How to read the Atlas

General information

This section provides a brief overview on how to understand the information provided in the species chapters present in this Atlas. In each chapter there is an extended summary of the current state of knowledge about that species, which is aimed to be written in an easily accessible style but at the same time scientifically grounded. Therefore, each chapter has been through a revision by scientific experts and includes a comprehensive list of scientific references. Although the chapters have been written by a number of different authors, they have been harmonized to obtain species information that is as homogeneous as possible throughout the Atlas. The full version of each chapter (expanded and fully peer-reviewed) will be published in the online version of the Atlas at http://w3id.org/mtv/FISE-Comm/v01/.

Each chapter starts with a summary and description of the species to continue with paragraphs concerning the species distribution, habitat and ecology, importance and usage and finally threats and diseases. Most chapters deal with a single species, although in a few cases the information is presented at **taxon** level (e.g. circum-Mediterranean firs).

A key contribution of this Atlas is the inclusion of innovative maps and diagrams concerning: 1) Frequency and **Chorology**; 2) Modelled Distribution; 3) Maximum Habitat Suitability; 4) Autoecology, for all those species for which sufficient data exist. High quality images are also included relative to forest habitat, individual trees or more detailed images concerning the bark, leaves, fruits and flowers.

Frequency and Chorology

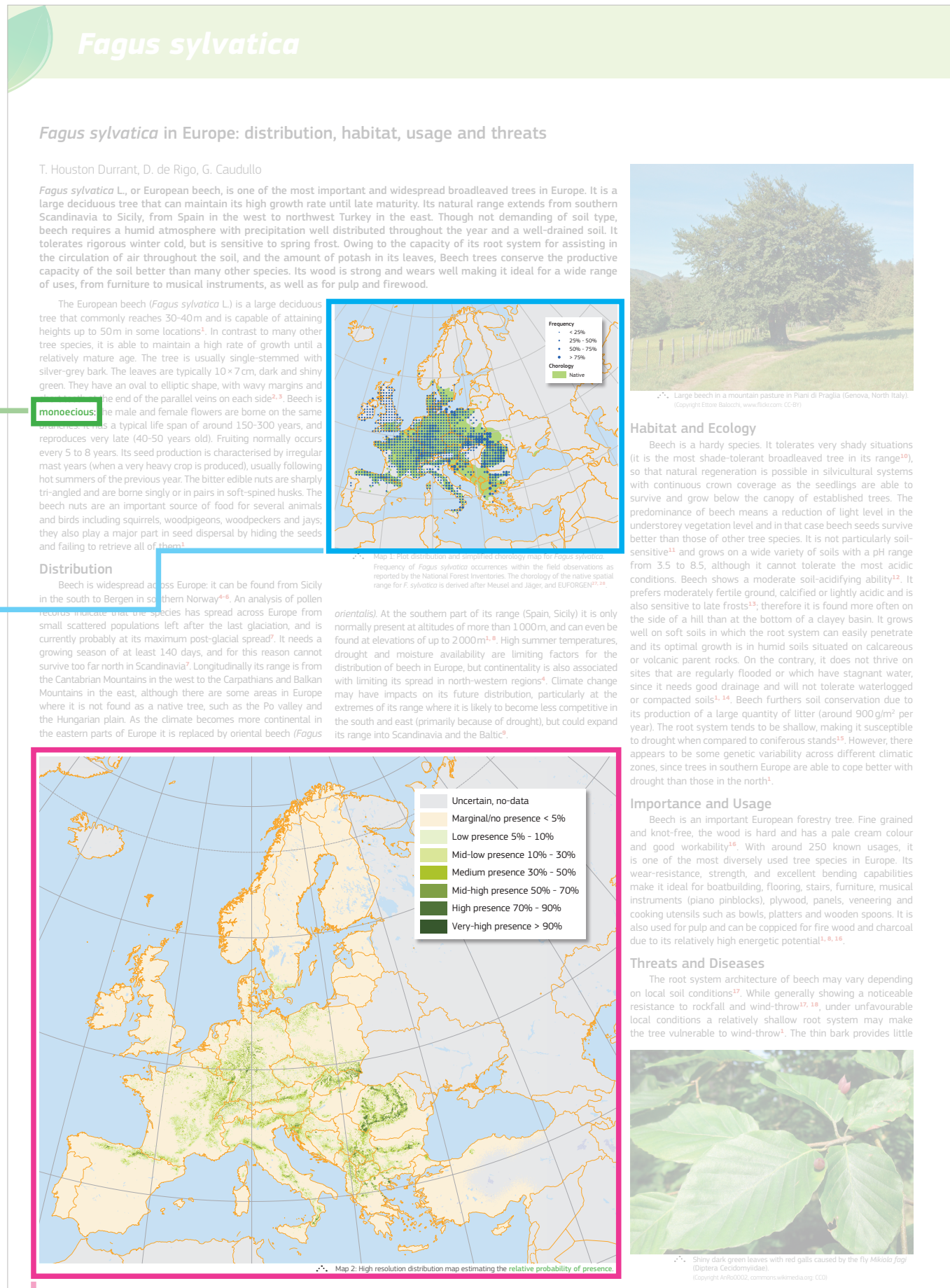
This map summarises two basic pieces of information concerning the species:

