Robinia pseudoacacia in Europe: distribution, habitat, usage and threats

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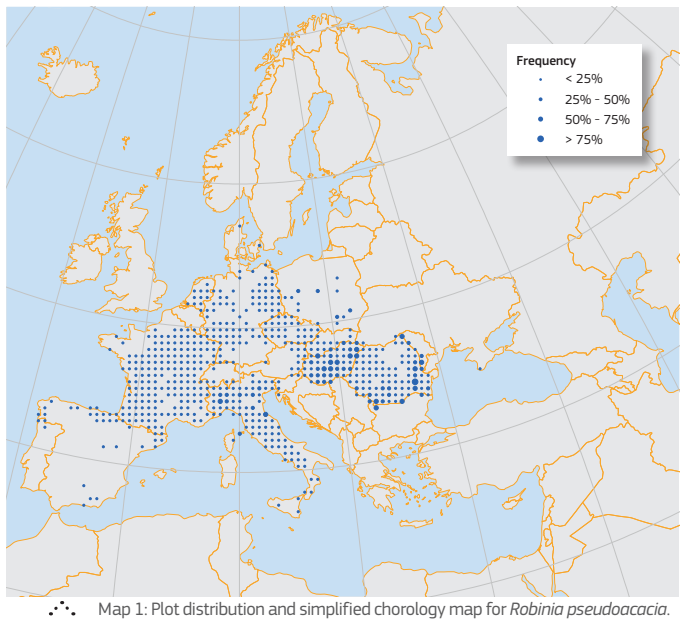
***Robinia pseudoacacia* L., commonly known as black locust, is a tree native to North America and is one of the most important and widespread broadleaved alien trees in Europe. It is a medium-sized, deciduous, fast-growing thorny tree with high suckering capacity. It has been extensively planted in Europe and now it is naturalised in practically the whole continent. Growing on a wide range of soil types, this tree species only avoids wet or compacted conditions. It is mainly distributed in sub-Mediterranean to warm continental climates and requires a rather high heat-sum. As a light-demanding pioneer species, it rapidly colonises grasslands, semi-natural woodlands and urban habitats, where it can persist for a long time. Owing to the capacity of fixing di-nitrogen through symbiotic rhizobia in root nodules, black locust can add high rates of nitrogen to soil which becomes available to other plants. The wood of black locust is durable and rot-resistant, making it adequate for multiple purposes such as fire and pulp wood, for fences, construction and furniture. In several parts of Europe, black locust is considered an invasive alien plant, because of shading and its ability to change soil conditions.**

