Carpinus betulus in Europe: distribution, habitat, usage and threats

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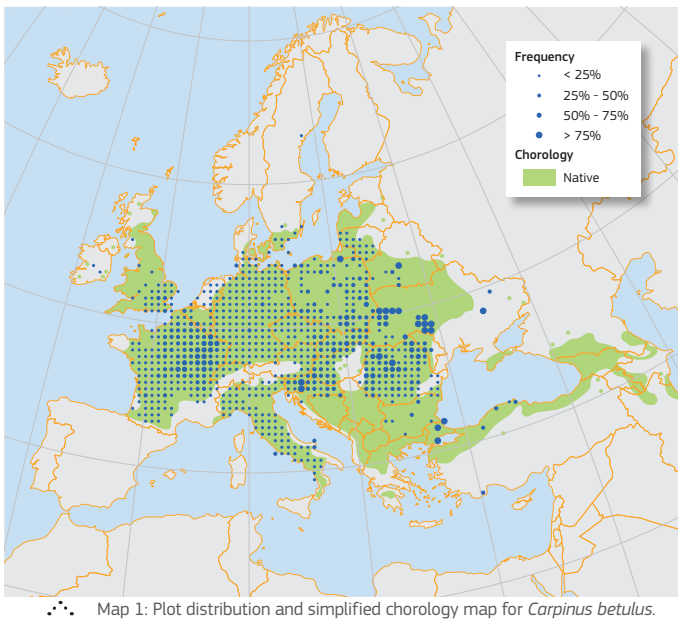
The common hornbeam (*Carpinus betulus* L.) is a small-medium deciduous tree which usually grows 20-25 m in height, rarely exceeding 30 m. In winter it is recognisable for its brown leaves which stay attached, dropping only in spring when the new green leaves are starting to come out. Its natural range extends from the Pyrenees to southern Sweden and eastwards to Iran. It is a typical temperate climate species along with deciduous oaks, requiring fairly abundant moisture and tolerant of a range of soil types. It can grow in full to partial sun, but it is also one of the few strongly shade tolerant native trees. Its wood is considered difficult to work due to its density and toughness, so this species has low silvicultural interest, except as a secondary species in mixed stands. In coppice forests it can provide firewood, very appreciated for its high calorific value.

The common hornbeam (*Carpinus betulus* L.) is a small-medium sized deciduous tree normally reaching heights of 20-25 metres[1-3], although in old growth forests heights can exceed 30 metres[4, 5]. The crown is irregular, ovoid or conic, becoming domed in old trees. The bark is smooth and steel grey, having a muscled character to its appearance[6]. The leaves are alternate, simple, **obovate**, with **serrated** margins, 8-10 cm long, opaque to dull green, with prominent parallel veins[2]. They are quite similar to those of the beech (*Fagus sylvatica*), but less shiny[6]. Leaves do not drop in winter, but only in spring when the new green leaves are starting to come out (**marcescence**). The autumn colour ranges from yellowish-green to golden yellow[2, 6]. The hornbeam is **monoecious**: flowers are **unisexual**, borne in pendulous catkins[3]. The male catkins are loose, up to 6 cm long, expanding in spring as yellow curtains[2]. The female catkins are up to 15 cm long and to 6 cm broad. Flowers blossom from March to April and are wind-pollinated. The fruits are clustered in about 8 pairs of nutlets (**achene**), 6-8 mm, each pair at the base of a green leathery tri-lobate bract, 3.5 cm long[1, 6, 7]. The hornbeam is an abundant seeding tree and is marked by vigorous natural regeneration. Seeds often do not germinate until the spring of the second year after sowing[7].



Map 1: Plot distribution and simplified chorology map for *Carpinus betulus*. Frequency of *Carpinus betulus* occurrences within the field observations as reported by the National Forest Inventories. The chorology of the native spatial range for *C. betulus* is derived after several sources[8, 23-25].

Distribution

The hornbeam has a wide range which covers southern Europe (excluding the Iberian Peninsula), Central Europe, up to southern England and the south of Sweden. Eastwards it occurs across the Black Sea reaching the Caucasus and northern Iran[8]. Its altitudinal distribution ranges from sea level to 700 m in Central Europe, 1 000 m in the Western Alps and 1800 m in Iran[8, 9].

