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Non-native Tree Species for European Forests - Experiences, Risks and Opportunities (FP1403)

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1- Introduction

Following the CBD (2002) definition the term 'non-native species' refers to "a species, subspecies or lower taxon, introduced (i.e. by human action) outside its natural past or present distribution; the term includes any part, gametes, seeds, eggs, or propagules of such species that might survive and subsequently reproduce". According to the FAO Global Forest Resources Assessment (FRA, 2015), and as accepted by Forest Europe (Indicator 4.4), introduced species are the species, subspecies or lower taxa, occurring outside their natural range (past or present) and having a potential to spread (i.e. outside the range they occupy naturally or could occupy sites without direct or indirect introduction or care by humans).

In Europe, the first introductions of non-native tree species from other continents, between the 16th and 19th century, were carried out mainly by botanists (review in Nyssen et al. 2016), when several species, like northern red oak (*Quercus rubra* L.), black locust (*Robinia pseudoacacia* L.), black cherry (*Prunus serotina* Ehrh.) and boxelder maple (*Acer negundo* L.) were used for ornamental and forestry purposes (Camenen et al. 2016). Non-native tree species were extensively planted towards the end of the 19th century in Europe. In that period, extensive reforestation efforts were made to counteract the overexploitation of autochthonous timber resources which had largely powered industrialization (Nyssen et al. 2016). Ever since, non-native tree species have been utilized as an important timber (Kjær et al. 2014), pulp (Carneiro et al. 2014) and biomass/energy (Lee et al. 2013) resource, as well as a source of non-timber wood products (e.g. Fotiadis et al. 2011). The most widely used species are fast growing ones, like Sitka spruce (*Picea sitchensis* (Bong.) Carr.), Douglas-fir (*Pseudotsuga menziesii* (Mirb). Franco), grand fir (*Abies grandis* (Douglas ex D. Don) Lindley), black locust (*Robinia pseudoacacia*), lodgepole pine (*Pinus contorta* Douglas), eucalypts (*Eucalyptus* spp.), northern red oak (*Quercus rubra*) and tree of heaven (*Ailanthus altissima* (Mill.) Swingle) (Nyssen et al. 2016). The initial introduction of non-native species was mainly motivated by curiosity and botanical interest (Nyssen et al. 2016), in a time when knowledge of genetics and local adaptation was lacking. During the late 18th and 19th centuries only small trial plantations were established in Europe for introduced species like *Pinus strobus* L. (Radu et al. 2008) and only at the beginning of the 20th century was it recognized that variation among trees may be partly inherited (Morgenstern 1996). The underlying processes or mechanisms that caused the observed growth variation were unknown at that time. Therefore, the introduction of seeds was not based on genecological knowledge and genetic criteria (i.e. their adaptability and potential productivity). The use of that reproductive material (introduced without genecological knowledge) in plantations often resulted in extensive failures, as it was maladapted to the planting sites, e.g. the interior variety of Douglas-fir in Central Europe (Kay and Anderson 1928) and the initial introduction of eastern white pine (Radu 2008). Following such failures, the significance of seed origin was increasingly recognized and thus, the introduction of non-native species has been carried out in a more organized way, taking also ecological and genetic knowledge into account (e.g. Kanzow 1937, Larsen and Ruetz 1980, Cannell et al. 1985).

From the genetic point of view, 'provenance' refers to the geographic location of the native population where the plant material originated, while 'seed source' denotes the geographic location from which the seed was obtained regardless of whether or not the parent trees were located in their native and autochthonous habitat (White et al. 2007). Most of the forest tree species introduced in Europe display vast geographic variation within their native range. Hence, the performance and survival of different provenances often varies strongly when these are planted outside their natural distribution area (Cannell et al. 1985, Eilmann et al. 2013, Chakraborty et al. 2016, Merceron 2016). The performance and survival of the genetic material originating from various parts of a species natural distribution can be evaluated by planting various provenances in common gardens, i.e. provenance tests, which are established across the environmental range of the intended planting regions (White et al. 2007). In this way, the most suitable provenances can be identified for each region. Provenance tests are of the utmost importance for species of high economic or ecological value, as they provide information on the plasticity, the adaptive/growth potential and tolerance to insects, diseases and cumulative environmental stress (Morgenstern, 1996).

In the second half of the 20th century, the numerous provenance trials that were established in Europe covered almost the complete natural range of selected economically important non-native species, e.g. the International Union of Forest Research Organizations (IUFRO) trial series, initiated in 1965 for Douglas fir (Kleinschmit and Bastien 1992, Bastien et al. 2013), and in 1968 for Sitka spruce (Ying and McKnight 1993, Lee et al. 2013). Such trials have and continue to provide valuable insights into adaptive and growth traits of different provenances. Studied traits included bud phenology (Cannell et al. 1985, Lines 1987, Daubree and Kremer 1993, Eckhart et al. 2017), frost hardiness (Cannell et al. 1985, Braun and Wolf 2001), drought tolerance (Eilmann et al. 2013, Jansen et al. 2013, Huang et al. 2017), height and volume growth (Nielsen 1994, Moise 1998), wood density (Murphy and Pfeifer 1991), as well as branching patterns (Cannell 1974, Nielsen 1994). In addition to the provenances originating from the native range, European seed sources/local land races have also been tested. A 'local land race' is formed when a species is introduced into an exotic environment and adapts through natural, and sometimes artificial, selection to the environmental conditions of the new planting zone (White et al. 2007). In several cases, the European land races outperformed the provenances introduced from the places of origin, e.g. in Sitka spruce (Ying and McKnight 1993) and Douglas fir (Larsen and Kromann 1983, Kjær et al. 1996). However, not all species with potential economic value were equally represented in such field trials. For instance, while different cultivated varieties are available for black locust (Straker et al. 2015), no extensive provenance trials including native origins have been established so far in Europe (see Chapter 5).

Results from provenance tests established in Europe for non-native species (i.e., the Douglas fir trials initiated in 1966 by IUFRO (OECD, 2008)) are already being used to formulate recommendations regarding the most suitable provenances that should be used for operational plantations across European ecoregions. In addition to provenance testing, breeding programs have also been launched for several economically important species (i.e. Sitka spruce in Britain and Ireland, Douglas fir in France (Pâques, 2013)). In the framework of the breeding effort, seed orchards and progeny tests have been established for production of improved forest reproductive material (FRM; e.g. Douglas fir (Bastien et al. 2013)). Such sources have also been included into proposed FRM recommendations by several countries (e.g. Samuel et al. 2007, Bastien et al. 2013).

To obtain a pan-European overview of the provenances and seed sources of non-native tree species tested/used and of the existing provenance recommendations at the national scale, a questionnaire was prepared and subsequently filled in by the Cost NNEXT Action partners. Twenty countries responded to the questionnaire and the outcome indicated that provenance testing and formulation of recommendations focused mainly on seven non-native species, namely Douglas fir (20 countries), grand fir (7 countries), Sitka spruce (5 countries), lodgepole pine (8 countries), eastern white pine (3 countries), Japanese larch (2 countries) and black locust (13 countries). Douglas fir was by far the most frequently reported species and the one with the highest number of trials and tested provenances. Provenance recommendations exist for this species in some countries, while attempts for recommendations at the European level have been made. For this reason, Douglas-fir was selected as a model species for European provenance recommendations in the current report. For the rest of the species the data set was limited, provenance trials have been reported to exist only in few countries, while provenance recommendations, if existing, apply only at the national level. Despite the above, the results could be interpreted in several cases at the European level. In the current paper, besides Douglas fir the following four non-native species are considered: (1) grand fir; being a species with limited occurrence in Central Europe for which information on provenance performance exists; (2) Sitka spruce; being a species with high economic importance for North-Western Europe, into which high breeding effort has been placed; (3) lodgepole pine; a species introduced into Nordic countries, and (4) black locust; a species distributed all over Europe for which only European local land races or selected clonal lines are planted.

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Provenance recommendations for Douglas-fir (*Pseudotsuga menziesii* (Mirb). Franco) as a model species

Provenance trials in Europe

The first provenance tests with Douglas-fir (*Pseudotsuga menziesii* (Mirb). Franco) were established in Europe and the Pacific Northwest America between 1910 and 1912 (Bastien et al. 2013). However, these trials covered only provenances from a small part of the species natural distribution and were established on a limited number of test sites. Due to a growing seed demand for European reforestations by the middle of the 20th century, seed imports from the interior part of the species natural range increased. Following seed introduction, drawbacks started to appear due to the increased susceptibility of the established forests to needle cast and the unsatisfactory growth performance in the new plantations (Schenck 1939, Kleinschmit 1973). These failures stimulated interest into provenance research questions (e.g. Schober 1954).

To gain information and knowledge on Douglas-fir variability, adaptability, physiology, provenance suitability, and for the preservation of the best genetic resources for future breeding, IUFRO initiated a systematic and representative collection of 182 indigenous provenances, covering nearly the whole natural range of the species in 1967. These provenances were distributed to 59 institutions and 36 countries across the globe, including 15 European ones (Ducci and Tocci 1987, Fletcher and Samuel 2010, Bastien 2013).

Additional collections, on more regional scales, were launched after the IUFRO collection in several European countries. They included the collection of provenances for practical seed supply, as well as progeny collections for the establishment of broader breeding populations and *ex situ* gene conservation areas (Sbytna and Fuchylo 2016, Pintaric 1991, Ballian et al. 1999, Govedar et al. 2003, Gabriel et al. 1993, Schultze and Raschka 2002, Orlić and Ocvirek 1996, Perić et al. 2006, Petkova et al. 2014, 2015; Popov 2010, Panetsos et al. 1985). Figure 1 depicts thecurrent location of Douglas fir provenance trials.

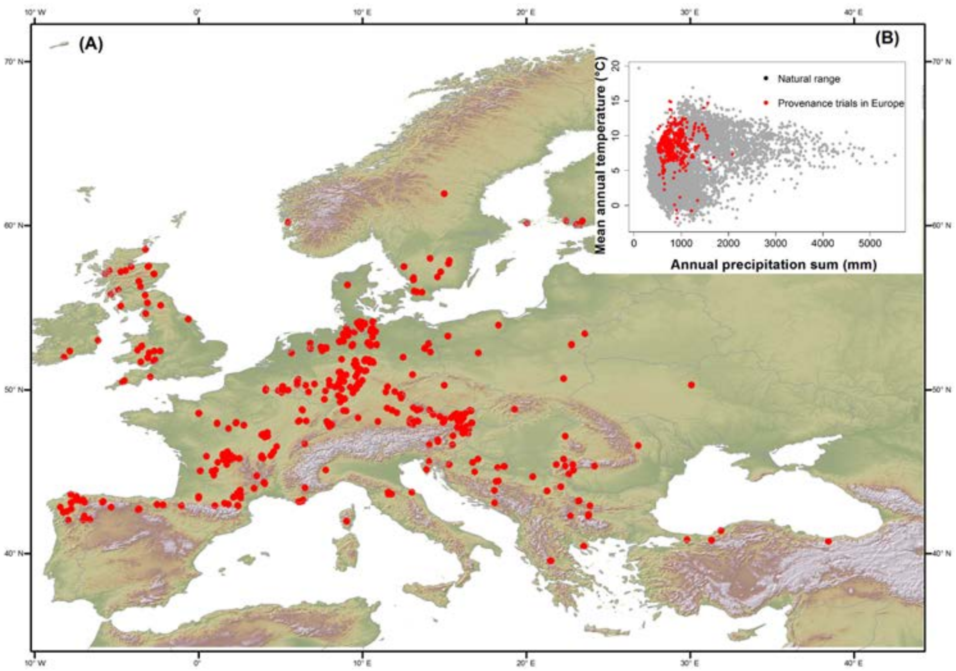

Fig. 1: A) Geographic location of the Douglas-fir provenance trials in Europe (red dots).
B) In the inset, the bioclimate of provenance trials in Europe (red dots) is plotted against the bioclimatic space (as defined by mean annual temperature (°C) and annual precipitation sum (mm)) that the species covers in its North American natural range (grey dots). .

Main results from European provenance trials

Douglas-fir provenance tests revealed high levels of genetic differentiation for adaptive traits between and within populations.

A major factor for Douglas-fir survival and growth is resistance to Rhabdocline needle cast (*Rhabdocline pseudotsugae* Syd.). The two varieties – coastal (var. *menziesii*) and interior (var. *glauca*) - show considerable variation in resistance; with the interior variety being much more susceptible than the coastal one (e.g. Stephan 1980, Petkova 2011).

In addition, late and early frost events are major determinants for Douglas-fir survival. Populations from colder origins, whether from higher elevations, from more northern latitudes or further from the Pacific Ocean, typically set buds earlier and are more tolerant to autumn frosts and winter cold. On the other hand, these populations flush slightly earlier in spring and are, therefore, more susceptible to late frost (e.g. St Clair 2006). Coastal populations, genetically programmed for a much higher heat-sum requirement prior to bud burst, are at low risk for late spring frost damage.

In provenance tests, genetic variation in height and volume growth is strongly determined by the geographical origin. The most striking difference is the generally slow growth of the interior variety (e.g. Breidenstein et al. 1990). Among the coastal provenances growth performance decreases with the increase of distance from the Pacific coast and the increase of elevation. In most European plantation areas, maximum productivity has been recorded for the low elevation provenances growing naturally in the range from southern Oregon to northern Washington/Vancouver Island. In rare cases (e.g. at continental sites), a trade-off between survival and growth appears, giving an advantage to sources of British Columbia, due to their higher survival (e.g. Burzyński 1999).

One of the striking features is the considerable variation within populations. Indeed, provenances and families within provenances contribute the same amount to the overall variation for almost all adaptive traits (Birot et al 1983, Wheeler et al. 1990). This may partly explain the broad adaptability of the preferentially planted coastal Douglas-fir provenances across Europe. Practically these provenances revealed higher amounts of variation in cold hardiness and growth phenology than the interior variety, fact which can't be explained by the prevailing climatic conditions (Balduman et al. 1999, Howe et al. 2006).

Provenance recommendations in Europe

Among the countries participating in the COST NNEXT Action, 20 have addressed Douglas fir in the relevant questionnaire. The responding countries can be grouped as follows:

- Five countries have not reported the existence of any *official or non-official* provenance recommendations for the species (Bosnia andHerzegovina, Estonia, Hungary, Norway and Serbia).
- Seven countries reported *no official provenance* recommendations, *but non-official* recommendations exist (Bulgaria, Croatia, Greece, Poland, Romania, Sweden and Switzerland).

- Eight countries reported *both official and non-official* provenance recommendations (Austria, France, Germany, Italy, the Former Yugoslav Republic of Macedonia, Slovenia, Spain and United Kingdom).

The *first group* includes countries where Douglas-fir is either a minor reforestation species or a species not recommended for ecological reasons.

The *second group* includes countries in which provenance tests have been established (from one in Greece and Switzerland, up to 10 in Sweden; average five). These countries, except for Sweden and Switzerland, published a list of best performing and recommended provenances from the natural range. Only *Sweden, Romania and Poland* published also a list of well performing local Douglas-fir selected stands (land races), which were tested together with provenances from western North America (Birot and Burzyński 1985, Burzyński 1999, Perić et al. 2011, Popov 2014).

The *third group* is populated by countries where Douglas-fir is or is about to become an important reforestation species, often considered as an alternative conifer to be used in the vulnerable stands of Norway spruce. Each country published an official list of recommended forest reproductive material (FRM) to be used for reforestation. These FRM can originate from: 1) seed orchards of European breeding programmes, 2) selected seed stands (European land races or certified selected North American seed stands) or 3) specified seed zones from North America identified in FRM category "source identified"'. Import regulations may vary between European countries.

In the third group, official recommendations on Douglas-fir FRM differ among countries:

United Kingdom (Fletcher and Samuel 2010) and the *Former Yugoslav Republic of Macedonia* (Andonovski 1995) promote the use of native FRM from northern Oregon to northern Washington, with a preference for the Washington coastal sources and Cascades sources in the U.K. (e.g. seed zones 030, 012, 403), and the Cascades sources in the Former Yugoslav Republic of Macedonia (seed zones 402, 403, 453, 661).

In *Austria, Germany, Italy and Spain*, use of FRM from both native and local land races as well as seed orchards is recommended (e.g. Zas et al. 2003, Ducci et al. 2005, Weißenbacher 2008, Alia et al. 2009, Anonymous 2016). In Austria and Slovenia, native FRM from northern Oregon to northern Washington Cascades (e.g. 461, 403, 430, 652) and productive local land races (selected seed stands) are always recommended. In Germany, FRM recommendations are organized at State level and differ according to the German provenance regions. Recommended FRM include German seed orchards (category qualified), German seed stands (categories tested or selected) and North American seed stands in Washington, Oregon and British Columbia, available on the national list, according to OECD criteria for selected stands (e.g. Anonymous 2016). Presently, such North American stands are located in Washington (seed zones 012, 030, 101, 202, 221, 222, 231, 232, 241, 402, 403, 411, 412, 422, 430, 652, 653). Moreover, in certain States of Germany Douglas-fir FRM produced in other European countries (i.e. French seed orchards) is recommended. In Italy recommended seed sources are both native FRM from specific seed zones of Central Washington to northern California and local land races from Calabrian and Tuscany provinces (Ducci et al 2003). In Spain, 11 native provenances from northern Oregon and southern Washington are recommended (Zas et al. 2003), as well as 19 Spanish stands and 2 Spanish seed orchards (Alia et al 2009).

France represents a specific case in Europe, as no Douglas-fir FRM from the native range is recommended since 2011. For Douglas-fir reforestations, France relies mainly on its own seed orchard production. If seed orchard FRM is not available, French selected seed stands can be accepted as a second choice (French Ministry of Agriculture 2017).

Provenance recommendations for Europe based on provenance tests and national recommendations

Until the last quarter of the 20th century, Douglas-fir seed transfers to Europe were based on an empirical assessment of ecological similarities between the native range and the plantation sites in Europe. Seed transfer rules for Europe took a new perspective given the numerous provenance tests, planted under the aegis of IUFRO, in which the good adaptability and growth of the coastal variety in Europe and the poor performance of the interior variety were manifested. Due to its much slower growth, when compared to the coastal variety, and its strong sensitivity to *Rhabdocline* needle cast, the interior type was found unsuitable for reforestation in Europe.

All the Douglas-fir seed sources recommended for reforestation in Europe, are originating from the part of the range between 40° and 50° latitude, west of the Cascade Range and below 600 m elevation (Bastian et al. 2013, Fletcher and Samuel 2010). According to plantation sites, recommendations are based on a compromise between growth and survival.

In Central and Eastern Europe, tolerance to fall and winter frosts should be considered. Therefore, in this area, provenances from the middle elevation zone of the Cascades range in Washington and from northern Oregon seem to be best suited (Enescu 1984, Moise 1998, Petkova 2011, Ruetz 1987, Weißenbacher 2008).

In Oceanic Europe, where frost is less likely, coastal provenances from Washington and Vancouver Island are recommended in priority for their nice branching architecture and superior growth (Fletcher and Samuel 2010, Michaud et al. 1993).

In northern and high elevation areas of the Mediterranean Europe, similar provenances as the ones recommended above could be used, together with provenances originating from

Northern Oregon (Cascades and coastal) (Andonovski 1995, Lavadinović et al. 2008, Zas et al. 2003). In southern or low elevation areas provenances from coastal southern Oregon and northern California (coastal and northern Sierra Nevada) could be recommended for their better survival in comparatively harsher and drier sites (Lupi 2016, Popov 1990, Ducci and Tocci 1987, Ducci et al. 2005, Ducci et al. 2009, Ducci et al. 2017).