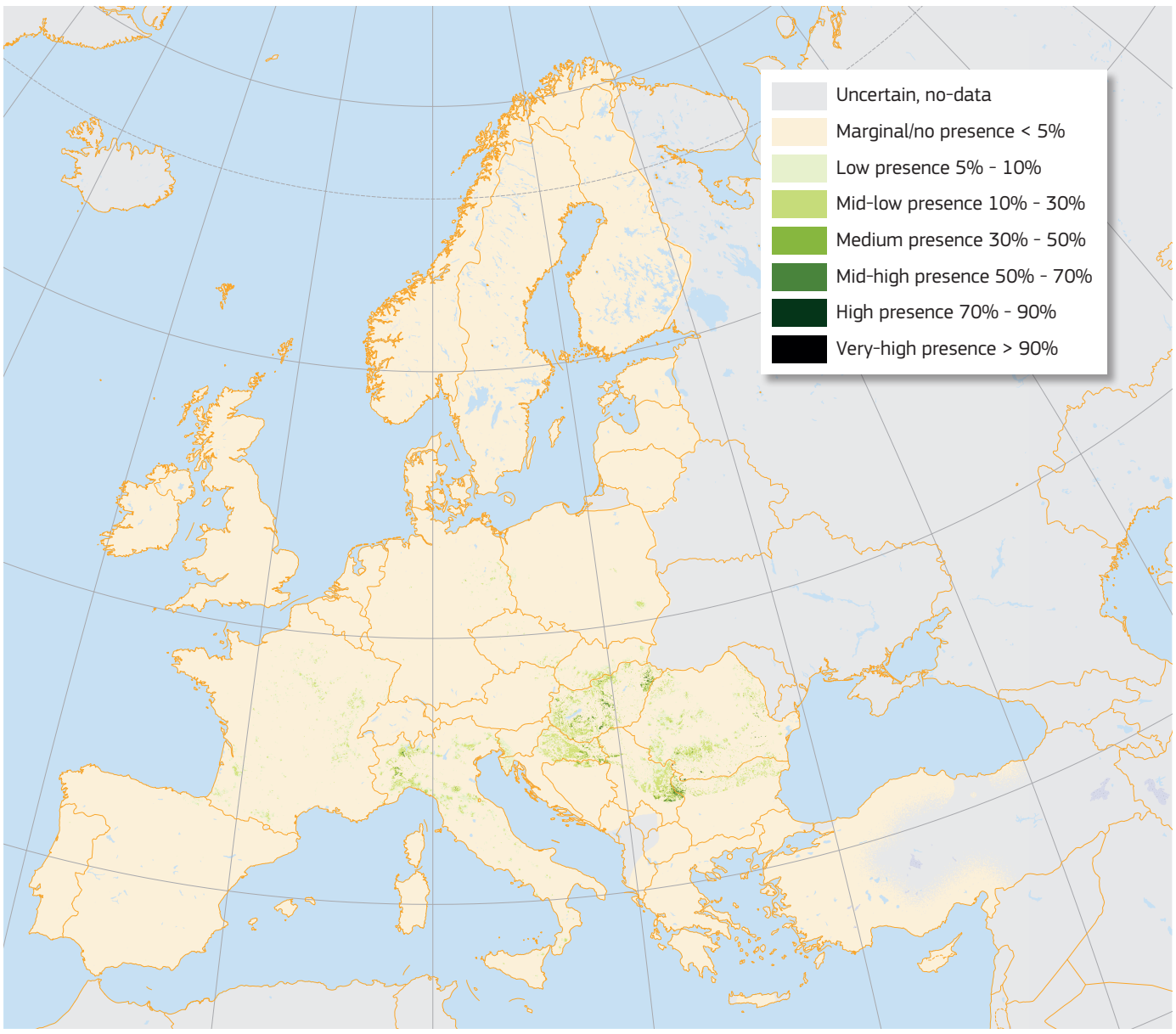
The black locust (*Robinia pseudoacacia* L.) is a medium-sized deciduous tree that commonly reaches 20 m as a single tree and 30 m within stands[1, 2], but capable of attaining heights up to 35 m in some locations[3]. It has a typical life span of about 60-100 years[4], although the current longevity record in Europe is for more than 300 years[5]. The tree is usually bent-stemmed with greyish-brown to dark brown bark, becoming longitudinally fissured with age. The leaves are composed, **pinnate**, 10-30 cm long, usually with a pair of spines at the base which persist on young shoots. The leaflets are commonly in 2-12 pairs, usually opposite, with an additional one at the end of the **rachis**. Leaf blades are oblong, elliptic or ovate, 2-5 × 1.5-2.5 cm, with entire margin. Black locust is a monoecious species: the hermaphrodite scented flowers have a white to cream corolla with yellow spots inside, up to 2 cm long and grouped in pendent, many-flowered, axillary racemes 10-20 cm long[6]. Black locust is a **monoecious** species: the **hermaphrodite**, white and fragrant flowers are arranged in pendulous **racemes** 10-20 cm long[6]. The fruit is a legume, 5-10 cm long dark brown pods hanging in winter and containing 4-10 seeds, mainly dispersed by gravity and wind[7]. Fruiting takes place once or twice per year at a tree age from 6 to 30-40 years[8].