Habitat and Ecology

The hornbeam is a typical **mesophilous** species of temperate climates, occurring on lowlands, hills and the low mountain belt. High summer temperatures limit its distribution in the south, while it is a very hardy species and even found in frost hollows. It favours deep moist and well-drained soils from sub-acid to calcareous, although it can tolerate wet heavy clay to light dry sandy soils, but never acid[3]. It grows in full to partial sunny conditions and it is also one of the few strongly shade-tolerant native trees in Europe, though slightly less than beech[7]. For this reason this species can play roles both as a secondary species and as an understorey tree and also as a coloniser on bare and disturbed soils whose fertility is improved by its growth[3]. In mixed forests it can be a dangerous invader, regenerating better and faster than valuable timber species, such as oaks, ash (*Fraxinus excelsior*) or Scots pine (*Pinus sylvestris*)[3, 10].

The common hornbeam grows mostly in mixed stands dominated by deciduous oaks (*Quercus robur, Quercus petraea*), forming oak-hornbeam forest communities. This vegetation represents the classic European temperate forest on fertile soils, typically with ash (*Fraxinus excelsior*), small-leaved lime (*Tilia cordata*), wild cherry (*Prunus avium*), field maple (*Acer campestre*), common hazel (*Corylus avellana*) and spindle (*Euonymus europaeus*). The hornbeam can also be found in beech forests (*Fagus sylvatica*), while pure stands are more rare[11-14].

Mature male catkins in the spring.
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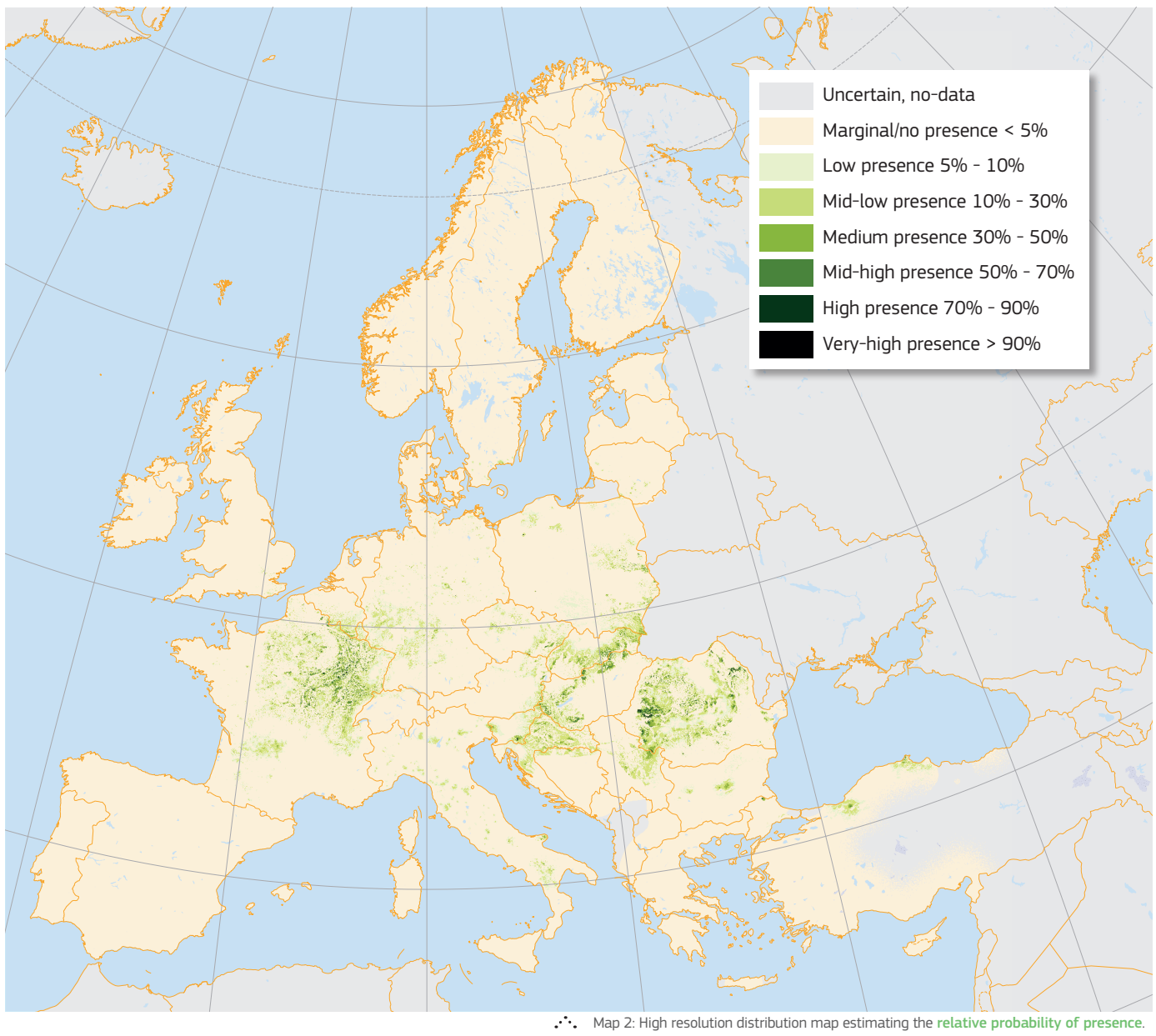

Map 2: High resolution distribution map estimating the **relative probability of presence**.