1. The species frequency over a 50 km square grid (blue dots): this shows the percentage of plots inside the grid that contain the species of interest. The sampling points are derived from the same datasets used to model the species distribution (Map 2) and the maximum habitat suitability (Map 3).
2. The species chorology: this is the broad range and qualitative spatial distribution of the tree species derived from one or more bibliographic sources. It is classified as "Native" (green area) when the species is thought to occur naturally and "Introduced" (orange area) when the species has been historically introduced and is nowadays naturalised. In cases where it is not possible to distinguish between the natural and introduced range, "*Actual*" range is shown.

For more details on the datasets and methodology used, as well as a list of the bibliographic sources used to construct the chorology, see the chapter "modelling, data and information on forest tree species" on page 40.

Technical terms

Technical words are presented in **this font** and are listed in the glossary on page 190 at the end of the Atlas.



Fagus sylvatica

Fagus sylvatica in Europe: distribution, habitat, usage and threats

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Fagus sylvatica L., or European beech, is one of the most important and widespread broadleaved trees in Europe. It is a large deciduous tree that can maintain its high growth rate until late maturity. Its natural range extends from southern Scandinavia to Sicily, from Spain in the west to northwest Turkey in the east. Though not demanding of soil type, beech requires a humid atmosphere with precipitation well distributed throughout the year and a well-drained soil. It tolerates rigorous winter cold, but is sensitive to spring frost. Owing to the capacity of its root system for assisting in the circulation of air throughout the soil, and the amount of potash in its leaves, Beech trees conserve the productive capacity of the soil better than many other species. Its wood is strong and wears well making it ideal for a wide range of uses, from furniture to musical instruments, as well as for pulp and firewood.

The European beech (*Fagus sylvatica* L.) is a large deciduous tree that commonly reaches 30-40 m and is capable of attaining heights up to 50 m in some locations[1]. In contrast to many other tree species, it is able to maintain a high rate of growth until a relatively mature age. The tree is usually single-stemmed with silver-grey bark. The leaves are typically 10 × 7 cm, dark and shiny green. They have an oval to elliptic shape, with wavy margins and [illegible] the end of the parallel veins on each side[2,3]. Beech is monoecious: the male and female flowers are borne on the same branches. It has a typical life span of around 150-300 years, and reproduces very late (40-50 years old). Fruiting normally occurs every 5 to 8 years. Its seed production is characterised by irregular mast years (when a very heavy crop is produced), usually following hot summers of the previous year. The bitter edible nuts are sharply tri-angled and are borne singly or in pairs in soft-spined husks. The beech nuts are an important source of food for several animals and birds including squirrels, woodpigeons, woodpeckers and jays; they also play a major part in seed dispersal by hiding the seeds and failing to retrieve all of them[1].