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

Distribution

Black locust is widespread across Europe, occurring from Sicily in Italy to South Norway and longitudinally from the Portugal littoral regions up to the Caucasus[9-11]. Core areas in the alien range of this species are in sub-Mediterranean to warm continental climates, where a rather high heat-sum is available[7] and prolonged drought is rare[12]. It can be found from sea level up to 1640 m in the Southern Alps (Prosser F., pers. comm., July 1, 2015). The species was introduced in Europe in the early 17th century. Linnaeus dedicated the genus name to Jean Robin, who, with his son Vespasien, was among the first arborists to introduce and cultivate this tree in Europe[5]. In the late 18th and early 19th century extensive planting of black locust trees started in Central Europe. Currently it occurs in 42 European countries and is naturalised in 32[13], covering with pure and mixed stands, for example, 400 000 ha in Hungary[14], 200 000 ha in France[15], 250 000 ha in Romania[16] and 230 000 ha in Italy[17]. Although accounted among the 100 most invasive alien species in Europe[11], only a few countries have policies and initiatives to tackle it[18].



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

Biodiversity concerns

Black locust invasion has been proven to have an impact on biodiversity when compared with the native habitats. This applies to both plant[34-36], bird[37] and lichen[38] communities. These effects depend on the stand age and the landscape type. For example, the presence of black locust in recent secondary stands in rural landscapes does not seem to play a major role in shaping the diversity of the understorey plant groups compared to native stands[39]. In urban areas, it seems to have the ability to homogenize processes at the plant community level[36]. Further research is needed to elucidate the effect of different management techniques on the ability of black locust to invade adjacent forest and semi-natural habitats[30].

Habitat and Ecology

Black locust is a light-demanding pioneer species and grows either as an upright, single- or multi-stemmed tree or, in harsh environments, as a multi-stemmed shrub. It tolerates a remarkably diverse range of soil conditions, being only limited by low soil aeration and waterlogging. On steep slopes, black locust is usually less vigorous[19]. The tree is easily damaged by extreme frosts in winter and presents low adaptability to arid conditions[6, 20]. Climate warming is expected to favour its further expansion[21]. Its reproduction is primary asexual through horizontal root elongation[22]. It is able to produces a high number of root suckers and therefore exhibits the capacity for clonal growth, up to an area of 100 square metres[23]. Disturbance favours clonal growth and causes an increase in the number of suckers[19]. The invasion of black locust is well documented in early succession habitats, like abandoned gravel-sand pits and landfills, brownfields, secondary forests, coppiced forests, lowland pastures, roadsides, and burned sites[6]. As with other species of the Fabaceae (syn. Leguminosae) family, the roots of black locust host rhizobia bacteria in symbiotic relationship within structures called root nodules. These bacteria have the capacity to take di-nitrogen gas (N_2) out of the air and convert it to a form usable to the host plant (nitrogen fixation). This process makes nitrogen available to other plants, mainly through mineralization of leaf litter, and improves the quality of the soils. Black locust can add between 23 and 300 kg of nitrogen in a hectare every year[6]. So stands of black locust may generate substantial soil alterations, increasing the total soil nitrogen, the litter and the organic carbon, also changing soil pH and decreasing the total phosphorus[6]. Its adaptability and the capacity of transforming ecosystem processes are the reason for its adverse effects on biodiversity. However, inferior competitive ability in later successional stages is reported where stands have been left unmanaged for a sufficient time[24]. Black locust commonly contributes to the composition of deciduous woodlands, mainly oak and riparian woods, which are the most frequently invaded[12]. Stands dominated by black locust are cultural forest communities, which can totally differ from native forest vegetation[25]. As such, they have been either classified within the **phytosociological** separate class *Robinietea* or included in other units, as a derivative community[26]. Several associations have been described in Central Europe, among which *Balloto-Robinietum* (diagnostic species include *Ballota nigra, Bromus sterilis, Dactylis glomerata*) on poor **aeolian** sandy soils, *Solidagino-Robinietum* (diagnostic species include *Solidago*

Black locust in Berlin, Germany.

