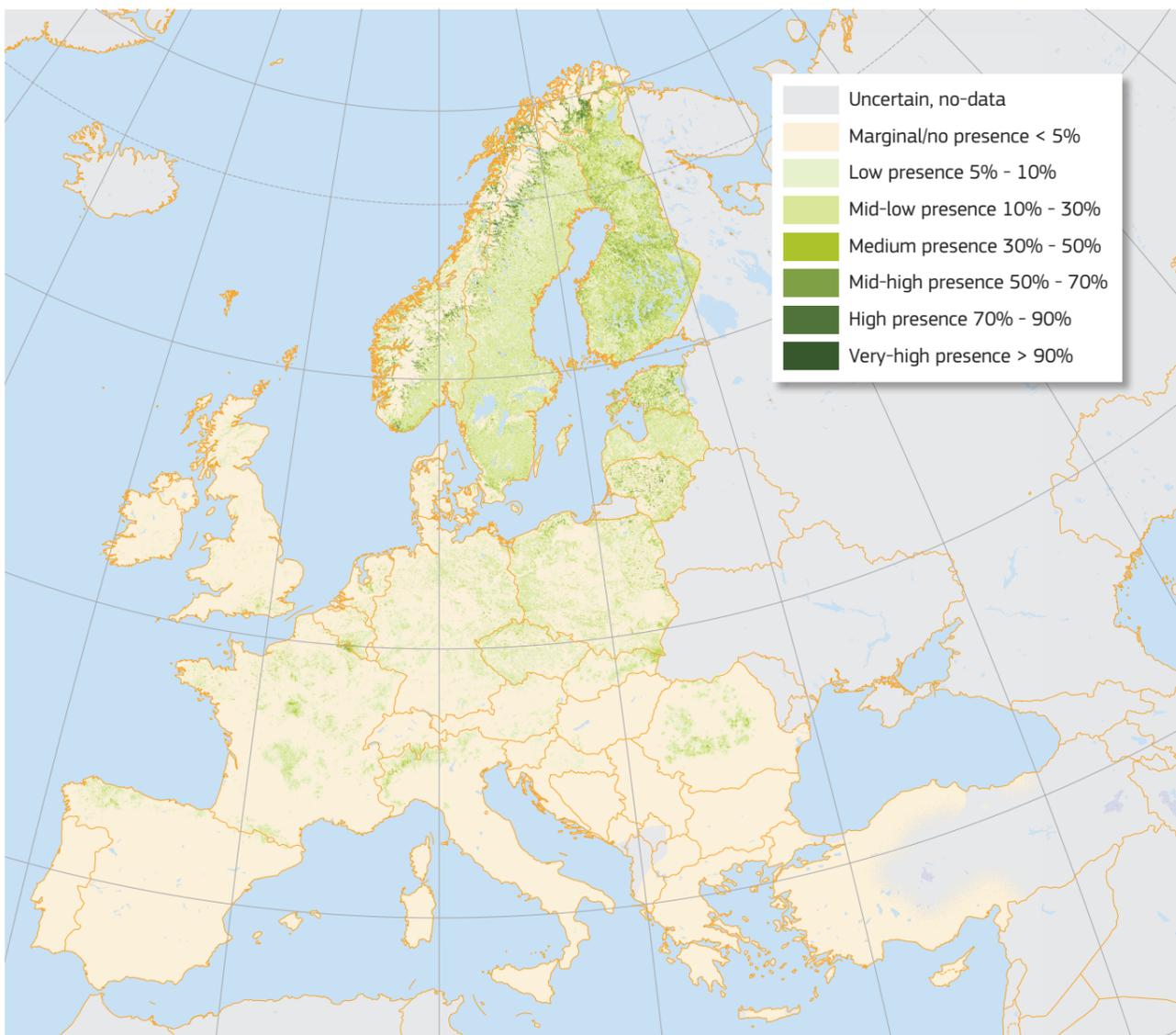


Silvery-white bark on a young tree with dark scars from dropped shoots and small horizontal dark grey lenticels.
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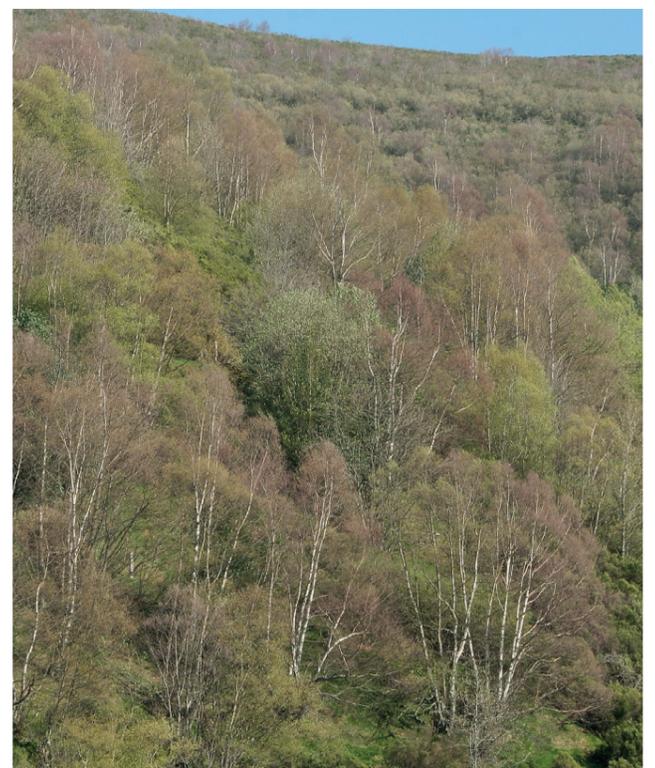
inflorescences developing as **unisexual** catkins, wind pollinated. Male catkins develop in summer, shedding pollen the following spring, a few days after female flowers have emerged. Female catkins are smaller, shorter and more erect than the longer, hanging, and clustered, male ones. Female catkins develop into fruits that are 1 to 4 cm long and 6 mm wide cylinder-shaped aggregates that eventually each disperse hundreds of small, winged fruits around August, with the amount varying with tree age and site conditions⁴. In denser stands, birch trees do not flower until they are 20-25 years old but free-standing trees can already flower at the age of ten. While it flowers every year, the production of viable seeds usually peaks every 2-3 years.

Distribution

Betula pendula and *Betula pubescens* occur naturally throughout most of Europe up to central Siberia. *Betula pubescens* has a more northerly and easterly distribution, growing further north in Europe than any other tree species, whereas *Betula pendula* can reach southern regions such as Iberian Peninsula, South Italy and Greece⁵. Given their wide distribution, these two birches show a high morphological variability and different subspecies and varieties have been described⁶. Moreover, in most parts of Europe they are **sympatric** and can naturally hybridise, generating plants



Map 2: High resolution distribution map estimating the relative probability of presence for the whole genus *Betula*.



Mixed broadleaved forest dominated by birch near Vallado (Asturia, North-West Spain).
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Summer foliage and maturing green hanging fruits. (Copyright Alan Semper, www.naturespot.ork.uk: AP)