Provenance tests planted at high elevation (above 900m) are rare in Europe. Nevertheless, these few tests indicate that seed sources from a higher elevation in the natural range (above 600 m) and from higher latitude (British Columbia) may have an advantage in growth and survival (Rosette 1986, Ruetz, personal communication). Thus, the altitude and latitude of FRM origin should be considered when reforestation is planned and carried out in mountainous sites of Europe.

Provenance recommendations for Douglas fir under climate change

Over the past 130 years, temperature increased by 1.3 °C in Europe (Kovats et al. 2014). Climatic change has already an impact on Douglas-fir phenology, an adaptive traits that strongly depend on spring temperatures (St Clair and Howe 2007). Observations obtained from a Douglas-fir clonal bank in Orléans (France) over the last 35 years indicate earlier flushing by approximately 6 days per decade (Bastien, personal observation). The main risk associated with this phenomenon is an increased sensitivity to late spring frosts. Climate change is also expected to result in an increase of water shortage during summer, which directly increases the risk of drought stress. Thus, long-term adaptation of Douglas-fir to future European climates is a challenge and it is questionable whether the seed material introduced, planted and propagated within the last century will perform equally well under future climatic conditions or whether alternative provenances from North America should be considered (Kölling 2008; Isaac-Renton et al. 2014).

In Europe, rotation times for Douglas-fir typically range from 40 to 120 years, depending on the ownership and country. Thus, many sites will be replanted one or two times during the next 100 years, which might allow choosing new seed sources with improved adaptive traits that could match the anticipated climate. Therefore, recommendations on provenance use are expected to be revised in the future.

For the next generation of Douglas-fir plantations, that are expectedin the next 40-60 years (which is approximately one Douglas-fir rotation period in many countries), the results obtained from the pan-European IUFRO Douglas-fir provenance trial network could be of great use, as they show that provenance height growth is higher when the mean temperature at the trial site is 2 °C higher than that at the place of seed origin (Badeau et al 2016). New modeling studies based on extensive provenance trials in Central Europe confirm this evaluation. At present, populations originating from regions with average annual temperatures ranging among 6–8°C were found to perform best in the current climate, while future reforestations should make use of seed material from slightly warmer climatic origins whose mean temperature is between 7–9°C (Chakraborty et al. 2015). Such new seed sources might be either obtained from lower altitudes or from more southerly located seed zones in Northwest America or by considering climate adaptation as specific trait for selection within the European breeding programmes. However, climate change might not only require adapted seed material, but will enable plantations on further forest sites: in particular high elevation sites (above 1000 m a.s.l.) will become more suitable for Douglas-fir (Chakraborty et al. 2016).

Predictions for seed source provision in the long-term, i.e. beyond 50 years from now are more difficult to derive, mainly because predictions for future climate are highly uncertain. For example, the uncertainty of climate change predictions was found to be higher than the model uncertainties of a provenance specific growth model (Chakraborty et al. 2016). Thus, long-term predictions are not yet convincing. Another major source of uncertainty in the findings of modeling studies, such as Chakraborty et al. (2016), is tthat the historical provenance trials were established on sites deemed suitable for planting the species and not in climatically extreme ones, as at that time climate change was not a factor of concern. Moreover, most historical trials do not include provenances originating from all parts of the distribution range of the species. A major factor in future plantations is anticipated to be the extreme climate events, such as long-term and recurrent droughts, but also potentially recurrent frost events in early spring and autumn. Genetic gain trade-offs might be required in the breeding programs in order to deal with these adverse climatic stress factors. The uncertain future climate emphasizes the importance of continuing the existing Douglas-fir provenance trial series across Europe, as well as the urgent additional testing of existing varieties and European land races in environments that mimic presumed future climates. A pragmatic approach to deal with climate uncertainty and missing trials under extreme climate conditions could be to assume that provenances currently outperforming could be also potentially used in the near future and under the worst case scenarios of climate change (e.g., 3-4 °C of temperature increase). This may incur increased risks in both smaller and larger changes than assumed, but the consequences (e.g., premature harvesting due to increased climatic risks) seem to be tolerable.’

European provenances – a necessary option for present and future afforestation

Douglas-fir provenance trials have demonstrated that, in many countries, progenies of some European populations (stands planted several decades ago) performed as well, or even better, than the best growing populations originating from the native range (e.g. Weißenbacher 2008). Under the climatic conditions of the continental part of Croatia for example high performance in diameter and height at the age of 40 to 45 was observed not only for certain Washington provenances but also for populations originating from Europe (Denmark and Bulgaria) (Perić et al. 2011). Thus these European land races are recommended for afforestations in this part of the country. The above has often been attributed to the appropriate genetic background (i.e. that the original material originates from one of the most productive provenances of the interior variety) and the indirect "genetic effect" of silviculture through selective thinning (Danusevicius et al. 2016). However, it has also been shown that adaptation to local environments can occur in a single generation (Skrøppa et al 1997). Adaptation to European environments, which are quite different from those found in the Pacific Northwest, appears to be a consequence of trade-offs between traits related to tolerance to low temperatures, i.e. resistance to early and late frosts, and growth traits that confer vigour in specific environments.

Molecular analysis carried out on adult trees and natural regeneration within European seed stands indicated that the genetic material is closely related to the recommended native seed sources from North America and represents both varieties and inter-varietal admixed individuals (Eckhart et al. 2016, van Loo et al. 2016, Fussi et al. 2013). Often, European seedlings have lower genetic diversity when compared to the North American seedlings and native populations (Eckhart et al. 2016, Konnert and Ruetz 2006). This challenges European Douglas-fir breeders to put further effort in identifying valuable "land races". Official registration as ‘selected seed source’, tracing the geographic origin of the original seed, assessment of a stand's genetic diversity, seed quality control and seedling traceability are required. Moreover, several countries (France, Germany, The Netherlands, Poland, etc.) have established breeding programs with selected superior genotypes, grafted in clonal archives. Such elite genotypes were mainly selected for superior growth performance and vitality and often originate from provenances or progenies well tested across a wide range of environments. It is thus of prime importance to preserve and actively manage these genetic resources to facilitate further adaptation to European environments, in view of the ongoing climate change, and to be used them for production of Douglas-fir genetic material "tailored" to European conditions.

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3. Grand fir (*Abies grandis* (*Douglas ex D. Don) Lindley*)

Provenance trials in Europe

Increasing interest in the use of *Abies grandis* (Douglas ex D. Don) Lindley in various European countries was the reason that IUFRO included in 1972 this species in the provenance research program. After a preliminary inventory of putative seed sources in 1973, seeds were collected in 1974 and 1976 from 41 sites in the natural range in British Columbia, Washington, Oregon, Idaho and Montana, on elevations ranging from 0 to 1500 m (Fletcher 1986). With this material, nursery and provenance tests were initiated in many European countries in 1980/1981, as for example in France (Bastien 1995), Austria (Liesebach and Weißenbacher 2007, Liesebach et al. 2008), Germany (Rau et al. 1991, 1998, 2008), the Netherlands (Kranenborg 1995), United Kingdom (Samuel 1996), the Czech Republic (Vančura and Beran 1995) and Poland (e.g. Burzyński and Górczyński 1990, Dolnicki and Kraj 1998).

An additional controlled seed collection was carried out in 1976 by the Bavarian Institute for Forest Seeding and Planting in Teisendorf, Germany, mainly along a west-east transect in Oregon, from the Pacific to the Cascades crest. Material from this collection was planted only in Germany. To our knowledge, no other grand fir provenance trials were installed in Europe since 1980. With few exceptions, land races from Europe were not included in the established trials.

From the 20 countries that responded to the COST NNEXT Action questionnaire on provenance recommendations, only seven provided information on grand fir. Information from Austria, France, Germany, the Former Yugoslav Republic of Macedonia, Poland and the United Kingdom concerns provenance trials, whereas Croatia reported only comparative trials with grand fir as one of the tested non-native species, without indicating the origin. For the Netherlands, the Czech Republic and Norway, information was collected exclusively from published material (Kranenborg 1995, Vančura et Beran 1995, Magnesen 1995). Figure 2 depicts the position of the 78 trials established for the species in the above mentioned countries. The site conditions in these plots are highly variable in terms of soil composition and climate.

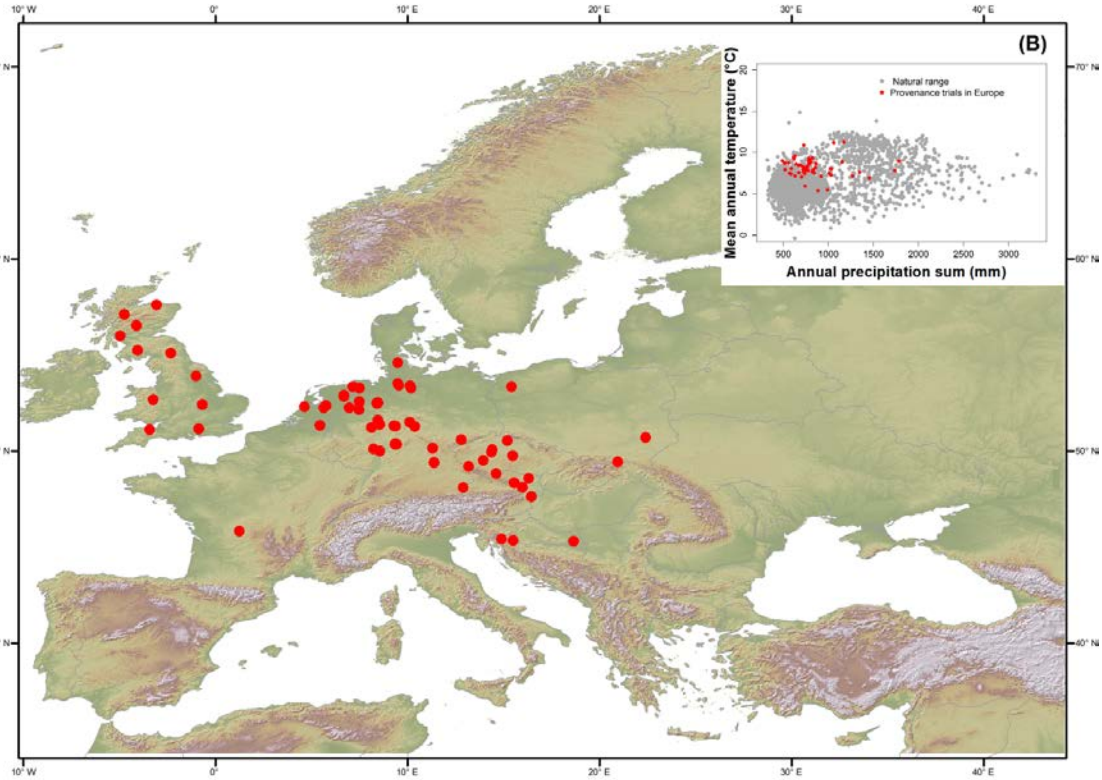

Fig. 2: A) Geographic location of the grand fir provenance trials in Europe (red dots). B) In the inset, the bioclimate of provenance trials in Europe (red dots) is plotted against the bioclimatic space (as defined by mean annual temperature (°C) and annual precipitation sum (mm)) that the species covers in its North American natural range (grey dots).

Main results from European provenance trials

Resistance to earlywinter and late frosts increases with the increasing distance of the place of origin from the coast. The Oregon provenances are less frost-resistant than provenances from Washington. Provenances closest to the coast have the latest bud burst (Larsen and Ruetz 1980). Generally, grand fir is not an appropriate species for areas in Europe affected by late frosts.

Variation in height is significant among provenances. In general, the ranking of provenances for height, as observed in the nursery stage remains the same at least until the age of 18 years (Vančura et al. 1995).

Large differences in vitality, growth and resistance have been recorded among plots and provenances. Growth is significantly better on wet sites. Under unfavorable conditions (low precipitation, impoverished nutrient status, low temperatures) the species does not perform well. A substantial problem is the high susceptibility of grand fir to the honey fungus

(*Armillaria mellea* (Vahl) P.Kumm.), which causes extensive damages or even complete loss of the plantations. Growth form is generally very good and without bifurcation at all sites (e.g. Rau et al. 2008).

The most vigorous and stable provenances originate from the Olympic Peninsula, Puget Sound (West Washington), Northern Western Cascades and Vancouver Island (British Columbia) regions (Rau et al. 1998, 2008, Vančura and Beran 1995, Kranenborg 1995, Samuel 1996). Provenances from the coastal area of Oregon are slower growing than the those from the coastal area of Washington. Provenances from the High and East Cascades in Oregon and from the Willamette Valley have shown relatively high losses and slow growth in provenance tests (Rau et al. 1998, 2008, Vančura and Beran 1995, Kranenborg 1995, Samuel 1996). A better height growth has been observed with the increase of latitude or the decrease of longitude of the place of seed origin (i.e. when moving from the coast to the interior (Magnesen 1995)).

Provenance recommendations on a national level

Based on the results from the trials at the ages of 18 to 27, specific provenances (generally tested in the IUFRO trials) or specific regions of origin (seed zones) have been recommended in several countries.

In *Germany*, provenances from the coastal Northern Oregon (seed zones 622, 631) and Washington areas (Puget Sound, Olympic Peninsula) (seed zones 030, 221, 212, 222, 231,240, 403), the Northern Cascades Washington (seed zone 403) and Vancouver Island (seed zone 1020) are best performing (Rau et al. 1998, 2008). Official recommendations in Southern Germany are restricted to local land races and material from the seed zones 030, 221, 231, 241, 403 (Anonymous 2016). Ten years ago, stands with the indigenous material of the IUFRO-provenance 12003 Indian Creek 'Elwha' were established in Bavaria (Southern Germany) (Storz and Huber 2017). The intention was to secure easy access to ample seed from the best performing provenance that could be used for afforestation in Germany and Europe in the near future (30-40 years). This strategy can also be considered as an *ex-situ* conservation one, preserving a valuable part of the species gene pool.

Similar, but non-official recommendations have been formulated in the *Czech Republic*. Planting of provenances from the eastern coast of Vancouver Island (seed zone 1020), from the Olympic Peninsula and the coastal area of Washington (Puget Sound, Olympic Peninsula) (seed zones 030, 041, 221, 212, 202, 201, 231, 232, 240), the north western Washington Cascades (seed zones 403, 401, 402), and the northern Oregon (seed zones 621, 622) but with some restrictions (Vančura and Beran 1995) is recommended. For higher elevations, provenances from northern Idaho may also be considered as appropriate for planting.

Recently the Forestry and Game Management Research Institute worked on the actualization of legislative rules for FRM transfer ((Act 139/2004 about FRM transfer; actualized by „Methodological Instruction of the Ministry of Agriculture“ – 19. 7. 2016) for grand fir (Beran et al. 2016a), as well as for Douglas fir. The recommendations for these two species are based on the updated seed areas in North America and Canada, and include new results from provenance experiments (IUFRO and national level) and new forest practice findings in the Czech Republic and other European countries (Beran et al. 2016a, 2016b).

In the *Netherlands*, specific IUFRO-provenances have been recommended and listed in the actual list of approved clones and provenances of trees (*https://www.rassenlijstbomen.nl/nl/Home/Soorten/Soorten-details.htm?dbid=1763&typeofpage=2142256):*

- from the coastal area of Washington provenances 12005 Bear Mountain resp. Louella (seed zone 221), 12048 Duckabush River (seed zone 222), 12049 (Shelton, seed zone 231) and 12051 (Rainbow Falls Park, seed zone 241);
- from the coastal area of Oregon the northernmost provenance 12052 Pittsburgh (seed zone 251);
- from Vancouver Island (seed zone 1020) provenances 12044 Kay Road, 12046 Mt. Provost, 12041 Oyster Bay and 12040 Salmon River.

In *Poland***,** the best performing populations are partially different among regions. For southern Poland the following IUFRO-provenances are recommended:

- from the coastal area of Washington provenances 12003 (Indian Creek, Elwha), 12005 (Bear Mountain resp. Louella), 12008 (Jack Creek), 12012 (Cascade Creek). 12016 (Santiam Summit), 12024 (Corville) and 12029 (St. Joe);
- from Vancouver Island provenance 12040 (Salmon River).

In the northwest and the north of Poland frost risk is higher. In these areas provenances 12007 (Eagle Creek), 12001 (Back Creek), and 12003 (Indian Creek) performed best (Burzyński and Górczyński 1990, Dolnicki and Kraj 1998, Kulej 2008, Kulej and Socha 2008).

In the *United Kingdom*, the best growth can be achieved by provenances from the Washington Olympic Peninsula, with provenance 12005 (Louella) being the most vigorous one. Seed sources from coastal zones in British Columbia and Oregon are also acceptable (Samuel 1996).

For most climatic regions of the *Former Yugoslav Republic of Macedonia* specific provenances from the coastal areas of Washington; 12005 (Bear Mountain resp. Louella), the east slope of Washington Cascades; 12006 (Eagle Creek), and the east slope of Oregon Cascades; 12016 (Santiam Summit) are considered to be the best performing ones (Andonovski 1995).

For southwestern *Norway,* provenances from the northernmost part of Vancouver Island and the northernmost part of the Washington Cascades, as well as from the continental areas in northern Idaho, are recommended (Magnesen 1995).

Provenance recommendations for Europe

Given the experimental results and recommendations in different European countries, as well as in the regions of origin (Chang and Cheng 2011), provenances from Vancouver Island (British Columbia), north eastern Olympic Peninsula (Washington), western Washington Cascades and the northernmost western Oregon Cascades can be recommended for afforestation in Europe (e.g. Rau et al.2008).

In warmer regions and regions with sub-atlantic environmental conditions, provenances from the Olympic peninsula (Washington State), from Northern Oregon and from the eastern part of Vancouver Island and the neighboring Islands in British Columbia should be the first choice (e.g.Samuel 1996, Andonovski 1995).

For Scandinavian countries provenances from the northernmost part of Vancouver Island and the northernmost part of the Washington Cascades, as well as from the continental areas in northern Idaho seem to be best adapted (Magnesen 1995).

For higher elevations with a more continental climate, interior provenances could have an advantage due to higher frost resistance (Kulej 2008, Kulej and Socha 2008). For dry regions, provenances from the Crest of the Cascades are recommended (König 2007, Rau et al. 2008).

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4. Sitka spruce (*Picea sitchensis* (Bong.) Carrieère)

Provenance trials in Europe

After the first introduction of the species to the British Isles in 1831, and for almost hundred years, the seed for Sitka spruce plantations were imported from North America, but soon after the search for the best-adapted provenances started (Samuel et al. 2007). In the first half of the 20th century, and before the launch of the IUFRO activities on Sitka spruce in 1968 (Samuel et al. 2007), the first provenance trials were established in several western European countries: at Radnor Forest in the UK (1929), near Bergen in Norway (1915 – 1928) and near Gahrenberg and Hannoversch Münden in Germany (1930) (Rook 1992, Magnesen 1986, 1999, Samuel et al. 2007). Between 1968 and 1970, IUFRO teams collected Sitka spruce seed from 84 locations throughout the entire distribution range, which were unevenly distributed to 22 countries. This initiative preceded the establisment of future provenance trials in Europe (Rook 1992). With a specific goal, to allow comparisons of similar provenances in a wide range of diverse sites, the so-called "IUFRO Sitka Spruce International Ten Provenance Experiments" was set up in 13 countries with a limited number of provenances (10), which, however, covered most of the species distribution range (Samuel et al. 2007, Orlić 1998, Bergez et al. 1988).