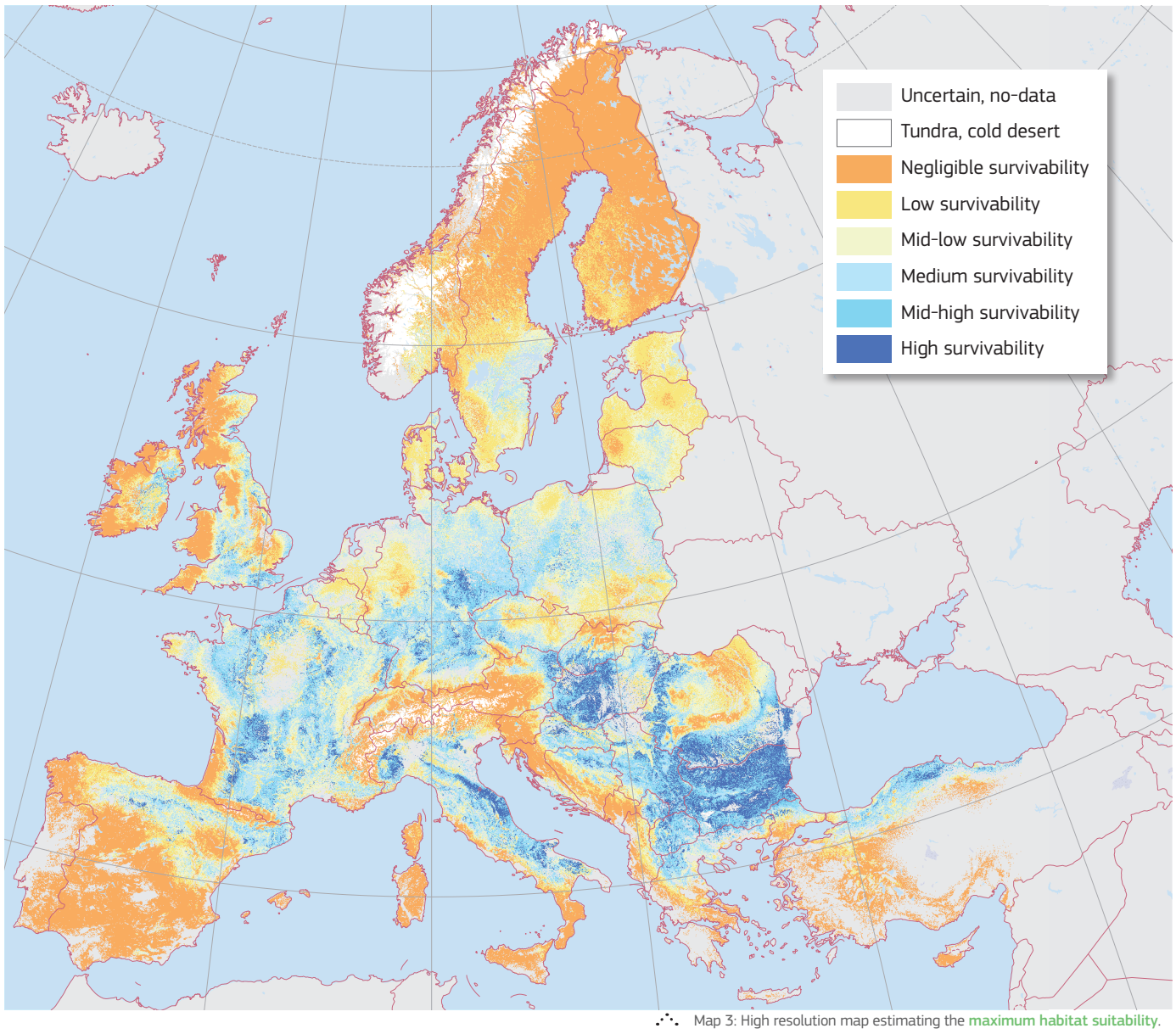
gigantea) on river valley soils, *Chelidonio-Robinietum* on slightly humid soils rich in humus, characterised by an understorey with the greater celandine (*Chelidonium majus*) and other species (*Sambucus nigra, Galium aparine, Urtica dioica, Geranium robertianum*), and *Poo nemoralis-Robinietum*, with herb layer dominated by *Poa nemoralis*, on slopes with acid bedrock[26].