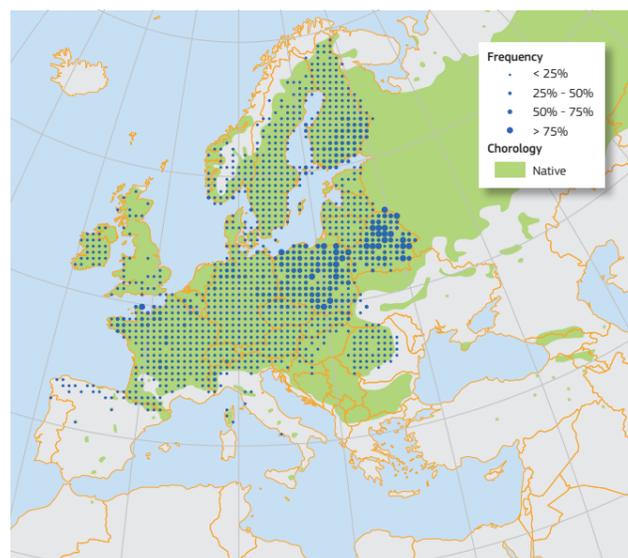
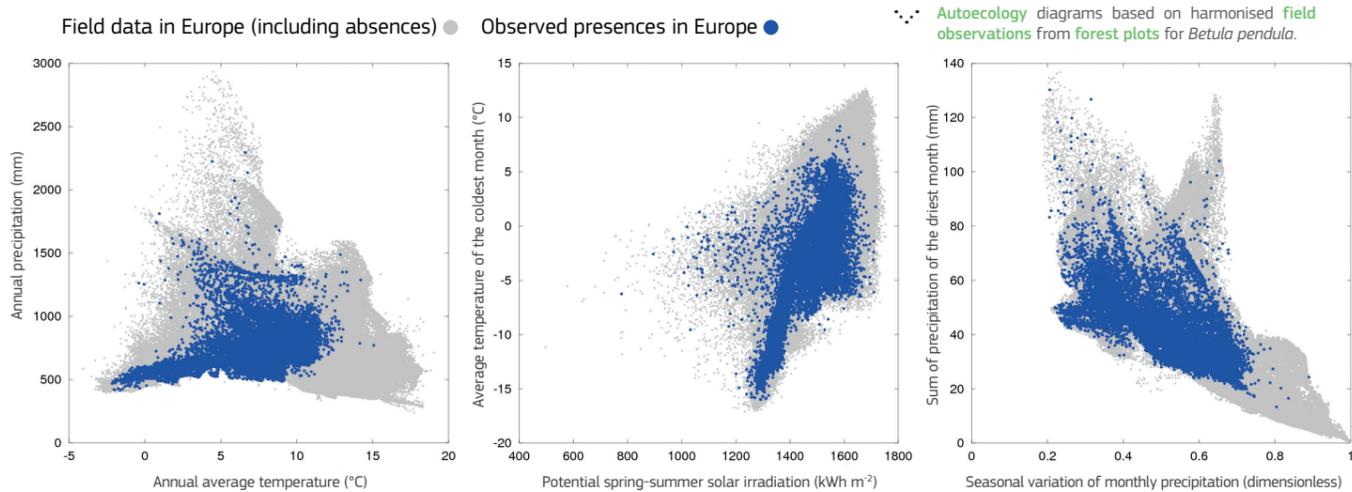
with intermediate morphological traits⁶. Birches can also generate **polyploid** forms, and this aptitude, associated with the variability, the hybridisation and the more recent introduction of artificially propagated cultivars outside the natural distribution, complicate remarkably not only their identification but also the taxonomical classification of the whole genus *Betula*^{2, 7-9}.

Habitat and Ecology

Birch trees commonly live for 90-100 years, and, more rarely, up to 150 years. They are light-demanding, can grow rapidly also on poor soils, their winged fruits are very efficiently distributed by wind and its roots are easily associated with a large number of **ectomycorrhizal** fungi¹⁰. These characteristics combine to make birch trees thrive as pioneers during early stages of secondary vegetation succession. They are valuable in the natural or **anthropogenic** regeneration of woodlands, particularly in the centre of their distribution range¹⁰⁻¹². *Betula pendula* grows best on fairly fertile, light, well-drained soils, particularly when soil conditions are acidic, while *Betula pubescens* tolerates damper soils and poorly drained heaths¹³. *Betula pendula* shows a moderate soil-acidifying ability¹⁴. Birches are most abundant in the boreal zone of northern Europe, where they can co-dominate or dominate in late-successional vegetation¹⁵. Owing to its cold-hardiness, *Betula pubescens* also has a higher elevational limit