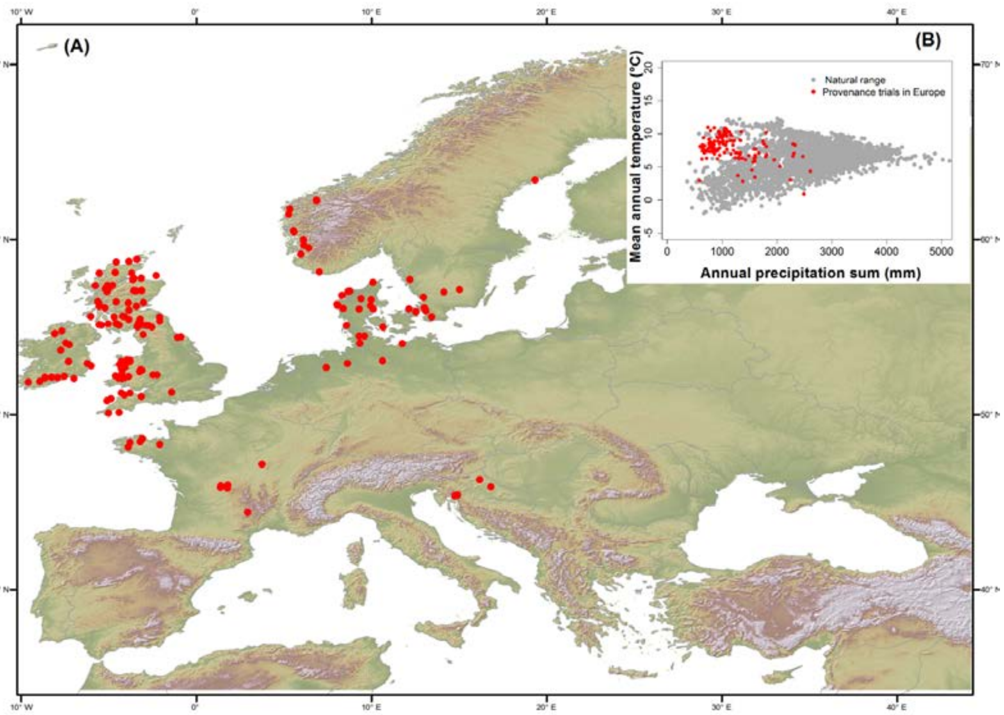

Fig. 3: A) Geographic location of the Sitka spruce provenance trials in Europe (red dots). B) In the inset, the bioclimate of provenance trials in Europe (red dots) is plotted against the bioclimatic space

(as defined by mean annual temperature (°C) and annual precipitation sum (mm)) that the species covers in its North American natural range (grey dots). A

The United Kingdom and Ireland

The largest field testing activity in a Sitka spruce breeding program was undertaken on the British Isles and involved both provenance and progeny trials. Since the 1960s, more than 100 field tests of different types have been established in the United Kingdom with different research objectives. One of the provenance investigations (1960/61) preceded the period of the IUFRO activity, and covered 13 origins of a wider part of the species distribution, ranging from Alaska to mid-Oregon. The location of experimental sites in 14 different forest stands was particularly important (Lines 1987b). These experiments provided significant results that were confirmed later on by the results of the IUFRO experiments. In most sites, the northern provenances performed better, but the southern ones responded better to favourable site conditions (Rook 1992). In 1969/70, the United Kingdom was involved in the IUFRO international provenance test network, establishing a set of 17 experimental sites with 70 provenances, but not all provenances were present at all sites (Fletcher 1992). Five years later (1974/75) provenance experiments were undertaken at a nationa level with up to 70 provenances tested on 18 sites (10 in Scotland, four in England and four in Wales) (Lines 1980). General conclusions from the British provenance trials indicate that the Queen Charlotte Islands (QCI) origin can be considered as a good general-purpose source (Rook 1992). The breeding program in Britain started with the selection of the phenotypically best British seed stands. Within the selected Sitka spruce stands, a total of 2.800 outstanding phenotypes (plus-trees) have been selected. The effort put in the selection provided the basic material to establish half-sib and full-sib progeny tests. Only 10 % of the plus-trees fulfilled the standards of the breeding program and have been incorporated into the breeding populations (Rook 1992). As a result of this breeding effort, nearly all Sitka spruce currently planted in Britain is derived from seed orchards (i.e. open or control pollinated families).

The Irish Sitka spruce breeding program places this country in Europe as a second player after Great Britain. Like other European countries, Ireland also joined the international provenance research programs. As part of the IUFRO Sitka Spruce International Ten Provenance Experiments, 10 commercially collected seed lots and one seed lot from Denmark were used to set up three provenance trials (Thompson et al. 2005). A much better-designed experiment started in Ireland in 1975, with 9 test sites, where 67 different provenances (seed origins) were tested (Pfeifer 1993, Samuel et al. 2007). These experiments confirmed previous findings that Oregon and northern Californian provenances were the fastest growing ones. Sitka spruce breeding program began in Ireland in the early 70's with the selection of 747 plus-trees. After six years, 86 progeny tested elite genotypes (mother trees) were selected using qualitative (stem straightness) and quantitative (height growth performance) criteria (Thompson 2013). Based on the results, controlled crossing was started, followed by progeny testing. Finally, outstanding genotypes were selected within the full sib families.

Western Europe (France, Germany, Belgium and the Netherlands)

France was involved in both the international IUFRO and national provenance experiments (Samuel et al. 2007). As a part of IUFRO experiments, three subsequent provenance trials were established in France; in Brittany, Southwest France and Massif Central (Samuel et al. 2007). The results obtained from these three trials clearly confirmed the best adaptation of the provenances from southern Oregon, northern California and coastal Washington. Another set of nine provenance trials was established by the French Institute of Technology for Forest-based and Furniture Sectors (FCBA) in the 1990s. Sites were located mainly in Brittany and Limousin regions. Currently, despite plans related to hybridization of Sitka spruce with other spruce species, breeding activity in France has decreased (Lee et al. 2013; Bastien: personal communication).

In Northern Germany, Sitka spruce provenance testing started much earlier than in France. In the 1930s, two test sites with eight and seven provenances (seed origins) were established in Gahrenberg near Hann. Münden. These experiments provided different results from those obtained in France. In terms of volume production the best provenances were from Washington and Queen Charlotte Islands (QCI), (the islands are currently called Haida Gwaii) followed by provenances from Oregon, while Californian provenances suffered from winter frosts. As a part of the 1972 IUFRO International Sitka Spruce Provenance Experiment, four experimental sites with 39 provenances were established in Germany (Samuel et al. 2007, Goeckede et al. 2014, Weller and Meiwes 2015). These experiments were significantly affected by losses suffered both at the nursery stage and in the field. Finally, eight years after planting, the lower elevation provenances (below 440 m) from Washington and some provenances from BC were proved to be the fastest growing ones.

Belgium and the Netherlands were only involved in the main IUFRO experiment; however, only 19 provenances were used to establish two Belgian trials. In the Dutch trials 48 provenances were tested. As in the case of northern Germany, the best seed sources for Belgium and the Netherlands originated from Washington State (Samuel et al. 2007).

Scandinavian countries

Two Scandinavian countries, Norway and Denmark, were involved in testing the suitability of Sitka spruce for growing in northern Europe (Magnesen 1986, Samuel et al. 2007). In the recent years, Sweden also joined the effort with the establishment of eight progeny tests. Norway was mainly involved in provenance studies testing adaptation to northern latitudes (correlation of survival with latitude of origin), while Denmark, apart from the provenance studies, has launched a breeding program, involving progeny tested first generation clonal seed orchards, as well as clonal tests (Lee et al. 2013). As a result of breeding activity in Denmark, clonal seed orchards are producing planting material recommended also in other countries (e.g. Sweden) (Lee et al. 2013). In Norway, in the first experimental site included 14 provenances originating from south-east Alaska and British Columbia west coast (Bauger 1978). As part of IUFRO Sitka Spruce Provenance Test 10 seed sources from British Columbia and Washington west coast were tested since 1975 in Osterøy, near Bergen (Magnesen 1986). However, currently only minor breeding activities are carried out mainly for maintaining the breeding population (Steffenrem, personal communication).

Southern and Eastern Europe

The main IUFRO provenance experiment also included several countries from south eastern Europe. Experimental sites were established in the former Yugoslavia and are currently located in Croatia (Orlić 1998).

Provenance recommendations on a national level

The importance of Sitka spruce in Ireland and the United Kingdom dictated the preparation of the official provenance recommendations for this species. The species accounts for nearly 52 % and 61 % of the area occupied by coniferous species in Ireland and Great Britain respectively (Samuel et al. 2007; Farrelly et al. 2009). In the U.K. and Ireland, the best-growing Sitka spruce provenance is Queen Charlotte Islands (QCI) (e.g. IUFRO prov. 7111). The long positive experience of utilizing this seed source was also confirmed by the results obtained from national provenance tests (Lines 1987a; Fletcher 1992). The main advantages of QCI origin are frost hardiness and acceptable wood quality. Alternative provenances to QCI, especially on the less demanding sites of south-west England and Wales can be those originating from Oregon (e.g. IUFRO prov. 7951), Washington (e.g. IUFRO prov. 7971, 7972) and Vancouver Island (e.g. IUFRO prov. 7116).

Unofficial recommendations for the use of QCI in Ireland are not as explicit as in the case of the U.K. Provenance from QCI is only recommended for higher elevation, above 300 m (Thompson 1994). Washington or Oregon origins are considered more appropriate for low to mid elevation sites with lower risk to late spring frosts. . Nevertheless, later results based on provenance testing and climate analysis, do not fully support the recommendation for planting of QCI in Ireland on cold, exposed sites (Thompson et al. 2005). As universal sources of Sitka spruce for Ireland the Washington provenances are recommended (Thompson et al. 2005; Thompson 2005).

Even in countries where the species has a marginal role, official rules at the national level have been defined. In France, depending upon the influence of the Atlantic Ocean, provenances from different seed zones in the countries of origin are recommended: Washington (seed zones 012, 030); Oregon (seed zones 041, 051, 052, 053, 061, 062, 071, 072, 081, 082, 090); California (seed zones 091, 092) (Bastien 2017). Moreover, material originating from Europe, as from seed orchards in Denmark (FP625, FP611) and one selected seed stand in France (PSI 901), are also recommended.

Official provenance recommendations for north western Germany (Anonymous 2004) were issued based upon the results from the provenance trial established by the Forest Research Institute of Lower Saxony (Kleinschmit 1993; Kleinschmit and Svolba 1993). The extraordinary results obtained for quantitative (survival rate, height, DBH) and qualitative traits for provenances from Vancouver Island, Washington and Oregon (Goeckede et al. 2014) render them as the best suited ones for planting in north western Germany.

The recommendations for north western Germany also apply for Belgium and the Netherlands (Samuel et al. 2007). Although Sitka spruce test conditions in western Norway differ from those of northern Germany, recommendations for Norway indicate south-east Alaska (Petersburg, Ketchikan, Kruzow and Seward) as the most appropriate origin for planting in western Norway, north of Bergen, in a harsh climate (Pâques et al. 2013). South of Bergen material from QCI (Magnesen 1986, 1999) is considered to be more appropriate. For Sweden, unofficial recommendations suggest the use of material from the Danish seed orchards or from local Swedish stands.

Provenance recommendations for Europe

The main provenances (IUFRO numbers in brackets) recommended in many European countries are originating from British Columbia; namely Queen Charlotte Islands (QCI) (seed zone 1110), Vancouver Island (seed zones 1010, 1020), Oregon (seed zones 041, 051, 052, 053, 061, 062, 071, 072, 081, 082, 090) and Washington (seed zones 012, 030). Nevertheless, depending on the severity of the site conditions, QCI provenances are suggested for harsher conditions, whereas provenances from Oregon and Washington are considered to be more appropriate for milder conditions (Thompson 1994, 2005; Thompson et al. 2005; Goeckede et al. 2014, Lee et al. 2013). For the extremely harsh conditions of northern Scandinavia, material originating from Seward, Alaska is recommended (Lee et al. 2013, Magnesen 1999). Still, QCI provenances can be planted even in Scandinavia, and specifically in southwestern Norway ((Bauger 1978, Magnesen 1986, 1999). In the case of countries with advanced breeding programs such as the U.K., Ireland or Denmark, the use of improved genetic material is strongly recommended (Bastien 2017). Tested progenies, obtained from controlled crosses among selected parents, are vegetatively propagated and are the first choice for deployment in commercial plantations (Samuel et al. 2007).

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5. Black locust (*Robinia pseudoacacia* L.)

Provenance testing in Europe

Provenance testing and breeding activities with black locust (*Robinia pseudoacacia* L.) in Europe are strongly affected by several factors and specific features of this species: 1) early introduction from Eastern North America, 2) multipurpose use, 3) early naturalization in Europe, 4) missing Europe-wide provenance research activity, such as the one carried out by IUFRO for other non-native species, 5) significant impacts on natural ecosystems and, 6) reproduction types, that include sexual as well as asexual (clonal) reproduction characterized by excellent regeneration capacity from stumps and roots. Due to the latter feature, clones (cultivars) are cultivated across Europe. Recommendations for FRM, therefore, can refer to clones, mixtures of clones and seed sources.

The large presence of black locust in Europe (in more than 35 European countries (GBIF) is not reflected in its presence in provenance trials. In some countries (Bosnia and Herzegovina, Croatia, Norway, the Former Yugoslav Republic of Macedonia, Romania, Slovenia provenance trials are missing and thus also official or unofficial recommendations are lacking in some of these countries (Bosnia and Herzegovina, Romania, Slovenia). European countries also differ in the authorization of the recommendations (official, unofficial) and obligation in use of FRM.

Genetic trials and provenance recommendations on a national level

Provenance testing and breeding activities with black locust in Europe are, in general, quite recent. Current provenance recommendations of individual countries reflect the status and the duration of these activities, following their initiation. Both of these aspects will be discussed below. Testing plots are depicted in Figure 4.

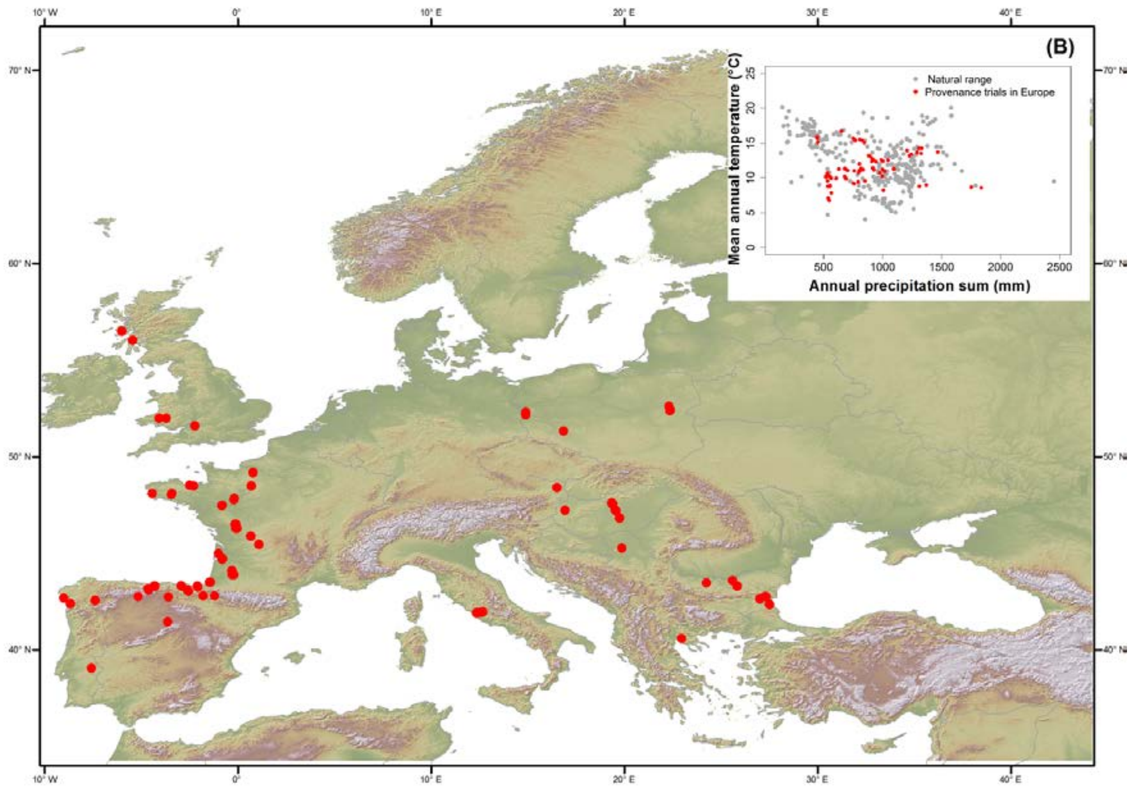

Fig. 4: A) Geographic location of the black locust provenance trials in Europe (red dots).B) In the inset, the bioclimate of provenance trials in Europe (red dots) is plotted against the bioclimatic space (as defined by mean annual temperature (°C) and annual precipitation sum (mm)) that the species covers in its North American natural range (grey dots).

In *Hungary,* black locust is the most widespread tree species covering approximately 465.000 ha (24 %) of the forested land (Rédei et al. 2015). Hungary is the leading country regarding selection and breeding of black locust among the European countries, if considering the spectrum of research aims and the length of research history. The selection and breeding program was initiated in 1930 (Kereseed zonestesi 1983). At present, 35 different experimental trials exist. Among these are eight genetic trials only with focus either on provenance or clone research (Rédei et al. 2001, 2002, 2006, 2013). The rest of the trials are devoted to cultivation technology, optimum spacing in plantations, energy plantations and primary stoolbed (see Rédei 1997, Rédei et al. 2006, 2014, Rédei and Veperdi 2009, Rédei et al. 2002, 2010, Rédei and Veperdi 2009). Official provenance recommendations for black locust exist in the country and are mandatory. In general, Forest Reproductive Material (FRM) of seven Hungarian and state-approved cultivars (*'Nyirségi', 'Üllôi', 'Zalai' Jáseed zoneskiséri'*, *'Kiskunsági'*, *'Eppelecsi',* and a hybrid *'Rózsaseed zonesín AC')* is recommended for use (Osváth-Bujtás and Rédei 2007, Kereztesi 1983, Kereztesi 1988, Rédei 2013). In addition to official FRM recommendations, unofficial recommendations also exist for five clones registered as cultivar candidates in Hungary under the names: *'Bácska' (*kh 56a 2/5)**,** *'Homoki'* (mb 17D 3/4), *'Vacsi'* (pv 201E 2/1), *'Seed zonesálas'* (pv 35 B/2), *'Oseed zoneslopos'* (pv 233 A/1) (Osváth-Bujtás and Rédei 2007, Kereztesi 1983, Kereztesi 1988, Rédei 2013, Malvolti et al. 2015).