Mature tree in Schwetzinger Hardt forest (Upper Rhine Valley, Germany).
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Importance and Usage

The wood of the hornbeam is white, dense, very hard and strong[3, 15]. In fact the name hornbeam means 'horn tree' in allusion to its hardness. However, trees tend to have irregular form. The wood has cross-grains and is therefore difficult to work.

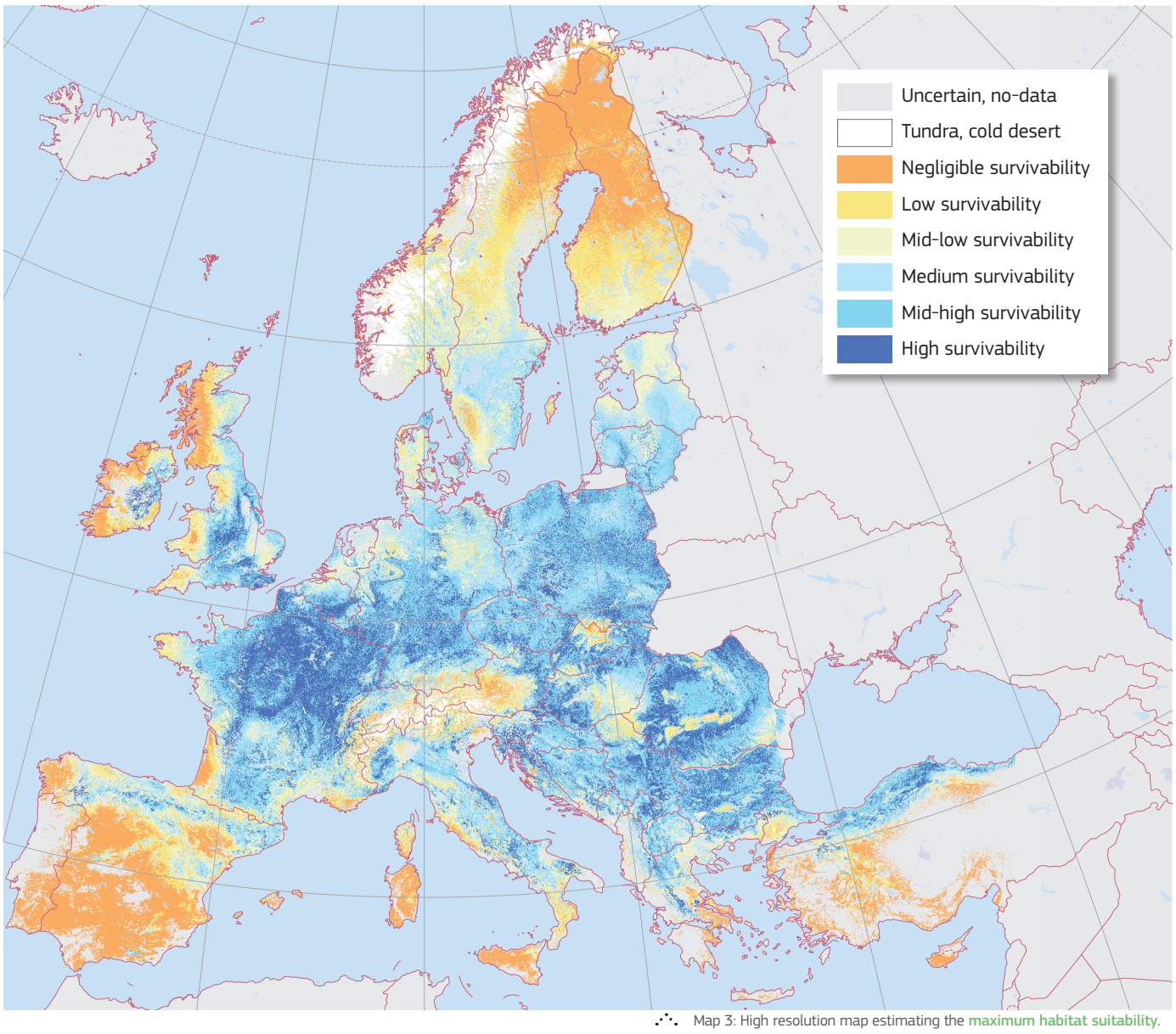
It is not flexible and shrinks greatly during the drying process. For these reasons hornbeam has low commercial interest and has never been industrially cultivated[16].