Cylinder-shape mature fruits of birches, which are formed by hundreds of winged seeds. (Copyright Giovanni Caudullo: CC-BY)



Map 1-A: Plot distribution and simplified chorology map for *Betula pendula*. Frequency of *Betula pendula* occurrences within the field observations as reported by the National Forest Inventories. The chorology of the native spatial range for *B. pendula* is derived after EUFORGEN⁴².

than *Betula pendula*, often forming the alpine tree-line in Nordic countries. Both the northern and elevational distribution limits of *Betula pubescens* appear to be determined by exposure to cold, dry north-easterly winds in winter, since the species is not particularly wind resistant. Southern distribution limits appear to be set by summer drought, which both species, and particularly *Betula pendula*, do not tolerate¹⁰.

Importance and Usage

Birch provides the commercially most important source of hardwood in northern Europe, and is often an important component in conifer plantations, such as those of Scots pine (*Pinus sylvestris*) and Norway spruce (*Picea abies*). Birch plantations can also provide a protective habitat for seedlings of other tree species, including those that are more frost-sensitive, such as beech (*Fagus sylvatica*) and Norway spruce⁴. Because it can tolerate a broad range of site conditions, and poor soils in particular, birch is often used for land reclamation and revegetation, improving the soil so other broad-leaved or coniferous tree species can be planted later⁴. Birches are widely planted in urban areas, roadsides and parkland^{1, 16}. Some silver birch varieties, such as *Betula pendula* var. *carelica* (curly birch), are particularly sought after for veneers and ornamental wood products because they can produce curly grains¹². *Betula pubescens* is mainly grown for pulp wood and low-cost fuel wood, as its stems may be too small or poor for use as saw logs or veneers¹² even if veneer compression may be exploited¹⁷. In spruce plantations in Scandinavia, naturally generating birch trees increase biodiversity of birds¹⁸ and lichens^{19, 20}. Root pressure builds in the lead up to bud burst and causes sap flow early in spring²¹. This birch **xylem** sap was until recently commonly tapped and consumed in Eastern Europe, either fresh as a tonic, fermented (birch beer or wine), or concentrated into a syrup^{22, 23}. *Betula pubescens* is used as a medicinal and aromatic plant in Croatia¹. The leaves and bark of *Betula pendula* are used for their diuretic properties¹⁶. Ointments for eczema and psoriasis may use birch tar as an astringent ingredient²³. Birches grow at high altitudes and in European boreal areas. Since mountainous areas in Europe show



Birch trunks with yellow leaves in autumn. (Copyright Superior National Forest, www.flickr.com: CC-BY)



Downy birch (*Betula pubescens*) in Vaglaskógur Forest (Frjóskaðalur, Iceland).
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Male catkins of silver birch (*Betula pendula*) pollinating in spring.
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a soil erosion rate higher than the average - especially in the boreal mountain system²⁴, birches provide a particularly valuable service in watershed protection and soil stabilisation^{23, 25}. Both birches are effective in erosion control; furthermore, *Betula pendula* plays a role in soil strength enhancement and is used for vegetated crib walls²⁵. The observed colonisation of boreal areas above the **treeline** by *Betula pubescens* may indicate its further protection potential under climate change²⁶.