In *France,* with some 200.000 ha of black locust (Inventaire-Forestier), provenance and breeding activities are aiming mainly towards the identification of seed sources that could be valuable for reforestation. A clonal test was planted in 2015 to compare Hungarian versus 250 French clones identified for their superior growth and stem formwithin selected seed stands. Moreover, France together with Portugal, Spain, the U.K. and Ireland launched in 2009 a transnational project and set up a network of 38 arboreta (known as *REINFFORCE* Arboretum & Demonstration Sites Network). Within this network, provenances of black locust from Bulgaria, Romania, Slovakia, the Former Yugoslav Republic of Macedonia and Turkey along with other tree species were planted in 32 different locations (i.e. arboreta) distributed across all the member countries, except for Ireland, in a wide range of environments. In France 14 arboreta involving black locust have been established. One of the main objectives is to identify species/provenances able to withstand and cope with the current weather conditions and future climates (Orazio et al. 2013). Limited by the young age of the established genetic tests listed before, provenance recommendations in France, at present, largely rely on knowledge from neighboring countries. Official recommendations (clones, provenances) exist, but are followed on a voluntary basis (French Ministry of Agriculture 2016). The use is recommended in this particular order: 1) Hungarian cultivars *'Appalachia'*, *'Jáseed zoneskiséri'*, *Kiskunsági'*, *'Nyirségi'*, *'Üllôi'*, *'Zalai'*, *'Rózsaseed zonesín*

AC, 2) seeds from Hungarian, Romanian and Bulgarian qualified seed orchards and, 3) seeds collected in selected stands in Bulgaria, Romania and in *'Putseed zonestavacs'* and *Nyirségi'* Hungarian regions.

In *Italy,* with black locust growing on 230.000 ha (INCF 2007), the selection and breeding program started in 1988, 50 years later than in Hungary. Six genetic trials (four provenances and two clonal trials) were established aiming to improve both wood quality, and biomass production for energy. In total, 160 different provenances/local races/cultivars/clones coming from Europe (Hungary and Italy), from the native range (125 provenances), as well as from countries of other continents (Argentina, South Korea, Chile, Canada) were used in the trials (Gras and Mughini 2009). For the use of black locust´s FRM both official and unofficial provenance recommendations exist in Italy. Official recommendations are mandatory for private and public forests. They follow, without regional differences, the national law (Dlgs. 386/2003) implementing the Council Directive 1999/105 /EC (Ducci 2005).

The black locust occupies an area of 150.590 ha in *Bulgaria*, which corresponds to 4% of the total forest area in this country (Executive Forests Agency 2010). Genetic and breeding work on black locust started in this country by selecting stands with trees of suitable growth and productivity characteristics (straight stem and fast growth) in the late 1970s (Kalmukov 2014). At the same time, clones from Hungary, former Yugoslavia, and former Czechoslovakia were imported. Using these clones and the Bulgarian material, the first collection of 50 clones (vegetative generations) was established in 1988 in the nursery of the Experimental Station for fast growing tree species in Svishtov (northern Bulgaria). Discovery of a repeatedly flowering form of black locust (*Robinia pseudoacacia* f. *semperflorens*) in Bulgaria enlarged the breeding options in this country. Since 1990 trees of *Robinia pseudoacacia* f. *semperflorens*, a form interesting for beekeepers, was additionally included into breeding programs (Kalmukov 2014). When Bulgarian and other European clones were tested in more than 25 trials across the country, individual clones strongly differed from each other depending on edaphoclimatic conditions. Bulgarian clones were more resistant to habitats with lower water table and more compact soil structure when compared to Hungarian clones preferring habitats with higher water table and lighter soil mechanical properties (Tsanov et al. 1992, Kalmukov 2014). At present, local and Hungarian clones are tested in 8 genetic (clonal) trials. Only unofficial recommendations exist for this species (Broshtilov 2009, Tsanov et al. 2009). Depending on the edaphoclimatic conditions, different clones (Bulgarian: *'Pordim-6'*, *'Pordim-9'*, *'Pordim-12'*, *'Pordim-13'*, *'Obretenik-1'*, *'Obretenik-3'*, *'Obretenik-4'*, *'Ryahovo-1'*, *'Ryahovo-2'*, *'Kroushovitsa-2'*, *'Kroushovitsa-3'*, *'SB-7'*, and Hungarian clone: *'Nyirségi'*) are recommended (Tsanov et al. 1992, Broshtilov 2009).

Because of its minor presence in forests (34.000 ha, BWI), breeders in *Germany* ignored black locust until 1990. The provenance and progeny testing started in the 1990s when the demand on black locust wood increased (Liesebach and Schneck 2012). Soon the interest in clones for forest plantations (Ewald et al. 2001) and energy plantations followed (Peters et al. 2007). Between 1995 and 2004 several trials with some clones and populations were established to inspect the stability of trunk form (straightness of trunks) and for selection of suitable propagation material (Liesebach et al. 2004). Since 2003, the production and marketing of seeds and plant material fall under the rules of the Act on Forest Reproductive Material in Germany. Official (mandatory) recommendations for FRM of black locust exist in at least 9 out the 16 country states ("Bundesländer"). Although recommendations of individual states differ in the strictness and the priority for specific FRM, in general, FRM from either German seed sources/local races (collected in qualified seed orchards, or selected seed stands from two existing provenance regions) and/or from Hungary (approved FRM from Region Nyirségi, and from east Hungary) can be planted (e.g. Herkunftsempfehlungen Brandenburg, Herkunftsempfehlungen Baden-Württemberg, Herkunftsempfehlungen Bayern, Herkunftsempfehlungen Hessen, Herkunftsempfehlungen Nordrhein-Westfalen, Liesebach and Schneck 2011).

The black locust in *Croatia* occupies an area of 35.070 ha, which corresponds to 1.47% of the total forest area in the country (Ministry of Agriculture 2010). Croatian forests Ltd. and private forest owners may use only those non-native tree species (their provenances and varieties), whose impact on the ecosystem, genetic integrity of native tree species and local provenances is professionally evaluated and whose negative impact can be avoided or diminished (Ministry of Agriculture 2005). For black locust, only FRM from Croatian seed sources (2 selected seed stands and selected plus trees) is recommended (Ministry of Agriculture 2017). This recommendation is mandatory. Nevertheless, the production of seedlings of black locust (as also of other non-natives) was very low in Croatia in the last 25 years, as presented in the data from the supervision of forest seedlings production in nurseries (Perić et al. 2008, 2009, 2010, 2013a, 2013b, 2014, 2017).

Breeding activity and FRM management of black locust growing on 14.947 ha in *Poland* (Gazda et al. 2017) is mainly focused on western Poland (Zielona Góra) where the spread of this species is the most extensive (Wojda et al. 2015). In publicly owned forests managed by the State Forests National Forest Holding (the State Forests) FRM from only Polish seed sources (3 selected seed stands, 44 selected plus trees and clonal seed orchards with polish clones) is recommended. The recommendation is mandatory. Genetic tests with material of Polish and Hungarian origin were established between 2004 – 2016 and are still largely in the testing stage. Up to 2035 (as presented in the "Program of conserving forest genetic resources and breeding of trees in Poland for the years 2011–2035") the seed base of black locust has to be further increased by selecting additional plus trees and progenies for use in rather fast-growing plantations on former farmlands than in the forests (Wojda et al. 2015, 2016).

In *Austria*, only unofficial provenance recommendations exist. These are based on tests in neighbouring countries as well as on results obtained from an Austrian clonal trial. This clonal trial was set up in 1988 when clones of two Hungarian and ten Austrian provenances were planted. In 1990, when the area of the trial was enlarged, two new Hungarian clones were added (Schüler et al. 2006). From the results of this trial, the three best performing Hungarian varieties: *'Appalachia'*, *'Jáseed zoneskiséri'* and *'Nyirségi',* characterized by more straight stems, are recommended for timber production together with two Austrian fast-growing clones (Tulln-81/83 and Tulln-81/62) suitable only for biomass production. In addition, one approved black locust stand (Rob1 (8.1/ko) of category "selected" also exists (BFW). Following the Austrian legislation for the FRM Ordinance 2002 (Bundesrecht 2002), FRM of this species can further be collected for the category "source identified". Besides this, clonal reproduction is also permitted.

As already mentioned, *Spain* together with other four European countries (France, Portugal, the UK and Ireland) takes part in the REINFFORCE transnational project (Orazio et al. 2013), where selected European land races of black locust are tested across different habitats. Following the aims of this project, 14 provenance trials (called arboreta sites) have been established in Spain.

Black locust is included in the species list of the Spanish regulation for the production and use of FRM (RD 289/2003, Resolución 2009, MAPAMA 2016). In addition to official recommendations, which are mandatory, also unofficial recommendations exist (Sanz Elorza et al. 2004, Dana Sánchez et al. 2005, Alía et al. 2009, Campos and Herrera 2009, Andreu et al. 2012). FRM (seeds) can be commercially produced in two provenance regions (identified FRM). Following the guidelines for ecological similarity among provenance regions (RIUs) established in Spain (RD 289/2003, Resolución 2009) and the EC regulation (Directive 1999/105/EC) for marketing and use of FRM, these two Spanish provenance regions (nº 26 Serranía de Cuenca -Resolución 2005 and nº 6 Litoral Vasco -Resolución 2008) can provide the identified FRM for 33 Spanish provenance regions (Alía et al. 2009, MAPAMA 2016). Although it is possible to use black locust at present, the tendency is not to do so, or even to eradicate this species from the forestlands where it currently grows (Sanz Elorza et al. 2004).

Provenance recommendations for Europe

Following national legislations, experiences from other countries, and/or results from genetic trails in eight European countries (Hungaria, Croatia, Germany, Austria, Belgium, Poland, France, Spaine), Forest Reproductive Material of black locust from only European basic material (seed source, stands, orchards, clone/clonal mixtures) is recommended. In Western and Central Europe, the use of FRM from seed sources, seed stands and orchards is country-specific. Concerning FRM of clones and clonal mixtures, only specific clones are recommended in more than two countries. For Central and Western Europe three clones *Appalachia' (Eppelecsi)*, *'Jáseed zoneskiséri' and 'Nyirségi'* are recommended (Kereseed zonestesi 1983, Kereseed zonestesi 1988, Schüler et al. 2006, Osváth-Bujtás andRédei 2007, Broshtilov 2009, Rédei 2013, Kalmukov 2014, French Ministry of Agriculture 2016).

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6. Lodgepole pine (*Pinus contorta* Dougl. ex. Loud.)

Provenance trials in Europe

Since the middle of the 20th century, there has been a general interest in testing fast-growing conifers on a national level in different European countries. The attraction of lodgepole pine for Europe convinced IUFRO to study the provenance question of lodgepole pine more thoroughly, and as the second species studied after Douglas fir (Simsek 1989). The initiative to cooperate around experiments with lodgepole pine seed collected throughout the the native distribution range, came from IUFRO in the end of the 1960s. Joint analyses across administrative borders have the potential to strengthen decisions on long-distance seed transfer over a wide range. The cooperation project was referenced as 42.5 IUFRO Section 22 and was called "IUFRO Working group on Pinus contorta provenance experiments. S2.02.6." (from 1976 "Working party, WP") (Lindgren 1992a). In the period 1966 - 1968 lodgepole pine seed collections (organized by K. Illingsworth, M. Hagner, J.W. Turnbull and others) were distributed through H. Barner (Humlebaek, Denmark). A total of 158 seed lots (identified by IUFRO provenance numbers) were distributed to more than 20 (mostly European) countries, and the resulting tests are often referred to as the IUFRO 70/71 (69 - 73, there are some variations) experiments. The IUFRO WP was set to coordinate the establishment and evaluations from the seed collections. From 1987 the responsibilities of the IUFRO WP were enlarged to "Contorta Pine Provenances and Breeding" (Lindgren 1993a). IUFRO 1970/71 series were often established as single-tree plots and are therefore not suitable for comparing volume production per hectare. Survival, plant height and damages for 121 provenances tested in northern Sweden were reported in a dissertation by Lindgren (1983), which in much determined the existing recommendations in Sweden. The study showed that provenances of northern origin, and within the altitude range 600-1000 m.a.s.l., are preferable in northern Sweden, and that coastal provenances should be avoided due to inferior growth, lower survival and damages.

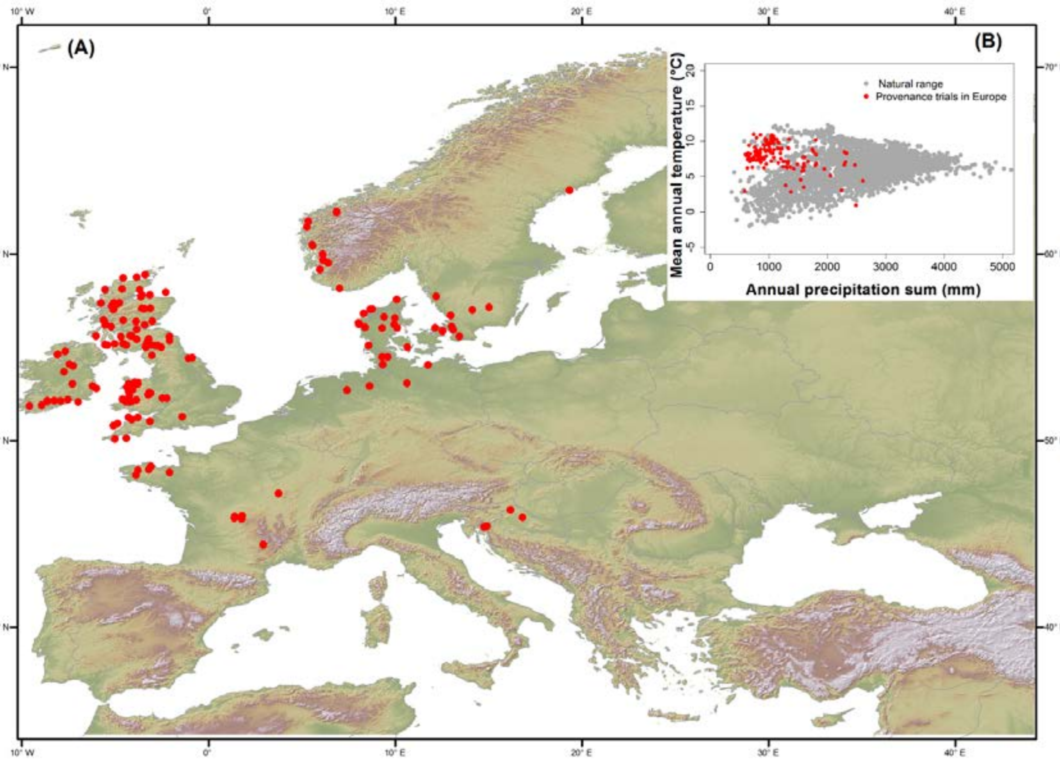


Fig. 5: A) Geographic location of the lodgepole pine provenance trials in Europe (red dots). B) In the inset, the bioclimate of provenance trials in Europe (red dots) is plotted against the bioclimatic space (as defined by mean annual temperature (°C) and annual precipitation sum (mm)) that the species covers in its North American natural range (grey dots).

Provenance recommendations on national level

There were few responses to the COST NNEXT questionnaire for this species, mainly as a result to the low interest for lodgepole pine afforestation across the European countries during the 21st century, partly due to the poor experimental provenance testing (Estonia, Spain, Greece) (Kasesalu 2000, Alia et al. 2000, Panetsos et al. 1983) and experiences from sensitivity to pathogens e.g. *Rhyacionia buoliana* (France) (Bastien, personal communication).

The exceptions are northern European countries, and especially Sweden (Figure 5), where the planting has been maintained, although on a smaller scale, compared to that in the 1980s. Promising results from small experimental plantations established during the 1920s in both Sweden and Finland attracted forest practitioners in the 1960s to include lodgepole pine in their afforestation programs. Existing plantations indicated that the *latifolia* variety in particular could grow much faster than Swedish native Scots pine, while growth of the coastal variety *contorta* in Sweden proved to be unsatisfactory (Lindgren 1993b). A large-scale introduction of lodgepole pine in Sweden started around 1970 as planting programs with lodgepole pine were initiated by forestry companies in northern Sweden to meet an expected shortfall in future wood supply. The similarity of the two species in wood properties, justified that the lodgepole pine wood could be processed and utilized as that of Scots pine.

Today, lodgepole pine is by far the most-planted exotic tree species in *Swedish* forests. It is the third-most planted overall in Sweden, with 16 million seedlings planted in 2011 or about 7% of the total planting stock. Lodgepole pine plantations now cover about 600 thousand hectares. Yield evaluations have shown a surplus of at least 30–40% for lodgepole pine versus Scots pine, irrespective of the site index (Elfving and Norgren 1993; Fries et al. 2016). Lodgepole pine has been particularly useful for afforestation in northern Sweden as the high productivity was shown to be combined with high cold tolerance and generally high survival. The use of lodgepole pine peaked in the late 1980s, but the annual planting area has since decreased significantly, as its use has been under review because of environmental concerns. Successive actions by the National Forestry Authority (Skogsstyrelsen) have imposed restrictions on the amount of lodgepole pine allowed for afforestation.

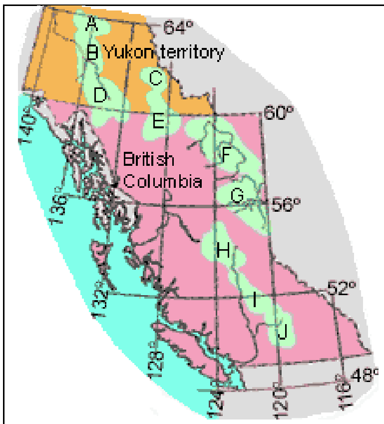
The large-scale introduction of lodgepole pine in Sweden initiated extensive collection and importation of seed materials from Canada, followed by a wide range of research projects (Elfving et al*.* 2001). Research also included experiments to find the most well-adapted provenances of lodgepole pine for Sweden. The provenance testing carried out in Sweden has been the most thorough of any European country. The first such experiment was established in northern Sweden in 1967 (Hagner and Fahlroth 1974; Hagner 1993). Both companies and institutions established many provenance trial series in the 1960s and 1970s, covering much of Sweden, as the basis for seed transfer recommendations (Lindgren *et al.*

1988). An IUFRO 1970/71 series was established in 1971 with nine trials in central and southern Sweden and ten trials in Northern Sweden.

Revision of provenance classification for lodgepole pine in Sweden has shifted towards regional instead of a latitudinal-altitudinal origin (Lindgren et al. 1988). Figure 6 shows recommended provenance regions of native lodgepole pine for the use in Sweden. The species is insensitive to minor provenance changes, and single provenances can perform surprisingly well over a rather wide geographical range in both *Sweden and Finland* (Ericsson 1993; Lindgren 1993b; Varmola *et al.* 2000). Early experiments indicated that provenances from interior British Columbia and from the Yukon Territory performed best. It was discovered that a transfer 2 to 5 degrees north into Sweden seemed to be optimal (Hagner andFahlroth 1974; Rosvall 1995). This result contrasts with domestic Scots pine that is transferred southward in order to increase survival in northern Sweden. Lodgepole pine provenance hardiness can be increased if sources from higher latitudes rather than higher elevations are used (Fries andLindgren 1986). Attention later shifted from provenance research to domesticated seed sources for long-term breeding efforts.