Fragrant white flowers clustered in a long raceme. (Mezzana, Northern Italy).

Importance and Usage

Black locust has been strongly encouraged as a forestry tree in Europe. The yellow and greenish wood is durable, resistant to stem rot and insect damage, with a marked contrasted colour between young and mature wood. Black locust is appreciated as firewood because of its high calorific potential and the high suckering capacity which makes coppicing the most cost-effective management system. The mechanical properties of the wood is moderate to high, but shrinkage has been observed[6, 27]. The potential uses include fence posts, boatbuilding, flooring, furniture, mine timbers, railway sleepers, turned objects, and veneer. Moreover, it is a promising fast-growing tree species for biomass production[28]. Finally, black locust produces a fruity and fragrant honey[29], and its blossoms are used for cooking. However, all these uses should consider the risk of further expansion of black locust in adjacent threatened habitats[30].

Long legume which can contain 4-10 seeds.



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

Threats and Diseases

Large herbivores cause only minor damage to black locust trees in Europe. Until now, exclusively one gall midge (*Obolodiplosis robiniae*) and two moths (*Phyllonorycter robiniella* and *Parectopa robiniella*) are known to cause some damage[31, 32]. Many **lignicolous** fungal species have been detected in the alien range, of which more than 40 are parasitic. Moreover, 11 mildews and leaf-spot diseases have been recorded in Germany[6]. Finally, some viruses, potentially pathogenic to crops, are known from the alien range[33]. In general, threats for black locust in Europe are much fewer and of lower intensity than those in its native range[6].

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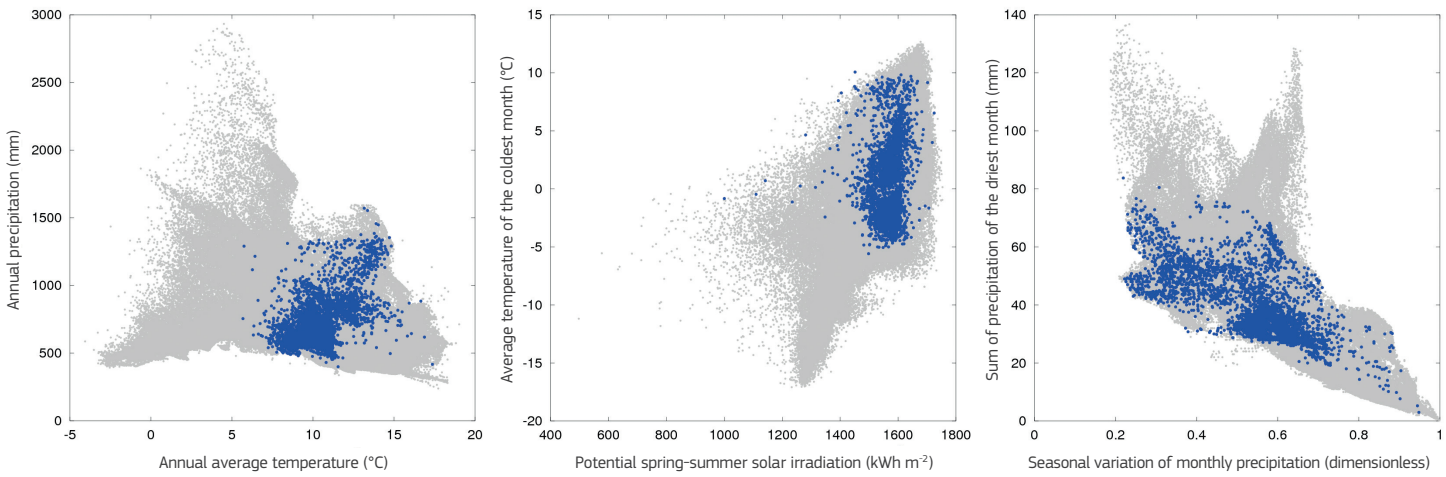
A stand with a dense carpet of celandines (*Chelidonium majus*) (Berlin, Germany).

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

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



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