Map 1: Plot distribution and simplified chorology map for *Fagus sylvatica*. Frequency of *Fagus sylvatica* occurrences within the field observations as reported by the National Forest Inventories. The chorology of the native spatial range for *F. sylvatica* is derived after Meusel and Jäger, and EUFORGEN[27,28].

Large beech in a mountain pasture in Piani di Praglia (Genova, North Italy). (Copyright Ettore Balocchi, www.flickr.com CC-BY)

Distribution

Beech is widespread across Europe: it can be found from Sicily in the south to Bergen in southern Norway[4-6]. An analysis of pollen records indicate that the species has spread across Europe from small scattered populations left after the last glaciation, and is currently probably at its maximum post-glacial spread[7]. It needs a growing season of at least 140 days, and for this reason cannot survive too far north in Scandinavia[7]. Longitudinally its range is from the Cantabrian Mountains in the west to the Carpathians and Balkan Mountains in the east, although there are some areas in Europe where it is not found as a native tree, such as the Po valley and the Hungarian plain. As the climate becomes more continental in the eastern parts of Europe it is replaced by oriental beech (*Fagus orientalis*). At the southern part of its range (Spain, Sicily) it is only normally present at altitudes of more than 1 000 m, and can even be found at elevations of up to 2 000 m[1,8]. High summer temperatures, drought and moisture availability are limiting factors for the distribution of beech in Europe, but continentality is also associated with limiting its spread in north-western regions[4]. Climate change may have impacts on its future distribution, particularly at the extremes of its range where it is likely to become less competitive in the south and east (primarily because of drought), but could expand its range into Scandinavia and the Baltic[9].

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

Habitat and Ecology

Beech is a hardy species. It tolerates very shady situations (it is the most shade-tolerant broadleaved tree in its range[10]), so that natural regeneration is possible in silvicultural systems with continuous crown coverage as the seedlings are able to survive and grow below the canopy of established trees. The predominance of beech means a reduction of light level in the understorey vegetation level and in that case beech seeds survive better than those of other tree species. It is not particularly soil-sensitive[11] and grows on a wide variety of soils with a pH range from 3.5 to 8.5, although it cannot tolerate the most acidic conditions. Beech shows a moderate soil-acidifying ability[12]. It prefers moderately fertile ground, calcified or lightly acidic and is also sensitive to late frosts[13]; therefore it is found more often on the side of a hill than at the bottom of a clayey basin. It grows well on soft soils in which the root system can easily penetrate and its optimal growth is in humid soils situated on calcareous or volcanic parent rocks. On the contrary, it does not thrive on sites that are regularly flooded or which have stagnant water, since it needs good drainage and will not tolerate waterlogged or compacted soils[1, 14]. Beech furthers soil conservation due to its production of a large quantity of litter (around 900 g/m² per year). The root system tends to be shallow, making it susceptible to drought when compared to coniferous stands[15]. However, there appears to be some genetic variability across different climatic zones, since trees in southern Europe are able to cope better with drought than those in the north[1].

Importance and Usage

Beech is an important European forestry tree. Fine grained and knot-free, the wood is hard and has a pale cream colour and good workability[16]. With around 250 known usages, it is one of the most diversely used tree species in Europe. Its wear-resistance, strength, and excellent bending capabilities make it ideal for boatbuilding, flooring, stairs, furniture, musical instruments (piano pinblocks), plywood, panels, veneering and cooking utensils such as bowls, platters and wooden spoons. It is also used for pulp and can be coppiced for fire wood and charcoal due to its relatively high energetic potential[1, 8, 16].