Although research has been conducted on lodgepole pine in *Finland* and shown that the species exhibited a growth advantage over native species, its use in Finnish forestry has always been minor. Two series of experiments in northern Finland showed that coastal provenances from Alaska had poor growth, whereas provenances from Yukon and northern British Columbia had the best growth and survival. Among the inland provenances, southern provenances were poorer than northern ones. There are five field trials with lodgepole pine, established with seed provided by IUFRO 70/71 (Ruotsalainen and Velling 1992).

Provenance experiments located on the coast in *Norway* showed that subspecies var. *contorta* was superior to var. *latifolia*, but inferior when the site was further inland. At all sites, survival tends to increase with increasing latitude of origin of the tested material. When test location was more southern, a provenance of more southern origin was also best (Magnesen 1993).



Provenance region	**Latitude**
	(approximate)
A, Mayo	63–64 ºN
B, Carmacks	61–63 ºN
C, Frances Lake	61–62 ºN
D, Whitehorse	59–61 ºN
E, Watson Lake	59–61 ºN
F, Fort Nelson	57–60 ºN
G, Fort St.John	54–58 ºN
H, Prince George	53–57 ºN
I, Williams Lake	51–53 ºN

	J, Kamloops	49–52 ºN	

Fig. 6. Approximate original provenance regions suitable for Northern Sweden (green on the map) for *Pinus contorta* (from Ericsson 1993; Lindgren et al. 1988).

In 2017, lodgepole pine (*Pinus contorta* Dougl. ex Loud.) was the fourth most important conifer species by area in *Great Britain*, covering 100.000 ha or about 7.6 % of the conifer forests (Anonymous 2017). This is less than the coverage of other conifers, such as Sitka spruce (51%), Scots pine (17%), larches (all species – 10%), but substantially more than better known non-natives such as Douglas fir (3.5%). The area of lodgepole pine dominated forest is primarily in Scotland (88.000 ha) where the species has typically been planted on nutrient poor, peaty soils in the north and the west.

The species was first introduced into Britain in 1853, but its widespread use in British forestry only commenced after 1945. This coincided with a major expansion of afforestation programmes onto marginal soils on upland sites in northern Britain that were being released from agriculture. On such soils, lodgepole pine was typically found to outperform native Scots pine in terms of survival and timber production. Because of the wide natural range of lodgepole pine in western North America, the potential importance of provenance variation was recognised by the 1930s, and a series of provenance experiments was established at intervals culminating in the IUFRO series planted in the early 1970s. A comprehensive report on British provenance trials with lodgepole pine was produced by Lines (1996), summarising results from over 90 experiments covering over 50 years. This document (Lines 1996 Table 60) recommended the use of coastal Alaskan origins for growing in nursing mixtures with Sitka spruce, North Coastal origins from Vancouver Island and Haida Gwaii (Queen Charlotte Islands) as hardy general purpose seed sources, and inland sources from the Skeena river region in British Columbia as the preferred material for less exposed mineral soils.

In addition to the provenance studies described above, a tree breeding programme with lodgepole pine was started in 1963 and continued until the early 1990s (Anonymous 2000). This included the selection of 3980 plus trees (more than for any other conifer species), the establishment of progeny tests from 1964 onwards, and the creation of 11 seedling seed orchards between 1979 and 1989. Level of genetic gain is not known. Thought to be modest beyond the selection of the most suitable origin (Lee 2004). A particular focus of breeding activities with this species was a systematic attempt to identify inter-provenance hybrids which would combine the good form of interior provenances with the vigour characteristic of south coastal material.

However, interest in the planting of lodgepole pine, and consequently in the support for breeding activities with this species, has declined since the late 1980s for several reasons.

First, increased awareness of the potential use of 'nutritional' mixtures between lodgepole pine and Sitka spruce on nutrient poor soils (Mason and Connolly 2018) resulted in a reduction in the planting of pure stands of lodgepole pine in favour of using the slow growing Alaskan origins to nurse Sitka spruce. Second, environmental concerns over the afforestation of peat soils in northern Scotland resulted in a change in forest policy in 1988 leading to a major decline in the amount of new planting in this region, which was where the bulk of the lodgepole pine forests are concentrated. Third, there were major outbreaks of the pine beauty moth (*Pannolis flammea*) in the 1980s and of *Dothistroma* needle blight from 2000 onwards which have resulted in widespread die back and death in pure lodgepole pine stands. As a result of these factors, the species is little planted at present and its future in British forestry is uncertain (Savill 2013).

Provenance recommendations for Europe

A collection of papers with regards to the IUFRO WP and the 70/71 experiments was presented at the IUFRO meeting in Umeå, Sweden, in 1992 (Lindgren 1992c). National provenance recommendations have been made but are often not revised in a timely manner. Based on the results compiled in Lindgren (1992b), provenance choice for continental Europe is of more southern origin compared to the boreal region in the Nordic countries. The southern provenances encompass Southern British Columbia and north Oregon and Washington coast (Germany, Netherlands), where more coastal provenances, coastal Alaska, coastal British Columbian, and Skeena river, are preferred in the most western part of Europe (United Kingdom).

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7. Conclusions

Provenance recommendations based on experimentation/testing across different bioclimatic European regions and countries are the key to successful use of non-native tree species in European forests. Bearing in mind that non-native tree species have been introduced from different continents and areas within them, and from environments which potentially differ from those in Europe, such recommendations should be based on thorough nursery and long-term field testing across Europe and its bioclimatic regions. Although the need for such tests has been recognized more than a century ago, the intensity of the field testing networks differs substantially between species and countries, as the efforts were driven by different national interests and plans. While for some species, such as Douglas fir, IUFRO has coordinated trials in which sets of common provenances have been evaluated in numerous European countries, for other species, such as *Quercus rubra*, very few such trials exist. The intensity of testing across European countries results in different levels of knowledge regarding the performance and suitability of provenances from non-native species when planted in different European environmental zones.

Currently, in some European countries provenance recommendations exist at a national level, either non-official or official. Informal recommendations are derived from results presented in scientific papers or trial reports, but not yet introduced into national legislation or the official regulations of a country. Official recommendations are part of national legislation or regulations and are binding for forest owners.

Despite of the efforts invested into European trial networks (e.g. Douglas fir, Grand fir, Sitka spruce) a common transboundary approach for provenance recommendations is still missing. Without any doubt a European network can (theoretically) get maximum information on the appropriate environmental niches for particular species and provenances rather than a natinal network can do. In the view of climate change concerted actions would be even more important, because they will allow the establishment of field trials on wide climatic gradients.

Following the synthesis of the up to now reported results of testing non-native tree species in various European countries, the first provenance recommendations for five selected non-native tree species have been formulated and are presented in the current report. As a next step towards the formulation of such recommendations, the coordinated evaluation and joint analysis of results obtained from existing provenance trials combined with modelling approaches would be necessary. Especially for species lacking established tests, new coordinated European wide tests should be initiated. In such tests European land races of non-native tree species must also be considered due to: 1) increasing restrictions on importing forest reproductive material (FRM) from the native range, 2) the enhanced adaptation to European environment and potential adaptability to novel climate conditions and 3) as a source of material for breeding in Europe.

Timber harvesting in the natural range of non-native to Europe tree species differs significantly among species and regions. In some regions (e.g. Olympic peninsula, Vancouver Island) clear cutting and increasing urban sprawl makes harvesting of Douglas fir and grand fir more and more difficult (Konnert 2011, Schüler and Weißenbacher 2014). Also, reorientation to FRM from seed orchards, managed by private companies with no interest in export, instead of that from natural forests is diminishing the chances of introducing seed of non-native species in Europe and thus, its availability. Therefore, well performing and often recommended provenances are becoming unavailable. The import of non-native Forest Reproductive Material to Europe is further complicated by legislation. Currently, the EU-Countries can only import from six countries which follow the OECD rules, namely Canada, Switzerland, Norway, Serbia, Turkey and the United States of America. FRM officially certified by the authorities of the above countries is considered equivalent to the seed and planting stock fulfilling the requirements of Directive 1999/105/EC. A precondition for OECD certification is the approval of seed stands or seed orchards and their introduction in a national registry. Generally, US and Canadian certification agencies certify seed as "source identified" meaning that seed zone and altitudinal range are guaranteed. It is also possible (but in practice rarely done) to import 'source identified'; seed certified at the stand level at additional cost.

To confront the above-mentioned seed supply shortage, there is a strong need to establish artificial stands with the best performing provenances in Europe by using seed of known origin that has been collected from the natural range of the species. First initiatives in this direction were undertaken in southern Germany where such stands have been established for Douglas fir and grand fir. These stands should serve in the future as sources for valuable forest reproductive material and contribute to the long-time gene conservation of the native gene pool of these species (*ex situ* conservation measure).

Indeed, progeny of artificially established non-native tree populations in Europe (Douglas fir, grand fir, red oak) performed just as well, or even better, to that collected from the best native populations. While an adequate gene pool and a potential indirect effect of selective thinning on allelic frequencies are often used as arguments to explain the above finding, it has been also demonstrated that adaptation to local environments is possible in a single generation. Good performance of land races explains why European breeders put so much effort in identifying them: official registration as selected seed sources, retrieval of geographic origin of original seed, assessment of stand's genetic diversity, seed quality control and seedling traceability are included in these efforts.

The amount of forest reproductive material originating from European sources is increasing steadily for all species. For some species, as black locust and red oak, only FRM from European land races or clones is currently used (results of a questionnaire within the COST NNEXT Action). In this context, the use of biotechnological approaches would be useful to facilitate the realization of various theoretical ideas and to resolve practical issues related to genetics and breeding, such as *ex situ* conservation of genetic resources, adaptation studies, etc. Implementation of plant biotechnology tools for *ex situ* conservation purposes could be an essential element of a holistic approach covering the exploitation of advanced technology acquisitions, like molecular markers, DNA banks, *in vitro* conservation, including long-term cryopreservation, etc.

Nevertheless, the most important action closely related to the efficiency of provenance testing and further use of non-native species in Europe is the elaboration of a clear strategy for the cultivation of such species, based on prioritization of the advantages of using non-natives versus the autochthonous ones and of the factors limiting their growth performance in novel environments. The possible output is supposed to promote the development of a new vision for climate-adjusted resilient use of non-native species.

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Attachment: Coordinates of the genetic trials for non-native species introduced into figures 1 to 5

Attachment to the Deliverable:

"European provenance recommendations for selected non-native species"

Coordinates of genetic trials for non-native species introduced into figures 1 to 5

Species	ID	lat	long	Country
Pseudotsuga menziesii	Df1	47,83300	2,75000	France
Pseudotsuga menziesii	Df2	45,81700	1,73000	France
Pseudotsuga menziesii	Df3	48,08300	6,57000	France
Pseudotsuga menziesii	Df4	45,81700	1,73000	France
Pseudotsuga menziesii	Df5	45,81700	1,70000	France
Pseudotsuga menziesii	Df6	43,45000	2,52000	France
Pseudotsuga menziesii	Df7	43,96700	3,38000	France
Pseudotsuga menziesii	Df8	48,08300	6,57000	France
Pseudotsuga menziesii	Df9	48,08300	6,57000	France
Pseudotsuga menziesii	Df10	43,45000	2,52000	France
Pseudotsuga menziesii	Df11	47,61700	1,82000	France
Pseudotsuga menziesii	Df12	44,78300	0,92000	France
Pseudotsuga menziesii	Df13	45,10000	1,02000	France
Pseudotsuga menziesii	Df14	48,08000	6,57000	France
Pseudotsuga menziesii	Df15	43,26700	6,36700	France
Pseudotsuga menziesii	Df16	43,26700	6,36700	France
Pseudotsuga menziesii	Df17	48,78300	6,30000	France
Pseudotsuga menziesii	Df18	48,78300	6,30000	France
Pseudotsuga menziesii	Df19	48,78300	6,30000	France
Pseudotsuga menziesii	Df20	48,78300	6,30000	France
Pseudotsuga menziesii	Df21	43,38000	2,57000	France
Pseudotsuga menziesii	Df22	43,38000	2,57000	France
Pseudotsuga menziesii	Df23	43,20000	6,32000	France
Pseudotsuga menziesii	Df24	43,20000	6,32000	France
Pseudotsuga menziesii	Df25	48,78300	6,30000	France
Pseudotsuga menziesii	Df26	48,78300	6,30000	France
Pseudotsuga menziesii	Df27	45,81700	1,73000	France
Pseudotsuga menziesii	Df28	45,81700	1,73000	France
Pseudotsuga menziesii	Df29	47,96700	2,27000	France
Pseudotsuga menziesii	Df30	47,96700	2,27000	France
Pseudotsuga menziesii	Df31	43,46700	0,00000	France
Pseudotsuga menziesii	Df32	43,38300	0,00000	France
Pseudotsuga menziesii	Df33	44,73300	3,55000	France
Pseudotsuga menziesii	Df34	44,02000	6,50000	France
Pseudotsuga menziesii	Df35	44,02000	6,50000	France
Pseudotsuga menziesii	Df36	48,00000	2,28000	France
Pseudotsuga menziesii	Df37	43,15000	6,17000	France
Pseudotsuga menziesii	Df38	43,15000	6,17000	France
Pseudotsuga menziesii	Df39	43,15000	6,10000	France
Pseudotsuga menziesii	Df40	48,08300	6,57000	France
Pseudotsuga menziesii	Df41	45,73300	1,52000	France
Pseudotsuga menziesii	Df42	43,06700	1,58000	France
Pseudotsuga menziesii	Df43	43,00000	1,82000	France

Pseudotsuga menziesii	Df44	43,22000	6,35000	France
Pseudotsuga menziesii	Df45	47,95000	1,13300	France
Pseudotsuga menziesii	Df46	45,98300	4,41700	France
Pseudotsuga menziesii	Df47	43,66700	2,35000	France
Pseudotsuga menziesii	Df48	46,00000	1,78300	France
Pseudotsuga menziesii	Df49	48,08000	6,12000	France
Pseudotsuga menziesii	Df50	48,10000	6,13300	France
Pseudotsuga menziesii	Df51	47,95000	1,13300	France
Pseudotsuga menziesii	Df52	46,13000	1,77000	France
Pseudotsuga menziesii	Df53	41,97000	9,02000	France
Pseudotsuga menziesii	Df54	44,25000	4,03000	France
Pseudotsuga menziesii	Df55	41,97000	9,02000	France
Pseudotsuga menziesii	Df56	44,32000	4,00000	France
Pseudotsuga menziesii	Df57	44,33000	3,98000	France
Pseudotsuga menziesii	Df58	42,91000	2,42000	France
Pseudotsuga menziesii	Df59	42,91000	2,42000	France
Pseudotsuga menziesii	Df60	45,01700	0,82000	France
Pseudotsuga menziesii	Df61	45,81700	1,73300	France
Pseudotsuga menziesii	Df62	42,92000	0,97000	France
Pseudotsuga menziesii	Df63	48,08300	6,57000	France
Pseudotsuga menziesii	Df64	45,71700	1,93000	France
Pseudotsuga menziesii	Df65	48,55000	-0,01700	France
Pseudotsuga menziesii	Df66	48,08000	6,12000	France
Pseudotsuga menziesii	Df67	45,98300	4,40000	France
Pseudotsuga menziesii	Df68	43,43300	2,13300	France
Pseudotsuga menziesii	Df69	45,97000	1,48000	France
Pseudotsuga menziesii	Df70	48,55000	-0,01700	France
Pseudotsuga menziesii	Df71	48,10000	6,13300	France
Pseudotsuga menziesii	Df72	46,51700	4,76700	France
Pseudotsuga menziesii	Df73	42,93300	2,38300	France
Pseudotsuga menziesii	Df74	48,55000	-0,01700	France
Pseudotsuga menziesii	Df75	48,05000	6,08300	France
Pseudotsuga menziesii	Df76	45,98300	4,40000	France
Pseudotsuga menziesii	Df77	42,93300	2,38300	France
Pseudotsuga menziesii	Df78	48,05000	6,08300	France
Pseudotsuga menziesii	Df79	45,87000	1,60000	France
Pseudotsuga menziesii	Df80	43,43300	2,13300	France
Pseudotsuga menziesii	Df81	45,78300	1,75000	France
Pseudotsuga menziesii	Df82	48,08000	6,57000	France
Pseudotsuga menziesii	Df83	45,93000	1,86000	France
Pseudotsuga menziesii	Df84	43,43300	2,15000	France
Pseudotsuga menziesii	Df85	45,78300	1,75000	France
Pseudotsuga menziesii	Df86	45,81700	1,73300	France
Pseudotsuga menziesii	Df87	45,88000	1,73000	France
Pseudotsuga menziesii	Df88	45,98000	1,95000	France
Pseudotsuga menziesii	Df89	47,91700	1,13000	France
Pseudotsuga menziesii	Df90	46,21700	1,75000	France
Pseudotsuga menziesii	Df91	45,78300	1,75000	France
Pseudotsuga menziesii	Df92	45,90000	3,82000	France
Pseudotsuga menziesii	Df93	43,87000	2,53000	France

Pseudotsuga menziesii	Df94	47,23000	3,85000	France
Pseudotsuga menziesii	Df95	45,85000	3,83000	France
Pseudotsuga menziesii	Df96	43,43000	2,13000	France
Pseudotsuga menziesii	Df97	46,05000	1,48000	France
Pseudotsuga menziesii	Df98	45,90000	1,50000	France
Pseudotsuga menziesii	Df99	45,82000	3,92000	France
Pseudotsuga menziesii	Df100	43,43000	2,15000	France
Pseudotsuga menziesii	Df101	47,15000	4,20000	France
Pseudotsuga menziesii	Df102	45,96000	3,85000	France
Pseudotsuga menziesii	Df103	45,43000	1,70000	France
Pseudotsuga menziesii	Df104	46,20000	4,57000	France
Pseudotsuga menziesii	Df105	43,42000	2,12000	France
Pseudotsuga menziesii	Df106	47,20000	3,98000	France
Pseudotsuga menziesii	Df107	49,95000	4,85000	France
Pseudotsuga menziesii	Df108	43,42000	2,12000	France
Pseudotsuga menziesii	Df109	45,83000	2,17000	France
Pseudotsuga menziesii	Df110	47,10000	4,03000	France
Pseudotsuga menziesii	Df111	43,45000	2,13000	France
Pseudotsuga menziesii	Df112	47,28000	3,93000	France
Pseudotsuga menziesii	Df113	43,80000	2,53000	France
Pseudotsuga menziesii	Df114	45,87000	1,58000	France
Pseudotsuga menziesii	Df115	45,87000	1,58000	France
Pseudotsuga menziesii	Df116	43,18990	43,19650	Bulgaria
Pseudotsuga menziesii	Df117	42,27580	42,27990	Bulgaria
Pseudotsuga menziesii	Df118	42,37600	42,37630	Bulgaria
Pseudotsuga menziesii	Df119	43,21640	43,20390	Bulgaria
Pseudotsuga menziesii	Df120	42,91450	42,91140	Bulgaria
Pseudotsuga menziesii	Df121	39,55000	21,50000	Greece
Pseudotsuga menziesii	Df122	39,55000	21,46670	Greece
Pseudotsuga menziesii	Df123	40,43330	23,50000	Greece
Pseudotsuga menziesii	Df124	58,53000	-3,25000	United Kingdom
Pseudotsuga menziesii	Df125	57,48000	-3,09000	United Kingdom
Pseudotsuga menziesii	Df126	57,24000	-4,46000	United Kingdom
Pseudotsuga menziesii	Df127	56,24000	-3,54000	United Kingdom
Pseudotsuga menziesii	Df128	56,06000	-4,91000	United Kingdom
Pseudotsuga menziesii	Df129	55,07000	-4,75000	United Kingdom
Pseudotsuga menziesii	Df130	55,10000	-2,32000	United Kingdom
Pseudotsuga menziesii	Df131	54,25000	-0,65000	United Kingdom
Pseudotsuga menziesii	Df132	52,63000	-3,47000	United Kingdom
Pseudotsuga menziesii	Df133	51,95000	-3,11000	United Kingdom
Pseudotsuga menziesii	Df134	51,71000	-3,53000	United Kingdom
Pseudotsuga menziesii	Df135	50,55000	-4,53000	United Kingdom
Pseudotsuga menziesii	Df136	52,40000	-3,74000	United Kingdom
Pseudotsuga menziesii	Df137	57,23000	-5,47000	United Kingdom
Pseudotsuga menziesii	Df138	55,72000	-3,26000	United Kingdom
Pseudotsuga menziesii	Df139	55,80000	-5,35000	United Kingdom
Pseudotsuga menziesii	Df140	55,26000	-3,14000	United Kingdom
Pseudotsuga menziesii	Df141	54,61000	-3,23000	United Kingdom
Pseudotsuga menziesii	Df142	48,30000	16,15000	Croatia
Pseudotsuga menziesii	Df143	45,43330	15,30000	Croatia