Threats and Diseases

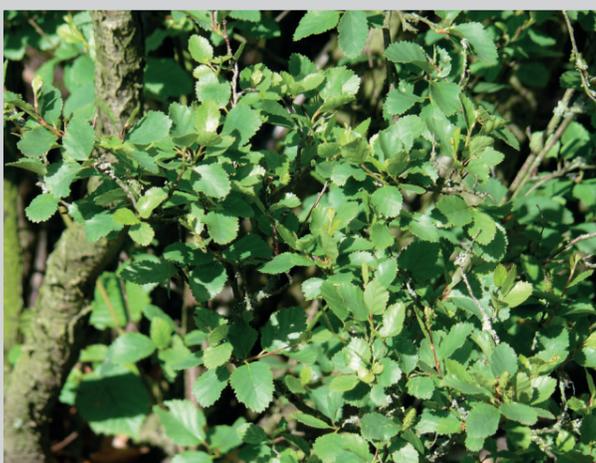
The bronze birch borer (*Agrilus anxius*) constitutes an increasing threat to birch trees. It is a wood-boring beetle native to North America, known to attack all species of birch (with varying susceptibility). Although healthy trees are generally able to produce callus tissue around the *Agrilus*' galleries, the European birches have little resistance and if the bronze birch borer were introduced in Europe no natural predators would mitigate its spread²³. Birch leaves are forage for the larvae of several butterflies, moths and

sawfly species. In some cases, such as that of geometrid moth species that feed on the leaves from the outside (e.g. *Epirrita autumnata* and *Operophtera fagata*) in northern **Fennoscandia**, this can cause pest outbreak conditions with cycles of mass defoliation, followed by collapse of the moth population²⁷. Larvae of other insects consume birch tissue from the inside either by burrowing through the leaf tissue, so-called leaf miners, or creating outgrowths, i.e. galls, in leaves, fruits, or fruit scales. Birch trees weakened by leaf miners become more susceptible to secondary invasion by the aforementioned organisms⁴. Fungal diseases can affect all parts of birch trees during all their life stages: birch rust (*Melampsorium botulinum*) affects birch leaves, and stunts growth, and reduces life expectancy. *Taphrina betulina* and *Taphrina nana* cause abnormal shot growth (so-called witch's broom) and leaf deformations. Yet other fungi, such as birch polypore (*Piptoporus betulinus*) causes wood rot, eventually killing infected trees. A range of fungal species are

Other birches in Europe

Shoots of the arctic dwarf birch (*Betula nana*) with small rounded leaves of 2 cm in diameter.
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In Europe other two main species of genus *Betula* are described: *Betula nana* (arctic dwarf birch) and *Betula humilis* (dwarf birch). Some authors identify other birch species, often rare, endemic and at the limits of the geographical ranges, which have not explicitly a defined systematic status and are treated in some case as hybrids, varieties or subspecies⁷. *Betula nana* is a shrubby birch occurring in a broad geographic range of Northern Europe, which spans from Iceland, Scotland and northern England up to Scandinavia and the Baltic area. In Central Europe it occurs at high elevations (northern Alps from Austria west to France; Carpathian mountains)³⁴. This birch lives in Arctic of high-mountain exposed environments. It is found in immature or peaty soils within alpine tundra, rocky barrens and moorlands, subalpine damp moorlands and open raised bogs³⁴. *Betula humilis* is another shrubby birch which has a very wide but scattered distribution, ranging from Western Europe with few locations in Germany, Austria, Poland, Romania and Switzerland, through Siberia up to Korea^{35, 36}. It is a relict birch distributed from the hill to the montane zone, preferring wet soils in forests and the edges of lakes. It may grow in shrubby pastures and alder thickets, transitional mires, on open raised or acid valley bogs and in natural/drainage fens^{35, 37}. Both these dwarf birches are **diploid**. They can naturally and frequently hybridise with *Betula pubescens* and *Betula pendula* in the overlapping living ranges, showing intermediate morphologies^{36, 38-41}.