In the past when metals were scarce and costly it was used more, for making small items which require resistance to wear, such as tool handles, mill wheels, agricultural tools, wooden rivets, etc.[1]. More recently it is used for flooring, billiard cues, drumsticks and piano mechanisms, and sometimes as an alternative to maple[3, 7]. The wood has a high calorific value as it burns slowly, making it excellent fuel wood and charcoal[3, 7].

Because of its ability to regenerate from root suckers, it can be cultivated in mixed coppices alongside oaks, limiting them in producing **epicormic** branches. It responds well even when pollarded, making it a good hedgerow and fodder tree. The hornbeam is also planted with oak in afforestation plantations on bare sloping areas for soil protection from erosion and landslides and maintained as a bush when needed[3]. Different varieties are available for ornamental purposes; one of the more frequently used is the 'Fastigicata' with a regular balloon-shape crown, more rare is the 'Columnaris' with densely teardrop shape, or the 'Incisa' with small and deeply lobed leaves. They can be found in urban parks, gardens and along roadsides, locally abundant on richer soils[2, 6].

Threats and Diseases

Because of its minor importance as a species and the absence of recorded outbreaks, specific diseases and pests on hornbeam have not been exhaustively studied[3]. Infections of generalist fungi of the genus *Nectria*, causing cankers, or of the genus *Armillaria*, causing root rot, are reported, as hornbeam can be a susceptible host alongside more valuable trees nearby. Hornbeam can be also a minor host of non-specialised invasive insects: e.g. **polyphagous** defoliators, such as the brown-tail moth *Euproctis chrysorrhoea*, the winter moth *Operophtera brumata*, or wood miners, such as the long-horned beetle *Anoplophora chinensis*[3, 17-19]. As other species in the genus Carpinus, the common hornbeam may be attacked by the gypsy moth (*Lymantria dispar*)[20, 21]. It is also a susceptible host for the processionary moth (*Thaumetopoea processionea*)[20, 22].

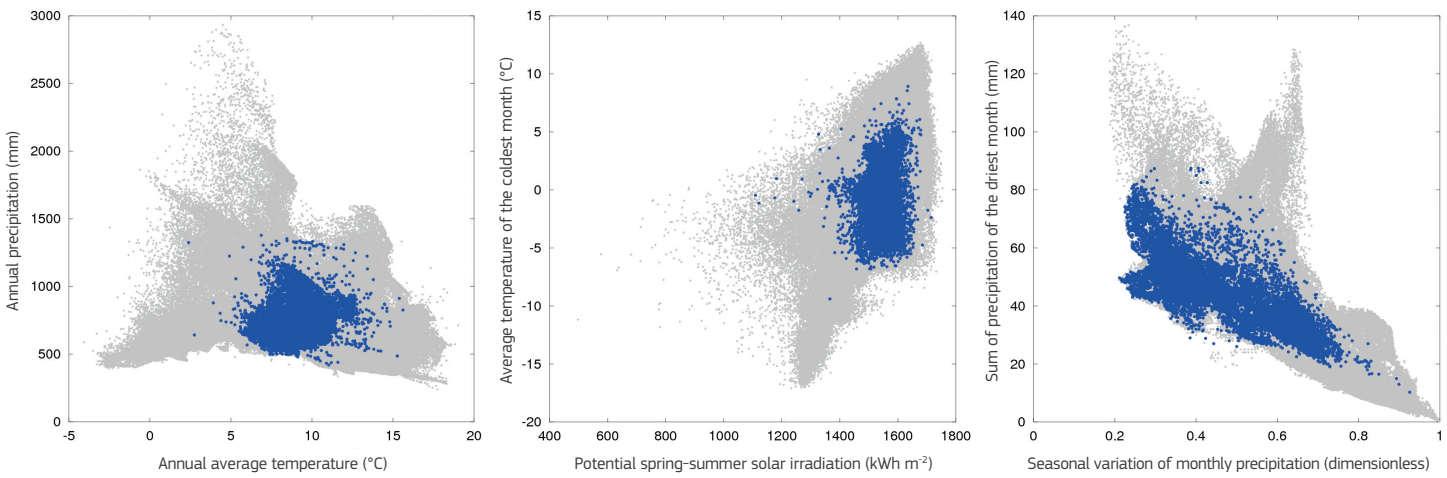


Map 3: High resolution map estimating the **maximum habitat suitability**.

Old neglected hornbeam coppice near Charlwood (West Sussex, England).
(Forestry Commission, www.forestry.gov.uk: © Crown Copyright)

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

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



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Obovate leaves with serrated margins: they are quite similar to those of the beech, but less shiny.
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