Pseudotsuga menziesii	Df144	45,23330	18,25000	Croatia
Pseudotsuga menziesii	Df145	45,31670	18,63330	Croatia
Pseudotsuga menziesii	Df146	45,76670	17,05000	Croatia
Pseudotsuga menziesii	Df147	45,43330	15,28330	Croatia
Pseudotsuga menziesii	Df148	47,15000	22,36670	Romania
Pseudotsuga menziesii	Df149	45,76670	22,26670	Romania
Pseudotsuga menziesii	Df150	45,06670	22,88330	Romania
Pseudotsuga menziesii	Df151	45,41670	21,81670	Romania
Pseudotsuga menziesii	Df152	48,34030	14,70370	Austria
Pseudotsuga menziesii	Df153	47,32600	16,11530	Austria
Pseudotsuga menziesii	Df154	47,49480	16,40460	Austria
Pseudotsuga menziesii	Df155	46,81460	14,60330	Austria
Pseudotsuga menziesii	Df156	48,48870	14,31050	Austria
Pseudotsuga menziesii	Df157	48,07370	13,40880	Austria
Pseudotsuga menziesii	Df158	48,33150	15,51250	Austria
Pseudotsuga menziesii	Df159	48,35250	15,57250	Austria
Pseudotsuga menziesii	Df160	48,34810	15,56200	Austria
Pseudotsuga menziesii	Df161	47,84610	13,06110	Austria
Pseudotsuga menziesii	Df162	47,65240	16,06080	Austria
Pseudotsuga menziesii	Df163	47,64380	16,05560	Austria
Pseudotsuga menziesii	Df164	47,70080	15,77700	Austria
Pseudotsuga menziesii	Df165	48,12740	12,89420	Austria
Pseudotsuga menziesii	Df166	48,19890	12,93450	Austria
Pseudotsuga menziesii	Df167	48,13240	15,97660	Austria
Pseudotsuga menziesii	Df168	48,18730	15,02340	Austria
Pseudotsuga menziesii	Df169	47,62030	16,00170	Austria
Pseudotsuga menziesii	Df170	48,07760	16,00270	Austria
Pseudotsuga menziesii	Df171	47,17600	15,51610	Austria
Pseudotsuga menziesii	Df172	46,93660	14,59360	Austria
Pseudotsuga menziesii	Df173	48,54360	15,73470	Austria
Pseudotsuga menziesii	Df174	48,52520	15,71910	Austria
Pseudotsuga menziesii	Df175	48,51300	15,72280	Austria
Pseudotsuga menziesii	Df176	47,95820	16,65230	Austria
Pseudotsuga menziesii	Df177	47,97790	16,64310	Austria
Pseudotsuga menziesii	Df178	47,68880	16,34820	Austria
Pseudotsuga menziesii	Df179	48,08900	13,13040	Austria
Pseudotsuga menziesii	Df180	48,74280	16,55480	Austria
Pseudotsuga menziesii	Df181	48,48340	16,03320	Austria
Pseudotsuga menziesii	Df182	47,76400	16,35970	Austria
Pseudotsuga menziesii	Df183	48,69700	16,57780	Austria
Pseudotsuga menziesii	Df184	48,70100	16,62300	Austria
Pseudotsuga menziesii	Df185	47,33040	16,44060	Austria
Pseudotsuga menziesii	Df186	48,04360	14,97270	Austria
Pseudotsuga menziesii	Df187	47,65130	16,45420	Austria
Pseudotsuga menziesii	Df188	47,69730	16,44580	Austria
Pseudotsuga menziesii	Df189	46,63580	15,48630	Austria
Pseudotsuga menziesii	Df190	47,98130	16,67590	Austria
Pseudotsuga menziesii	Df191	48,10950	13,30230	Austria
Pseudotsuga menziesii	Df192	48,08480	15,82760	Austria
Pseudotsuga menziesii	Df193	48,59020	16,31630	Austria

Pseudotsuga menziesii	Df194	46,63820	14,06210	Austria
Pseudotsuga menziesii	Df195	48,33260	15,77740	Austria
Pseudotsuga menziesii	Df196	47,60730	16,43080	Austria
Pseudotsuga menziesii	Df197	48,21050	16,11070	Austria
Pseudotsuga menziesii	Df198	48,00070	14,90610	Austria
Pseudotsuga menziesii	Df199	48,43200	15,56030	Austria
Pseudotsuga menziesii	Df200	45,60370	14,05600	Slovenia
Pseudotsuga menziesii	Df201	45,60860	14,05650	Slovenia
Pseudotsuga menziesii	Df202	42,28000	6,97000	Spain
Pseudotsuga menziesii	Df203	42,52000	8,26000	Spain
Pseudotsuga menziesii	Df204	42,03000	7,05000	Spain
Pseudotsuga menziesii	Df205	42,55000	8,05000	Spain
Pseudotsuga menziesii	Df206	43,27000	7,53000	Spain
Pseudotsuga menziesii	Df207	43,45000	7,45000	Spain
Pseudotsuga menziesii	Df208	43,27000	7,35000	Spain
Pseudotsuga menziesii	Df209	43,22000	7,23000	Spain
Pseudotsuga menziesii	Df210	43,27000	7,07000	Spain
Pseudotsuga menziesii	Df211	43,12000	6,95000	Spain
Pseudotsuga menziesii	Df212	43,12000	5,88000	Spain
Pseudotsuga menziesii	Df213	43,18000	5,84000	Spain
Pseudotsuga menziesii	Df214	42,82000	5,36000	Spain
Pseudotsuga menziesii	Df215	42,98000	2,54000	Spain
Pseudotsuga menziesii	Df216	42,97000	2,18000	Spain
Pseudotsuga menziesii	Df217	42,92000	1,05000	Spain
Pseudotsuga menziesii	Df218	43,61670	11,58330	Italy
Pseudotsuga menziesii	Df219	43,73330	13,00000	Italy
Pseudotsuga menziesii	Df220	60,14000	20,03000	Finland
Pseudotsuga menziesii	Df221	60,26000	23,42000	Finland
Pseudotsuga menziesii	Df222	60,02000	23,33000	Finland
Pseudotsuga menziesii	Df223	60,08000	23,33000	Finland
Pseudotsuga menziesii	Df224	60,40000	26,07000	Finland
Pseudotsuga menziesii	Df225	59,56000	23,26000	Finland
Pseudotsuga menziesii	Df226	60,22000	25,01000	Finland
Pseudotsuga menziesii	Df227	60,27000	22,44000	Finland
Pseudotsuga menziesii	Df228	44,98330	16,85000	Bosnia
Pseudotsuga menziesii	Df229	44,40360	18,15080	Bosnia
Pseudotsuga menziesii	Df230	43,84310	18,04890	Bosnia
Pseudotsuga menziesii	Df231	44,41670	18,30000	Bosnia
Pseudotsuga menziesii	Df232	55,91000	13,64000	Sweden
Pseudotsuga menziesii	Df233	55,99000	13,16000	Sweden
Pseudotsuga menziesii	Df234	56,68000	13,07000	Sweden
Pseudotsuga menziesii	Df235	57,16000	14,77000	Sweden
Pseudotsuga menziesii	Df236	57,48000	12,52000	Sweden
Pseudotsuga menziesii	Df237	57,85000	15,30000	Sweden
Pseudotsuga menziesii	Df238	55,93000	13,32000	Sweden
Pseudotsuga menziesii	Df239	56,68000	13,12000	Sweden
Pseudotsuga menziesii	Df240	56,85000	14,57000	Sweden
Pseudotsuga menziesii	Df241	57,97000	14,12000	Sweden
Pseudotsuga menziesii	Df242	57,66000	15,25000	Sweden
Pseudotsuga menziesii	Df243	56,80000	13,12000	Sweden

Pseudotsuga menziesii	Df244	61,93000	14,98000	Sweden
Pseudotsuga menziesii	Df245	50.425095	35,00580	Ukraine
Pseudotsuga menziesii	Df246	50,28640	30,07460	Ukraine
Pseudotsuga menziesii	Df247	53,23330	15,20000	Poland
Pseudotsuga menziesii	Df248	53,90000	18,30000	Poland
Pseudotsuga menziesii	Df249	50,68330	22,26670	Poland
Pseudotsuga menziesii	Df250	52,71670	22,75000	Poland
Pseudotsuga menziesii	Df251	52,24190	17,06680	Poland
Pseudotsuga menziesii	Df252	48,55000	0,01670	France
Pseudotsuga menziesii	Df253	48,08330	6,11670	France
Pseudotsuga menziesii	Df254	45,96670	4,38330	France
Pseudotsuga menziesii	Df255	43,43330	2,13330	France
Pseudotsuga menziesii	Df256	45,98330	1,48330	France
Pseudotsuga menziesii	Df257	48,55000	0,01670	France
Pseudotsuga menziesii	Df258	48,10000	6,13330	France
Pseudotsuga menziesii	Df259	46,51670	4,76670	France
Pseudotsuga menziesii	Df260	42,93330	2,38330	France
Pseudotsuga menziesii	Df261	48,55000	0,01670	France
Pseudotsuga menziesii	Df262	48,05000	6,08330	France
Pseudotsuga menziesii	Df263	45,96670	4,38330	France
Pseudotsuga menziesii	Df264	42,93330	2,38330	France
Pseudotsuga menziesii	Df265	48,05000	6,08330	France
Pseudotsuga menziesii	Df266	45,86670	1,58330	France
Pseudotsuga menziesii	Df267	43,43330	2,13330	France
Pseudotsuga menziesii	Df268	45,78330	1,75000	France
Pseudotsuga menziesii	Df269	48,08330	6,11670	France
Pseudotsuga menziesii	Df270	45,93330	0,48330	France
Pseudotsuga menziesii	Df271	43,43330	2,13330	France
Pseudotsuga menziesii	Df272	45,78330	1,75000	France
Pseudotsuga menziesii	Df273	50,30000	6,01670	Belgium
Pseudotsuga menziesii	Df274	50,20000	5,11670	Belgium
Pseudotsuga menziesii	Df275	50,06670	5,11670	Belgium
Pseudotsuga menziesii	Df276	49,83330	5,08330	Belgium
Pseudotsuga menziesii	Df277	50,50000	6,00000	Belgium
Pseudotsuga menziesii	Df278	49,96670	5,05000	Belgium
Pseudotsuga menziesii	Df279	50,05000	5,10000	Belgium
Pseudotsuga menziesii	Df280	50,05000	4,10000	Belgium
Pseudotsuga menziesii	Df281	49,95000	4,08330	Belgium
Pseudotsuga menziesii	Df282	49,81670	5,06670	Belgium
Pseudotsuga menziesii	Df283	50,63330	6,08330	Belgium
Pseudotsuga menziesii	Df284	50,20000	5,13330	Belgium
Pseudotsuga menziesii	Df285	43,10000	7,78330	Spain
Pseudotsuga menziesii	Df286	43,60000	7,81670	Spain
Pseudotsuga menziesii	Df287	42,81670	8,45000	Spain
Pseudotsuga menziesii	Df288	42,70000	7,78330	Spain
Pseudotsuga menziesii	Df289	42,66670	3,70000	Spain
Pseudotsuga menziesii	Df290	42,06670	6,63330	Spain
Pseudotsuga menziesii	Df291	42,70000	3,63330	Spain
Pseudotsuga menziesii	Df292	57,03330	-8,70000	United Kingdom
Pseudotsuga menziesii	Df293	52,35000	-7,86670	United Kingdom

Pseudotsuga menziesii	Df294	51,73330	-2,75000	United Kingdom
Pseudotsuga menziesii	Df295	57,03330	-2,73330	United Kingdom
Pseudotsuga menziesii	Df296	52,35000	-2,71670	United Kingdom
Pseudotsuga menziesii	Df297	57,03330	-2,71670	United Kingdom
Pseudotsuga menziesii	Df298	51,73330	-2,71670	United Kingdom
Pseudotsuga menziesii	Df299	57,03330	-2,75000	United Kingdom
Pseudotsuga menziesii	Df300	52,35000	-2,35000	United Kingdom
Pseudotsuga menziesii	Df301	51,73330	-2,73330	United Kingdom
Pseudotsuga menziesii	Df302	51,73330	-2,73330	United Kingdom
Pseudotsuga menziesii	Df303	47,83300	2,75000	France
Pseudotsuga menziesii	Df304	45,81700	1,73000	France
Pseudotsuga menziesii	Df305	48,08300	6,57000	France
Pseudotsuga menziesii	Df306	45,81700	1,73000	France
Pseudotsuga menziesii	Df307	45,81700	1,70000	France
Pseudotsuga menziesii	Df308	43,45000	2,52000	France
Pseudotsuga menziesii	Df309	43,96700	3,38000	France
Pseudotsuga menziesii	Df310	48,08300	6,57000	France
Pseudotsuga menziesii	Df311	48,08300	6,57000	France
Pseudotsuga menziesii	Df312	43,45000	2,52000	France
Pseudotsuga menziesii	Df313	47,61700	1,82000	France
Pseudotsuga menziesii	Df314	44,78300	0,92000	France
Pseudotsuga menziesii	Df315	45,10000	1,02000	France
Pseudotsuga menziesii	Df316	48,08000	6,57000	France
Pseudotsuga menziesii	Df317	43,26700	6,36700	France
Pseudotsuga menziesii	Df318	43,26700	6,36700	France
Pseudotsuga menziesii	Df319	48,78300	6,30000	France
Pseudotsuga menziesii	Df320	48,78300	6,30000	France
Pseudotsuga menziesii	Df321	48,78300	6,30000	France
Pseudotsuga menziesii	Df322	48,78300	6,30000	France
Pseudotsuga menziesii	Df323	43,38000	2,57000	France
Pseudotsuga menziesii	Df324	43,38000	2,57000	France
Pseudotsuga menziesii	Df325	43,20000	6,32000	France
Pseudotsuga menziesii	Df326	43,20000	6,32000	France
Pseudotsuga menziesii	Df327	48,78300	6,30000	France
Pseudotsuga menziesii	Df328	48,78300	6,30000	France
Pseudotsuga menziesii	Df329	45,81700	1,73000	France
Pseudotsuga menziesii	Df330	45,81700	1,73000	France
Pseudotsuga menziesii	Df331	47,96700	2,27000	France
Pseudotsuga menziesii	Df332	47,96700	2,27000	France
Pseudotsuga menziesii	Df333	43,46700	0,00000	France
Pseudotsuga menziesii	Df334	43,38300	0,00000	France
Pseudotsuga menziesii	Df335	44,73300	3,55000	France
Pseudotsuga menziesii	Df336	44,02000	6,50000	France
Pseudotsuga menziesii	Df337	44,02000	6,50000	France
Pseudotsuga menziesii	Df338	48,00000	2,28000	France
Pseudotsuga menziesii	Df339	43,15000	6,17000	France
Pseudotsuga menziesii	Df340	43,15000	6,17000	France
Pseudotsuga menziesii	Df341	43,15000	6,10000	France
Pseudotsuga menziesii	Df342	48,08300	6,57000	France
Pseudotsuga menziesii	Df343	45,73300	1,52000	France

Pseudotsuga menziesii	Df344	43,06700	1,58000	France
Pseudotsuga menziesii	Df345	43,00000	1,82000	France
Pseudotsuga menziesii	Df346	43,22000	6,35000	France
Pseudotsuga menziesii	Df347	47,95000	1,13300	France
Pseudotsuga menziesii	Df348	45,98300	4,41700	France
Pseudotsuga menziesii	Df349	43,66700	2,35000	France
Pseudotsuga menziesii	Df350	46,00000	1,78300	France
Pseudotsuga menziesii	Df351	48,08000	6,12000	France
Pseudotsuga menziesii	Df352	48,10000	6,13300	France
Pseudotsuga menziesii	Df353	47,95000	1,13300	France
Pseudotsuga menziesii	Df354	46,13000	1,77000	France
Pseudotsuga menziesii	Df355	41,97000	9,02000	France
Pseudotsuga menziesii	Df356	44,25000	4,03000	France
Pseudotsuga menziesii	Df357	41,97000	9,02000	France
Pseudotsuga menziesii	Df358	44,32000	4,00000	France
Pseudotsuga menziesii	Df359	44,33000	3,98000	France
Pseudotsuga menziesii	Df360	42,91000	2,42000	France
Pseudotsuga menziesii	Df361	42,91000	2,42000	France
Pseudotsuga menziesii	Df362	45,01700	0,82000	France
Pseudotsuga menziesii	Df363	45,81700	1,73300	France
Pseudotsuga menziesii	Df364	42,92000	0,97000	France
Pseudotsuga menziesii	Df365	48,08300	6,57000	France
Pseudotsuga menziesii	Df366	45,71700	1,93000	France
Pseudotsuga menziesii	Df367	48,55000	-0,01700	France
Pseudotsuga menziesii	Df368	48,08000	6,12000	France
Pseudotsuga menziesii	Df369	45,98300	4,40000	France
Pseudotsuga menziesii	Df370	43,43300	2,13300	France
Pseudotsuga menziesii	Df371	45,97000	1,48000	France
Pseudotsuga menziesii	Df372	48,55000	-0,01700	France
Pseudotsuga menziesii	Df373	48,10000	6,13300	France
Pseudotsuga menziesii	Df374	46,51700	4,76700	France
Pseudotsuga menziesii	Df375	42,93300	2,38300	France
Pseudotsuga menziesii	Df376	48,55000	-0,01700	France
Pseudotsuga menziesii	Df377	48,05000	6,08300	France
Pseudotsuga menziesii	Df378	45,98300	4,40000	France
Pseudotsuga menziesii	Df379	42,93300	2,38300	France
Pseudotsuga menziesii	Df380	48,05000	6,08300	France
Pseudotsuga menziesii	Df381	45,87000	1,60000	France
Pseudotsuga menziesii	Df382	43,43300	2,13300	France
Pseudotsuga menziesii	Df383	45,78300	1,75000	France
Pseudotsuga menziesii	Df384	48,08000	6,57000	France
Pseudotsuga menziesii	Df385	45,93000	1,86000	France
Pseudotsuga menziesii	Df386	43,43300	2,15000	France
Pseudotsuga menziesii	Df387	45,78300	1,75000	France
Pseudotsuga menziesii	Df388	45,81700	1,73300	France
Pseudotsuga menziesii	Df389	45,88000	1,73000	France
Pseudotsuga menziesii	Df390	45,98000	1,95000	France
Pseudotsuga menziesii	Df391	47,91700	1,13000	France
Pseudotsuga menziesii	Df392	46,21700	1,75000	France
Pseudotsuga menziesii	Df393	45,78300	1,75000	France