Threats and Diseases

The root system architecture of beech may vary depending on local soil conditions[17]. While generally showing a noticeable resistance to rockfall and wind-throw[17, 18], under unfavourable local conditions a relatively shallow root system may make the tree vulnerable to wind-throw[1]. The thin bark provides little

Shiny dark green leaves with red galls caused by the fly *Mikiola fagi* (Diptera Cecidomyiidae). (Copyright AnRo0002, commons.wikimedia.org, CC0)

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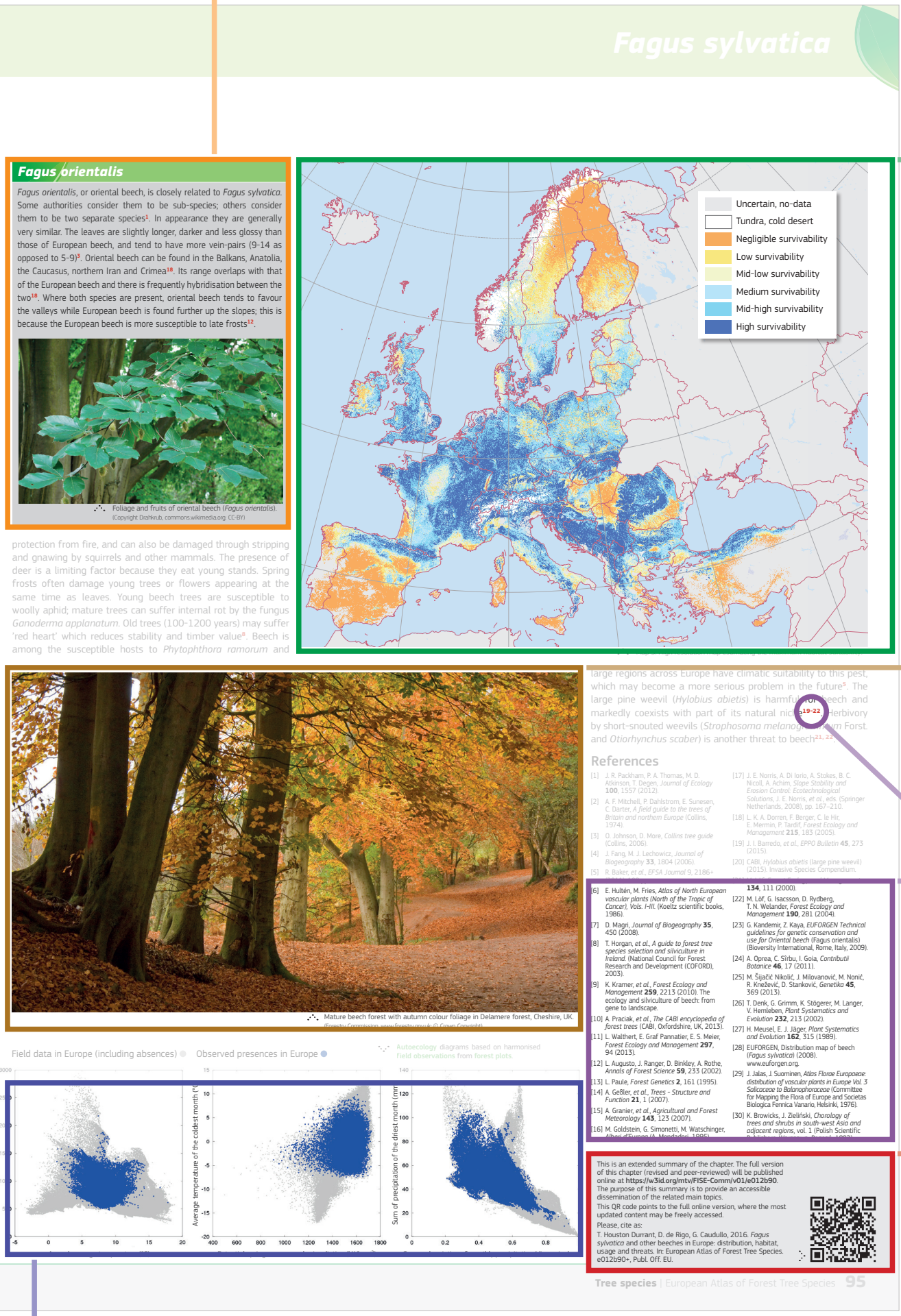
Modelled spatial distribution of the species

This map represents the **relative probability of presence** of the species derived from a harmonised dataset of forest **field observations** made from a number of different surveys and available within the Forest Information System for Europe (FISE). The maps are presented at a high-spatial resolution of 1 km. Dark green colour means the species is very likely to be found at that location, while the pale brown colour signifies a low probability of presence. For some regions there were not enough data available to make any predictions about the probability of presence; these are coloured pale grey. The map has been modelled with an innovative methodology designed to take into account the different local densities of the underlying data sets.