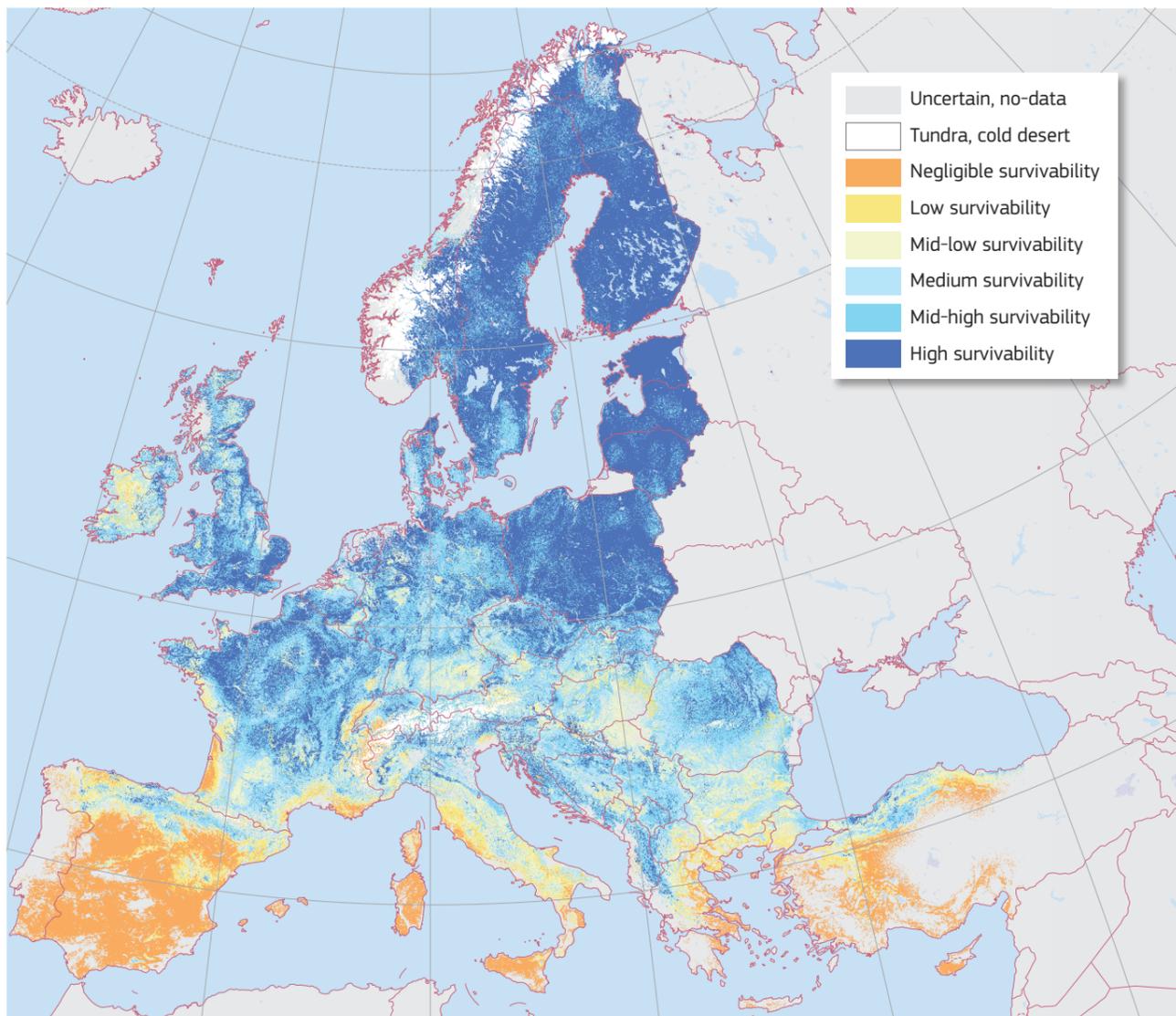
Foliage of dwarf birch (*Betula humilis*) with ovate and glabrous leaves.
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Triangular smooth leaves of silver birch (*Betula pendula*) with toothed margins.
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Red squirrel (*Sciurus vulgaris*) stripping birch bark.
(Copyright Peter Trimming: CC-BY)