Pseudotsuga menziesii	Df394	45,90000	3,82000	France
Pseudotsuga menziesii	Df395	43,87000	2,53000	France
Pseudotsuga menziesii	Df396	47,23000	3,85000	France
Pseudotsuga menziesii	Df397	45,85000	3,83000	France
Pseudotsuga menziesii	Df398	43,43000	2,13000	France
Pseudotsuga menziesii	Df399	46,05000	1,48000	France
Pseudotsuga menziesii	Df400	45,90000	1,50000	France
Pseudotsuga menziesii	Df401	45,82000	3,92000	France
Pseudotsuga menziesii	Df402	43,43000	2,15000	France
Pseudotsuga menziesii	Df403	47,15000	4,20000	France
Pseudotsuga menziesii	Df404	45,96000	3,85000	France
Pseudotsuga menziesii	Df405	45,43000	1,70000	France
Pseudotsuga menziesii	Df406	46,20000	4,57000	France
Pseudotsuga menziesii	Df407	43,42000	2,12000	France
Pseudotsuga menziesii	Df408	47,20000	3,98000	France
Pseudotsuga menziesii	Df409	49,95000	4,85000	France
Pseudotsuga menziesii	Df410	43,42000	2,12000	France
Pseudotsuga menziesii	Df411	45,83000	2,17000	France
Pseudotsuga menziesii	Df412	47,10000	4,03000	France
Pseudotsuga menziesii	Df413	43,45000	2,13000	France
Pseudotsuga menziesii	Df414	47,28000	3,93000	France
Pseudotsuga menziesii	Df415	43,80000	2,53000	France
Pseudotsuga menziesii	Df416	45,87000	1,58000	France
Pseudotsuga menziesii	Df417	45,87000	1,58000	France
Pseudotsuga menziesii	Df418	49,71670	12,35000	Germany
Pseudotsuga menziesii	Df419	49,63330	12,43330	Germany
Pseudotsuga menziesii	Df420	49,68330	12,41670	Germany
Pseudotsuga menziesii	Df421	49,48330	12,35000	Germany
Pseudotsuga menziesii	Df422	48,73330	13,33330	Germany
Pseudotsuga menziesii	Df423	49,88330	11,96670	Germany
Pseudotsuga menziesii	Df424	47,95000	12,90000	Germany
Pseudotsuga menziesii	Df425	50,01670	9,38330	Germany
Pseudotsuga menziesii	Df426	49,90000	9,45000	Germany
Pseudotsuga menziesii	Df427	50,06670	9,61670	Germany
Pseudotsuga menziesii	Df428	50,06670	9,61670	Germany
Pseudotsuga menziesii	Df429	50,31670	9,80000	Germany
Pseudotsuga menziesii	Df430	50,18330	11,51670	Germany
Pseudotsuga menziesii	Df431	48,81670	13,51670	Germany
Pseudotsuga menziesii	Df432	48,88330	13,10000	Germany
Pseudotsuga menziesii	Df433	48,73330	11,80000	Germany
Pseudotsuga menziesii	Df434	48,73330	11,80000	Germany
Pseudotsuga menziesii	Df435	48,73330	11,80000	Germany
Pseudotsuga menziesii	Df436	48,73330	11,80000	Germany
Pseudotsuga menziesii	Df437	48,86670	11,50000	Germany
Pseudotsuga menziesii	Df438	48,58330	12,10000	Germany
Pseudotsuga menziesii	Df439	49,80000	9,41670	Germany
Pseudotsuga menziesii	Df440	49,85000	11,41670	Germany
Pseudotsuga menziesii	Df441	48,78330	13,33330	Germany
Pseudotsuga menziesii	Df442	48,05000	10,95000	Germany
Pseudotsuga menziesii	Df443	53,50000	10,50000	Germany

Pseudotsuga menziesii	Df444	53,50000	10,50000	Germany
Pseudotsuga menziesii	Df445	52,50000	7,63670	Germany
Pseudotsuga menziesii	Df446	52,51670	7,66330	Germany
Pseudotsuga menziesii	Df447	52,55000	7,46330	Germany
Pseudotsuga menziesii	Df448	52,30000	14,13670	Germany
Pseudotsuga menziesii	Df449	50,56670	7,96330	Germany
Pseudotsuga menziesii	Df450	53,66670	10,53670	Germany
Pseudotsuga menziesii	Df451	53,66670	10,53670	Germany
Pseudotsuga menziesii	Df452	50,91670	8,76330	Germany
Pseudotsuga menziesii	Df453	52,71670	10,86330	Germany
Pseudotsuga menziesii	Df454	52,50000	13,80000	Germany
Pseudotsuga menziesii	Df455	52,50000	13,80000	Germany
Pseudotsuga menziesii	Df456	49,68330	12,30000	Germany
Pseudotsuga menziesii	Df457	54,10000	10,60000	Germany
Pseudotsuga menziesii	Df458	49,68330	12,30000	Germany
Pseudotsuga menziesii	Df459	53,70000	10,60000	Germany
Pseudotsuga menziesii	Df460	53,50000	10,80000	Germany
Pseudotsuga menziesii	Df461	53,70000	10,60000	Germany
Pseudotsuga menziesii	Df462	53,75000	9,00000	Germany
Pseudotsuga menziesii	Df463	54,10000	10,66330	Germany
Pseudotsuga menziesii	Df464	52,91670	8,58330	Germany
Pseudotsuga menziesii	Df465	53,50000	9,00000	Germany
Pseudotsuga menziesii	Df466	50,31670	7,98330	Germany
Pseudotsuga menziesii	Df467	54,01670	10,11670	Germany
Pseudotsuga menziesii	Df468	51,36670	9,68330	Germany
Pseudotsuga menziesii	Df469	53,95000	10,13330	Germany
Pseudotsuga menziesii	Df470	51,85000	10,18330	Germany
Pseudotsuga menziesii	Df471	52,83330	10,33330	Germany
Pseudotsuga menziesii	Df472	53,35000	8,81670	Germany
Pseudotsuga menziesii	Df473	51,31670	9,73330	Germany
Pseudotsuga menziesii	Df474	52,66670	9,33330	Germany
Pseudotsuga menziesii	Df475	51,66670	10,43330	Germany
Pseudotsuga menziesii	Df476	51,66670	9,55000	Germany
Pseudotsuga menziesii	Df477	52,91670	8,83330	Germany
Pseudotsuga menziesii	Df478	51,66670	10,43330	Germany
Pseudotsuga menziesii	Df479	52,91670	8,60000	Germany
Pseudotsuga menziesii	Df480	53,95000	10,13330	Germany
Pseudotsuga menziesii	Df481	53,16670	10,60000	Germany
Pseudotsuga menziesii	Df482	53,26670	9,11670	Germany
Pseudotsuga menziesii	Df483	54,10000	9,81670	Germany
Pseudotsuga menziesii	Df484	53,46670	9,50000	Germany
Pseudotsuga menziesii	Df485	52,88330	8,60000	Germany
Pseudotsuga menziesii	Df486	51,36670	9,68330	Germany
Pseudotsuga menziesii	Df487	54,10000	9,81670	Germany
Pseudotsuga menziesii	Df488	51,85000	8,71670	Germany
Pseudotsuga menziesii	Df489	52,80000	10,30000	Germany
Pseudotsuga menziesii	Df490	50,26670	6,53330	Germany
Pseudotsuga menziesii	Df491	50,33330	7,06670	Germany
Pseudotsuga menziesii	Df492	52,68330	10,50000	Germany
Pseudotsuga menziesii	Df493	52,81670	10,36670	Germany

Pseudotsuga menziesii	Df494	51,30000	9,73330	Germany
Pseudotsuga menziesii	Df495	51,36670	9,68330	Germany
Pseudotsuga menziesii	Df496	52,68330	10,50000	Germany
Pseudotsuga menziesii	Df497	52,68330	10,50000	Germany
Pseudotsuga menziesii	Df498	53,66670	9,91670	Germany
Pseudotsuga menziesii	Df499	52,68330	10,50000	Germany
Pseudotsuga menziesii	Df500	51,33330	9,71670	Germany
Pseudotsuga menziesii	Df501	51,98330	12,46670	Germany
Pseudotsuga menziesii	Df502	51,56670	9,61670	Germany
Pseudotsuga menziesii	Df503	52,73330	9,41670	Germany
Pseudotsuga menziesii	Df504	50,23330	8,50000	Germany
Pseudotsuga menziesii	Df505	50,43330	9,81670	Germany
Pseudotsuga menziesii	Df506	50,41670	8,55000	Germany
Pseudotsuga menziesii	Df507	49,63330	8,53330	Germany
Pseudotsuga menziesii	Df508	49,43330	8,91670	Germany
Pseudotsuga menziesii	Df509	51,06670	8,56670	Germany
Pseudotsuga menziesii	Df510	51,01670	9,70000	Germany
Pseudotsuga menziesii	Df511	51,21670	9,85000	Germany
Pseudotsuga menziesii	Df512	51,40000	9,58330	Germany
Pseudotsuga menziesii	Df513	51,15000	10,11670	Germany
Pseudotsuga menziesii	Df514	50,41670	9,75000	Germany
Pseudotsuga menziesii	Df515	51,06670	8,63330	Germany
Pseudotsuga menziesii	Df516	50,15000	9,25000	Germany
Pseudotsuga menziesii	Df517	50,16670	8,31670	Germany
Pseudotsuga menziesii	Df518	50,68330	8,63330	Germany
Pseudotsuga menziesii	Df519	50,51670	8,85000	Germany
Pseudotsuga menziesii	Df520	50,03330	8,73330	Germany
Pseudotsuga menziesii	Df521	50,81670	9,58330	Germany
Pseudotsuga menziesii	Df522	51,55000	9,48330	Germany
Pseudotsuga menziesii	Df523	50,33330	8,56670	Germany
Pseudotsuga menziesii	Df524	46,69934	6,46880	Switzerland
Abies grandis	Ag1	48,13333	15,98333	Austria
Abies grandis	Ag2	48,58333	16,31667	Austria
Abies grandis	Ag3	47,65000	16,45000	Austria
Abies grandis	Ag4	48,10000	12,91667	Austria
Abies grandis	Ag5	48,35000	15,56667	Austria
Abies grandis	Ag6	45,42900	14,91500	Croatia
Abies grandis	Ag7	45,36000	15,50000	Croatia
Abies grandis	Ag8	45,32300	18,64800	Croatia
Abies grandis	Ag9	49,52000	13,95000	Czech Republic
Abies grandis	Ag10	49,76000	15,48000	Czech Republic
Abies grandis	Ag11	50,54000	15,20000	Czech Republic
Abies grandis	Ag12	50,09000	14,42000	Czech Republic
Abies grandis	Ag13	48,84000	14,63000	Czech Republic
Abies grandis	Ag14	49,94500	14,39000	Czech Republic
Abies grandis	Ag15	45,41000	1,49000	France
Abies grandis	Ag16	49,20000	13,20000	Germany
Abies grandis	Ag17	50,60000	12,80000	Germany
Abies grandis	Ag18	50,16000	11,32000	Germany
Abies grandis	Ag19	50,40000	9,37000	Germany

Abies grandis	Ag20	53,53000	9,50000	Germany
Abies grandis	Ag21	53,29000	10,20000	Germany
Abies grandis	Ag22	49,41000	11,39000	Germany
Abies grandis	Ag23	53,36000	7,16000	Germany
Abies grandis	Ag24	53,29000	7,51000	Germany
Abies grandis	Ag25	53,40000	10,15000	Germany
Abies grandis	Ag26	51,30000	10,38000	Germany
Abies grandis	Ag27	51,40000	8,58000	Germany
Abies grandis	Ag28	51,23000	8,13000	Germany
Abies grandis	Ag29	52,17000	7,47000	Germany
Abies grandis	Ag30	52,51000	8,40000	Germany
Abies grandis	Ag31	51,31000	9,38000	Germany
Abies grandis	Ag32	52,57000	7,51000	Germany
Abies grandis	Ag33	53,43000	9,57000	Germany
Abies grandis	Ag34	54,60000	9,51000	Germany
Abies grandis	Ag35	51,30000	10,38000	Germany
Abies grandis	Ag36	51,40000	8,58000	Germany
Abies grandis	Ag37	51,23000	8,13000	Germany
Abies grandis	Ag38	52,17000	7,47000	Germany
Abies grandis	Ag39	52,52000	8,47000	Germany
Abies grandis	Ag40	52,58000	7,50000	Germany
Abies grandis	Ag41	53,43000	9,57000	Germany
Abies grandis	Ag42	54,60000	9,51000	Germany
Abies grandis	Ag43	51,52000	10,12000	Germany
Abies grandis	Ag44	51,32000	9,31000	Germany
Abies grandis	Ag45	50,00000	8,57000	Germany
Abies grandis	Ag46	51,60000	8,46000	Germany
Abies grandis	Ag47	50,36000	9,45000	Germany
Abies grandis	Ag48	50,36000	9,36000	Germany
Abies grandis	Ag49	50,11000	8,24000	Germany
Abies grandis	Ag50	52,31600	4,64900	The Netherlands
Abies grandis	Ag51	52,37400	5,76900	The Netherlands
Abies grandis	Ag52	52,26600	6,98000	The Netherlands
Abies grandis	Ag53	52,90500	6,70000	The Netherlands
Abies grandis	Ag54	52,85400	6,69200	The Netherlands
Abies grandis	Ag55	52,25200	5,65800	The Netherlands
Abies grandis	Ag56	51,35500	5,45300	The Netherlands
Abies grandis	Ag57	49,45000	20,96667	Poland
Abies grandis	Ag58	53,35000	15,43000	Poland
Abies grandis	Ag59	50,71000	22,41000	Poland
Abies grandis	Ag60	57,62000	-3,07000	United Kingdom
Abies grandis	Ag61	57,12000	-4,73000	United Kingdom
Abies grandis	Ag62	56,54000	-4,10000	United Kingdom
Abies grandis	Ag63	56,01000	-4,95000	United Kingdom
Abies grandis	Ag64	55,25000	-4,04000	United Kingdom
Abies grandis	Ag65	55,10000	-2,32000	United Kingdom
Abies grandis	Ag66	53,91000	-0,99000	United Kingdom
Abies grandis	Ag67	52,68000	-3,23000	United Kingdom
Abies grandis	Ag68	52,42000	-0,68000	United Kingdom
Abies grandis	Ag69	51,17000	-0,87000	United Kingdom

Abies grandis	Ag70	51,13000	-3,42000	United Kingdom
Robinia pseudoacacia	Rob1	48,40939	16,51587	Austria
Robinia pseudoacacia	Rob2	46,85000	19,77000	Hungary
Robinia pseudoacacia	Rob3	47,59000	19,36667	Hungary
Robinia pseudoacacia	Rob4	46,83000	19,75000	Hungary
Robinia pseudoacacia	Rob5	47,61000	19,36667	Hungary
Robinia pseudoacacia	Rob6	47,55000	19,38000	Hungary
Robinia pseudoacacia	Rob7	47,57000	19,40000	Hungary
Robinia pseudoacacia	Rob8	47,20000	19,58273	Hungary
Robinia pseudoacacia	Rob9	47,25000	19,52316	Hungary
Robinia pseudoacacia	Rob10	47,63000	19,36667	Hungary
Robinia pseudoacacia	Rob11	47,23000	16,92974	Hungary
Robinia pseudoacacia	Rob12	41,90000	12,35000	Italy
Robinia pseudoacacia	Rob13	41,93000	12,36000	Italy
Robinia pseudoacacia	Rob14	41,94000	12,40000	Italy
Robinia pseudoacacia	Rob15	41,95000	12,50000	Italy
Robinia pseudoacacia	Rob16	41,95000	12,60000	Italy
Robinia pseudoacacia	Rob17	41,98000	12,70000	Italy
Robinia pseudoacacia	Rob18	52,30000	14,90000	Poland
Robinia pseudoacacia	Rob19	52,17385	14,90122	Poland
Robinia pseudoacacia	Rob20	51,32294	16,86764	Poland
Robinia pseudoacacia	Rob21	52,31000	14,91000	Poland
Robinia pseudoacacia	Rob22	52,43389	22,38000	Poland
Robinia pseudoacacia	Rob23	52,38278	22,35000	Poland
Robinia pseudoacacia	Rob24	52,60972	22,32000	Poland
Robinia pseudoacacia	Rob25	45,28333	19,88333	Serbia
Robinia pseudoacacia	Rob26	56,03805	-5,44664	United Kingdom
Robinia pseudoacacia	Rob27	52,00225	-4,07631	United Kingdom
Robinia pseudoacacia	Rob28	51,60767	-2,21569	United Kingdom
Robinia pseudoacacia	Rob29	49,17403	0,79051	France
Robinia pseudoacacia	Rob30	48,50223	0,70953	France
Robinia pseudoacacia	Rob31	48,54294	-2,49130	France
Robinia pseudoacacia	Rob32	48,04883	-3,44252	France
Robinia pseudoacacia	Rob33	47,84842	-0,16927	France
Robinia pseudoacacia	Rob34	47,48107	-0,82695	France
Robinia pseudoacacia	Rob35	46,51383	-0,14529	France
Robinia pseudoacacia	Rob36	46,29830	-0,04682	France
Robinia pseudoacacia	Rob37	45,88350	0,66219	France
Robinia pseudoacacia	Rob38	45,46607	1,09881	France
Robinia pseudoacacia	Rob39	44,72584	-0,79729	France
Robinia pseudoacacia	Rob40	48,10012	-4,42178	France
Robinia pseudoacacia	Rob41	43,89955	-0,28146	France
Robinia pseudoacacia	Rob42	43,50808	-1,45396	France
Robinia pseudoacacia	Rob43	43,33097	-2,92221	Spain
Robinia pseudoacacia	Rob44	43,30871	-4,33518	Spain
Robinia pseudoacacia	Rob45	43,26302	-2,07975	Spain
Robinia pseudoacacia	Rob46	43,14483	-4,63639	Spain
Robinia pseudoacacia	Rob47	43,05109	-2,56048	Spain
Robinia pseudoacacia	Rob48	42,79799	-1,80099	Spain
Robinia pseudoacacia	Rob49	42,80055	-1,19815	Spain