For more details on the data set and modelling techniques used, see the Atlas chapter "modelling, data and information on forest tree species" on page 40.

Key Fact

In some chapters there is a supplementary box focusing on some particular aspects of the species or taxon considered (e.g. notes on the taxonomy of the species or information about a related species).



Modelled maximum habitat suitability

This map represents the Maximum Habitat Suitability of the species, namely the areas where the species could potentially occur if climatic conditions and ecological conditions are met. It is modelled based on a harmonised and very dense dataset of forest plots available for most of Europe (see Map 1, Frequency) in combination with high-resolution bioclimatic parameters (e.g. temperature and precipitation), solar irradiation and elevation range. The maps are presented at a high-spatial resolution of 1 km.

Dark blue areas represent areas that are highly suitable for the species to survive (denoted in the legend as high survivability areas). In these areas, the local bioclimatic conditions are very similar to those of at least some of the field observations where the species occurs. Conversely, orange areas highlight low survivability conditions. This refers to areas with a bioclimatic pattern very dissimilar from all the observed patterns where the species is found.

In practice, a given species may not be found in all the areas marked "high survivability" for other reasons (e.g. competition from or preferential planting of other species). However, in those areas marked "negligible survivability" the species is unlikely to grow, even if deliberately planted there.

The map is modelled with an innovative methodology taking into account the different spatial distributions of the underlying datasets as well as a number of bioclimatic and geographic factors. Detailed information on the data and techniques used can be found in the chapter "modelling, data and information on forest tree species" on page 40.

Images

Images have been carefully selected to help identification/ understanding of species. Captions also identify the individuals who have provided the image and the relative copyrights. A complete list of contributors is at the beginning of the atlas.

References

Each chapter has been fully referenced with the most up-to-date scientific literature, which has been revised by three scientific experts. All the references are sequentially included through the text and listed at the end of the chapter. A revised and extended set of references will be available in the full online version of each chapter.

QR chapter code and citation information

This code points to the full online version of the species chapter, where the most up-to-date content can be found.

The correct way to cite this extended summary is also shown here (in the online version, readers will find the correct way to cite the full chapter).

In the online version it will additionally be possible to navigate through the expanded, fully peer-reviewed version of the chapter having the possibility to download maps, diagrams and text.

The online version will be hosted within the newly established Forest Information System for Europe (FISE). The Online European Atlas of Forest Tree Species will be part of the FISE Communications (FISE-Comm):
http://w3id.org/mtv/FISE-Comm/v01/

Autoecology Diagrams

In most chapters, autoecology diagrams (also known as climate-space diagrams) have been derived for the described species, based on the datasets of field observations as harmonised within the Forest Information System for Europe (FISE). These observations are the same as those used to estimate the coarse-resolution forest plot distribution presented in Map 1. The local bioclimatic conditions where a given species is observed are obtained by means of a number of high-resolution bioclimatic and geographic variables. The number of possible combinations of variables is very large and for this Atlas we have focussed on three: 1. Annual average temperature vs Annual precipitation; 2. Potential spring-summer solar irradiation vs. Average temperature of the coldest month; 3. Seasonal variation of monthly precipitation vs. Sum of precipitation of the driest month. In the online version of the Atlas other combinations of variables may also be found.

The overall climate space occupied by each of the field observations on every species is represented by a grey spot (one for every plot), while those plots containing the species of interest are coloured blue, thus illustrating the specific climate niche of that species, and showing how a given species might be constrained by one or more climatic conditions. Grey patches on this page may be coloured blue in others where different species are adapted to different conditions.

For more details on the data and modelling aspects, see the Atlas chapter "modelling, data and information on forest tree species" on page 40.