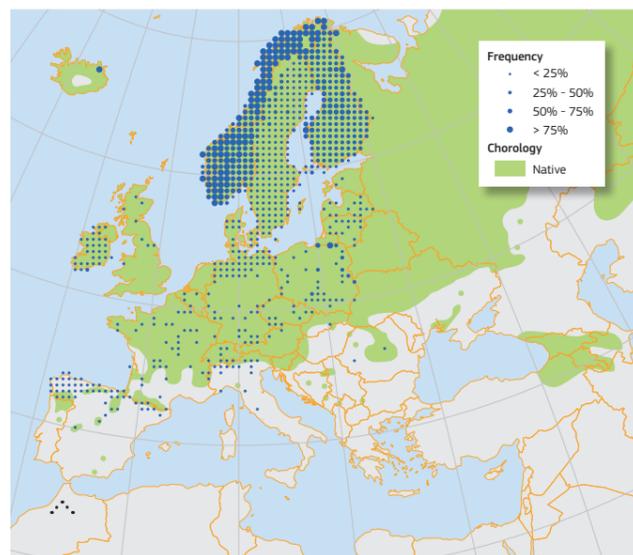
Map 3: High resolution map estimating the maximum habitat suitability for the whole genus *Betula*.

associated with more general die-back with affects crown health (i.e. *Anisogramma virgultorum* and *Discula betulina*)^{28,29}. Although the large pine weevil (*Hylobius abietis*) is mostly known as one of the most serious pests affecting young coniferous forests in

Europe, it is also harmful for *Betula pendula* which partly coexists with the natural niche of the large pine weevil³⁰⁻³². Herbivory by short-snouted weevils (*Strophosoma melanogrammum* and *Otiorhynchus scaber*) is another threat to birch³³.



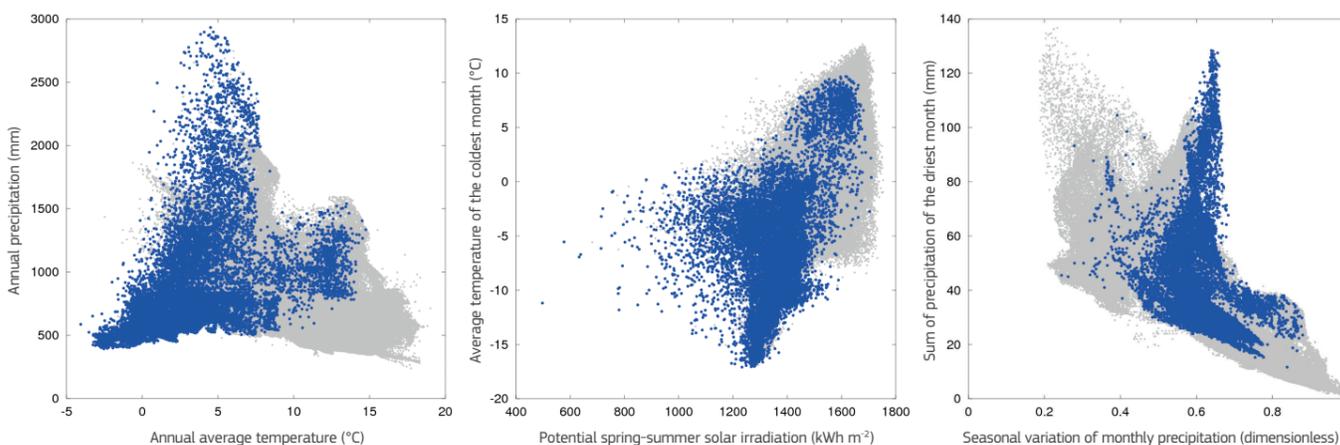
Young foliage of downy birch (*Betula pubescens*), which is covered by a smooth down, unlike the silver birch (*Betula pendula*).
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Map 1-B: Plot distribution and simplified chorology map for *Betula pubescens*. Frequency of *Betula pubescens* occurrences within the field observations as reported by the National Forest Inventories. The chorology of the native spatial range for *B. pubescens* is derived after Meusel and Jäger⁵.

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

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



Winter silver birch (*Betula pendula*) with covering of hoar frost in Babno Polje (Loška Dolina, South Slovenia).
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