Robinia pseudoacacia	Rob50	42,76879	-5,15174	Spain
Robinia pseudoacacia	Rob51	42,74421	-3,58419	Spain
Robinia pseudoacacia	Rob52	42,69059	-8,99582	Spain
Robinia pseudoacacia	Rob53	42,55678	-7,38885	Spain
Robinia pseudoacacia	Rob54	42,38896	-8,66487	Spain
Robinia pseudoacacia	Rob55	41,46592	-3,61963	Spain
Robinia pseudoacacia	Rob56	39,05715	-7,57596	Portugal
Robinia pseudoacacia	Rob57	56,50000	-6,00000	United Kingdom
Robinia pseudoacacia	Rob58	52,00000	-3,70000	United Kingdom
Robinia pseudoacacia	Rob59	51,60000	-2,20000	United Kingdom
Robinia pseudoacacia	Rob60	49,20000	0,80000	France
Robinia pseudoacacia	Rob61	48,50000	0,70000	France
Robinia pseudoacacia	Rob62	48,50000	-2,30000	France
Robinia pseudoacacia	Rob63	48,10000	-3,40000	France
Robinia pseudoacacia	Rob64	47,80000	-0,20000	France
Robinia pseudoacacia	Rob65	47,50000	-0,80000	France
Robinia pseudoacacia	Rob66	46,50000	-0,10000	France
Robinia pseudoacacia	Rob67	46,30000	-0,10000	France
Robinia pseudoacacia	Rob68	45,90000	0,70000	France
Robinia pseudoacacia	Rob69	45,00000	-1,00000	France
Robinia pseudoacacia	Rob70	44,70000	-0,80000	France
Robinia pseudoacacia	Rob71	44,10000	-0,30000	France
Robinia pseudoacacia	Rob72	43,90000	-0,20000	France
Robinia pseudoacacia	Rob73	43,50000	-1,40000	France
Robinia pseudoacacia	Rob74	43,30000	-2,90000	Spain
Robinia pseudoacacia	Rob75	43,30000	-2,90000	Spain
Robinia pseudoacacia	Rob76	43,30000	-2,90000	Spain
Robinia pseudoacacia	Rob77	43,30000	-4,30000	Spain
Robinia pseudoacacia	Rob78	43,30000	-2,10000	Spain
Robinia pseudoacacia	Rob79	43,10000	-4,60000	Spain
Robinia pseudoacacia	Rob80	43,10000	-2,60000	Spain
Robinia pseudoacacia	Rob81	42,80000	-1,80000	Spain
Robinia pseudoacacia	Rob82	42,76556	27,32111	Bulgaria
Robinia pseudoacacia	Rob83	43,31222	25,84306	Bulgaria
Robinia pseudoacacia	Rob84	43,31222	25,84306	Bulgaria
Robinia pseudoacacia	Rob85	43,47111	24,24833	Bulgaria
Robinia pseudoacacia	Rob86	43,60917	25,58889	Bulgaria
Robinia pseudoacacia	Rob87	42,76278	27,26806	Bulgaria
Robinia pseudoacacia	Rob88	42,65111	27,00389	Bulgaria
Robinia pseudoacacia	Rob89	42,35194	27,51139	Bulgaria
Robinia pseudoacacia	Rob90	40,58333	22,96667	Greece
Robinia pseudoacacia	Rob91	40,58333	22,96667	Greece
Pinus contorta	Lp1	57,68000	15,16000	Sweden
Pinus contorta	Lp2	59,50000	17,53000	Sweden
Pinus contorta	Lp3	57,68000	15,18000	Sweden
Pinus contorta	Lp4	59,71600	15,50000	Sweden
Pinus contorta	Lp5	56,45000	13,96000	Sweden
Pinus contorta	Lp6	59,71000	15,50000	Sweden
Pinus contorta	Lp7	58,00000	14,03000	Sweden
Pinus contorta	Lp8	57,38000	14,28000	Sweden

Pinus contorta	Lp9	66,52900	23,33200	Sweden
Pinus contorta	Lp10	65,44000	17,94000	Sweden
Pinus contorta	Lp11	61,82200	13,89500	Sweden
Pinus contorta	Lp12	61,99600	16,85300	Sweden
Pinus contorta	Lp13	65,59100	19,54700	Sweden
Pinus contorta	Lp14	64,98200	17,72800	Sweden
Pinus contorta	Lp15	63,10000	17,03000	Sweden
Pinus contorta	Lp16	63,90000	20,55000	Sweden
Pinus contorta	Lp17	63,90000	20,55000	Sweden
Pinus contorta	Lp18	67,72000	22,55000	Sweden
Pinus contorta	Lp19	67,67000	20,83000	Sweden
Pinus contorta	Lp20	64,93000	16,27000	Sweden
Pinus contorta	Lp21	65,93000	20,85000	Sweden
Pinus contorta	Lp22	67,35000	21,13000	Sweden
Pinus contorta	Lp23	62,75000	17,13000	Sweden
Pinus contorta	Lp24	64,15000	20,32000	Sweden
Pinus contorta	Lp25	61,79500	12,87900	Sweden
Pinus contorta	Lp26	61,53000	16,92000	Sweden
Pinus contorta	Lp27	61,15700	15,48700	Sweden
Pinus contorta	Lp28	60,11600	14,82000	Sweden
Pinus contorta	Lp29	64,03000	18,18000	Sweden
Pinus contorta	Lp30	66,28000	20,98000	Sweden
Pinus contorta	Lp31	64,53000	18,05000	Sweden
Pinus contorta	Lp32	64,77000	19,63000	Sweden
Pinus contorta	Lp33	62,67000	15,75000	Sweden
Pinus contorta	Lp34	63,95000	16,77000	Sweden
Pinus contorta	Lp35	65,80000	19,00000	Sweden
Pinus contorta	Lp36	67,83000	22,03000	Sweden
Pinus contorta	Lp37	66,90000	20,55000	Sweden
Pinus contorta	Lp38	66,55700	22,81000	Sweden
Pinus contorta	Lp39	64,97000	17,30000	Sweden
Pinus contorta	Lp40	65,80000	19,00000	Sweden
Pinus contorta	Lp41	61,80000	12,88000	Sweden
Pinus contorta	Lp42	63,62000	14,98000	Sweden
Pinus contorta	Lp43	63,33000	15,00000	Sweden
Pinus contorta	Lp44	61,68000	13,73000	Sweden
Pinus contorta	Lp45	62,18000	13,58000	Sweden
Pinus contorta	Lp46	61,17000	15,07000	Sweden
Pinus contorta	Lp47	61,23700	16,87900	Sweden
Pinus contorta	Lp48	62,58000	17,68000	Sweden
Pinus contorta	Lp49	61,52000	16,57400	Sweden
Pinus contorta	Lp50	63,19600	17,25100	Sweden
Pinus contorta	Lp51	65,02300	17,91600	Sweden
Pinus contorta	Lp52	65,03400	20,11900	Sweden
Pinus contorta	Lp53	63,96300	20,39400	Sweden
Pinus contorta	Lp54	63,43000	15,42000	Sweden
Pinus contorta	Lp55	63,96300	20,39400	Sweden
Pinus contorta	Lp56	65,44400	17,94400	Sweden
Pinus contorta	Lp57	66,18900	21,69600	Sweden
Pinus contorta	Lp58	62,19600	15,49400	Sweden

Pinus contorta	Lp59	62,45500	13,43700	Sweden
Pinus contorta	Lp60	62,61100	17,11300	Sweden
Pinus contorta	Lp61	62,52600	14,44400	Sweden
Pinus contorta	Lp62	63,38700	17,36900	Sweden
Pinus contorta	Lp63	60,70600	13,85300	Sweden
Pinus contorta	Lp64	62,15700	15,44300	Sweden
Pinus contorta	Lp65	67,17000	22,13000	Sweden
Pinus contorta	Lp66	65,92000	20,83000	Sweden
Pinus contorta	Lp67	64,77000	16,78000	Sweden
Pinus contorta	Lp68	63,40000	16,67000	Sweden
Pinus contorta	Lp69	63,90000	14,52000	Sweden
Pinus contorta	Lp70	62,53000	15,68000	Sweden
Pinus contorta	Lp71	66,78000	21,28000	Sweden
Pinus contorta	Lp72	67,13000	23,03000	Sweden
Pinus contorta	Lp73	65,93000	19,30000	Sweden
Pinus contorta	Lp74	64,42000	18,38000	Sweden
Pinus contorta	Lp75	63,88000	20,55000	Sweden
Pinus contorta	Lp76	62,25000	13,25000	Sweden
Pinus contorta	Lp77	62,15000	15,93000	Sweden
Pinus contorta	Lp78	62,15000	15,93000	Sweden
Pinus contorta	Lp79	60,11100	16,87400	Sweden
Pinus contorta	Lp80	60,45600	15,75300	Sweden
Pinus contorta	Lp81	59,96000	14,33500	Sweden
Pinus contorta	Lp82	59,91700	15,26000	Sweden
Pinus contorta	Lp83	59,49800	14,54400	Sweden
Pinus contorta	Lp84	59,42800	13,35000	Sweden
Pinus contorta	Lp85	60,31600	13,52200	Sweden
Pinus contorta	Lp86	60,85300	16,44800	Sweden
Pinus contorta	Lp87	61,56600	13,41800	Sweden
Pinus contorta	Lp88	61,08700	14,85500	Sweden
Pinus contorta	Lp89	60,29400	14,51400	Sweden
Pinus contorta	Lp90	60,90900	12,74800	Sweden
Pinus contorta	Lp91	59,86400	12,29100	Sweden
Pinus contorta	Lp92	61,59700	16,01000	Sweden
Pinus contorta	Lp93	61,86800	15,15900	Sweden
Pinus contorta	Lp94	60,17400	12,56300	Sweden
Pinus contorta	Lp95	57,74000	15,53000	Sweden
Pinus contorta	Lp96	58,78000	16,00000	Sweden
Pinus contorta	Lp97	56,72000	13,29000	Sweden
Pinus contorta	Lp98	56,81000	14,52000	Sweden
Pinus contorta	Lp99	63,65000	19,92000	Sweden
Pinus contorta	Lp100	64,05000	18,05000	Sweden
Pinus contorta	Lp101	65,22000	18,38000	Sweden
Pinus contorta	Lp102	65,82000	17,92000	Sweden
Pinus contorta	Lp103	55,60000	14,25000	Sweden
Pinus contorta	Lp104	58,46700	13,61700	Sweden
Pinus contorta	Lp105	59,43300	18,18300	Sweden
Pinus contorta	Lp106	58,46700	13,61700	Sweden
Pinus contorta	Lp107	59,43300	18,18300	Sweden
Pinus contorta	Lp108	60,88300	14,38300	Sweden

Pinus contorta	Lp109	63,05000	14,68300	Sweden
Pinus contorta	Lp110	65,70000	19,36700	Sweden
Pinus contorta	Lp111	66,73300	21,31700	Sweden
Pinus contorta	Lp112	60,93000	14,88000	Sweden
Pinus contorta	Lp113	64,25000	19,80000	Sweden
Pinus contorta	Lp114	62,46000	15,66000	Sweden
Pinus contorta	Lp115	64,26000	19,65000	Sweden
Pinus contorta	Lp116	65,48000	19,33000	Sweden
Pinus contorta	Lp117	66,76000	19,71000	Sweden
Pinus contorta	Lp118	63,95000	20,50000	Sweden
Pinus contorta	Lp119	63,88000	20,50000	Sweden
Pinus contorta	Lp120	64,16000	19,60000	Sweden
Pinus contorta	Lp121	64,28000	19,45000	Sweden
Pinus contorta	Lp122	64,06000	19,40000	Sweden
Pinus contorta	Lp123	64,08000	19,80000	Sweden
Pinus contorta	Lp124	64,05000	19,85000	Sweden
Pinus contorta	Lp125	61,05000	14,86000	Sweden
Pinus contorta	Lp126	64,05000	19,84000	Sweden
Pinus contorta	Lp127	62,15000	13,48000	Sweden
Pinus contorta	Lp128	62,09000	16,83000	Sweden
Pinus contorta	Lp129	63,11000	15,86000	Sweden
Pinus contorta	Lp130	64,00000	15,12000	Sweden
Pinus contorta	Lp131	63,60000	18,74000	Sweden
Pinus contorta	Lp132	64,86000	17,85000	Sweden
Pinus contorta	Lp133	65,86000	20,80000	Sweden
Pinus contorta	Lp134	60,36000	13,09000	Sweden
Pinus contorta	Lp135	60,27000	16,57000	Sweden
Pinus contorta	Lp136	67,50000	21,14000	Sweden
Pinus contorta	Lp137	56,64000	15,57000	Sweden
Pinus contorta	Lp138	57,39000	14,28000	Sweden
Pinus contorta	Lp139	59,49000	14,37000	Sweden
Pinus contorta	Lp140	66,50000	25,05000	Finland
Pinus contorta	Lp141	67,01700	24,48300	Finland
Pinus contorta	Lp142	65,70000	28,90000	Finland
Pinus contorta	Lp143	60,71700	24,90000	Finland
Pinus contorta	Lp144	60,71700	24,90000	Finland
Pinus contorta	Lp145	62,18300	22,80000	Finland
Pinus contorta	Lp146	62,10000	25,03300	Finland
Pinus contorta	Lp147	60,60000	24,43300	Finland
Pinus contorta	Lp148	61,80000	29,28300	Finland
Pinus contorta	Lp149	65,53300	28,18300	Finland
Pinus contorta	Lp150	65,53300	28,18300	Finland
Pinus contorta	Lp151	60,66700	24,36700	Finland
Pinus contorta	Lp152	60,50000	24,70000	Finland
Pinus contorta	Lp153	60,50000	22,76700	Finland
Pinus contorta	Lp154	59,96700	22,90000	Finland
Pinus contorta	Lp155	67,28300	23,75000	Finland
Pinus contorta	Lp156	60,50000	24,70000	Finland
Pinus contorta	Lp157	65,55000	27,58300	Finland
Pinus contorta	Lp158	66,31700	25,68300	Finland

Pinus contorta	Lp159	67,81700	25,90000	Finland
Pinus contorta	Lp160	66,60000	28,38300	Finland
Pinus contorta	Lp161	65,41700	26,11700	Finland
Pinus contorta	Lp162	67,21700	23,75000	Finland
Pinus contorta	Lp163	60,77000	4,90000	Norway
Pinus contorta	Lp164	58,83000	6,03000	Norway
Pinus contorta	Lp165	61,03000	12,12000	Norway
Pinus contorta	Lp166	58,39000	-3,57000	United Kingdom
Pinus contorta	Lp167	57,99000	-4,83000	United Kingdom
Pinus contorta	Lp168	57,16000	-4,51000	United Kingdom
Pinus contorta	Lp169	56,58000	-5,86000	United Kingdom
Pinus contorta	Lp170	55,08000	-4,79000	United Kingdom
Pinus contorta	Lp171	54,34000	-0,54000	United Kingdom
Pinus contorta	Lp172	58,64320	26,37180	Estonia
Pinus contorta	Lp173	39,55000	21,50000	Greece
Picea sitchensis	Sp1	58,88333	-3,41667	United Kingdom
Picea sitchensis	Sp2	57,80000	-3,15000	United Kingdom
Picea sitchensis	Sp3	57,40000	-4,76667	United Kingdom
Picea sitchensis	Sp4	56,40000	-3,90000	United Kingdom
Picea sitchensis	Sp5	52,28333	-2,48333	United Kingdom
Picea sitchensis	Sp6	55,11667	-2,75000	United Kingdom
Picea sitchensis	Sp7	55,08333	-2,73333	United Kingdom
Picea sitchensis	Sp8	55,01667	-2,53333	United Kingdom
Picea sitchensis	Sp9	54,41667	-1,08333	United Kingdom
Picea sitchensis	Sp10	53,05000	-3,78333	United Kingdom
Picea sitchensis	Sp11	52,58333	-3,20000	United Kingdom
Picea sitchensis	Sp12	52,58333	-3,18333	United Kingdom
Picea sitchensis	Sp13	52,18333	-3,88333	United Kingdom
Picea sitchensis	Sp14	50,10000	-5,01667	United Kingdom
Picea sitchensis	Sp15	50,91667	-4,88333	United Kingdom
Picea sitchensis	Sp16	52,06667	-4,23333	United Kingdom
Picea sitchensis	Sp17	57,40000	-5,08333	United Kingdom
Picea sitchensis	Sp18	57,38333	-5,78333	United Kingdom
Picea sitchensis	Sp19	56,20000	-3,43333	United Kingdom
Picea sitchensis	Sp20	55,13333	-4,41667	United Kingdom
Picea sitchensis	Sp21	55,43333	-3,23333	United Kingdom
Picea sitchensis	Sp22	53,01667	-3,91667	United Kingdom
Picea sitchensis	Sp23	57,95000	-2,30000	United Kingdom
Picea sitchensis	Sp24	55,20000	-5,03333	United Kingdom
Picea sitchensis	Sp25	56,31667	-5,55000	United Kingdom
Picea sitchensis	Sp26	52,65000	-4,30000	United Kingdom
Picea sitchensis	Sp27	52,11667	-4,13333	United Kingdom
Picea sitchensis	Sp28	58,13333	-4,65000	United Kingdom
Picea sitchensis	Sp29	52,08333	-4,43333	United Kingdom
Picea sitchensis	Sp30	52,63333	-4,21667	United Kingdom
Picea sitchensis	Sp31	55,01667	-3,38333	United Kingdom
Picea sitchensis	Sp32	52,28333	-2,23333	United Kingdom
Picea sitchensis	Sp33	54,79114	-7,67680	Ireland
Picea sitchensis	Sp34	54,10709	-7,45787	Ireland
Picea sitchensis	Sp35	54,62545	-8,11037	Ireland

Picea sitchensis	Sp36	52,20402	-7,55290	Ireland
Picea sitchensis	Sp37	51,87629	-9,58982	Ireland
Picea sitchensis	Sp38	53,03333	-7,30000	Ireland
Picea sitchensis	Sp39	52,13333	-8,65000	Ireland
Picea sitchensis	Sp40	52,15000	-8,26667	Ireland
Picea sitchensis	Sp41	52,15000	-8,65000	Ireland
Picea sitchensis	Sp42	52,92991	8,61398	Germany
Picea sitchensis	Sp43	54,49535	9,27775	Germany
Picea sitchensis	Sp44	54,49795	9,59090	Germany
Picea sitchensis	Sp45	53,08333	10,61667	Germany
Picea sitchensis	Sp46	52,71301	7,39556	Germany
Picea sitchensis	Sp47	60,51559	5,53458	Norway
Picea sitchensis	Sp48	58,16044	7,01163	Norway
Picea sitchensis	Sp49	59,16507	5,94733	Norway
Picea sitchensis	Sp50	59,52984	6,40532	Norway
Picea sitchensis	Sp51	59,68757	6,12517	Norway
Picea sitchensis	Sp52	60,00760	6,09770	Norway
Picea sitchensis	Sp53	62,285529	3,740429	France
Picea sitchensis	Sp54	48,313597	-2,086043	France
Picea sitchensis	Sp55	48,617413	-3,11256	France
Picea sitchensis	Sp56	45,979154	1,77425	France
Picea sitchensis	Sp57	48,417644	-3,789667	France
Picea sitchensis	Sp58	45,947737	1,390936	France
Picea sitchensis	Sp59	45,858469	1,373274	France
Picea sitchensis	Sp60	44,436625	2,91347	France
Picea sitchensis	Sp61	45,816353	1,769148	France
Picea sitchensis	Sp67	48,462979	-3,201527	France
Picea sitchensis	Sp68	48,619512	-3,106208	France
Picea sitchensis	Sp69	48,159758	-3,897587	France
Picea sitchensis	Sp70	44,436564	2,919478	France
Picea sitchensis	Sp62	46,3	16,15	Croatia
Picea sitchensis	Sp63	45,421492	14,898148	Croatia
Picea sitchensis	Sp64	45,37194	14,764154	Croatia
Picea sitchensis	Sp65	45,391638	14,756686	Croatia
Picea sitchensis	Sp66	45,888242	16,80702	Croatia

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