A photograph of several green, cone-shaped conifer cones, likely from a species like *Podocarpus neriifolius*, against a light blue background. The cones are arranged in a cluster, with some in the foreground and others slightly behind. The lighting is bright, highlighting the texture of the cones.

**EXOTIC CONIFER SPECIES
IN SOLBÖLE**

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This report has been prepared for the International Dendrological Society
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Solböle Experimental Area on June 24th, 1997.

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1. Introduction to Solböle

The Solböle experimental area was established in 1926 in areas which the state already owned at the time. The area is located in the southernmost parts of Finland. Most of the area is in the mainland but some islands are included as well. The area comprises 9 lots with a total forest area of 1470 hectares. The main areas are the lots of Solböle and Knopkägra in the village of Solböle within the town of Tammisaari. The map drawing (back cover) shows the different parts of the experimental area. The offices are at 60° 2'41" northern latitude and 23° 2'5" eastern longitude.

With respect to botany, the area belongs to the northernmost part of the central European oak zone. Fertile herb-rich forest sites with lush vegetation are typical of this zone. Tree species otherwise uncommon in Finland, such as oak, lime, ash and elm, grow naturally in the surrounding regions. These exceptional conditions offer good possibilities to grow deciduous tree species which cannot be grown elsewhere in the country, and also to experiment with exotic tree species. Local pine heaths and forests on rocky outcrops have certain distinctive features that have proved to be worth studying. These natural conditions gave impetus to the establishment of the experimental area.

Climate

Solböle has a clearly maritime climate with plenty of rain, small daily and annual temperature differences. Springs and autumns are long, winters rich in snow and there is not much or no soil frost at all. The maritime climate is favourable for the vegetation even though the low rainfall during spring and summer can restrict the growth.

The monthly mean temperatures below are from a 76 years period (1920-1995) measured at Tvärminne (59°51'N, 23°15'E) and Hanko (59°50'N, 23°0'E) meteorological stations. The temperature values have been converted to match Solböle location.

Monthly mean temperatures °C

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
-6.1	-6.6	-3.0	3.0	9.8	14.2	17.4	15.5	10.5	4.9	0.8	-3.0

The annual rainfall ranges from 600 to 700 mm.

Bedrock and soil types

The bedrock in the Solböle and Knopkägra lots is granite and gneissose granite. The lush vegetation surrounding the rocky hills would indicate that the bedrock contains alkaline rock types as well. This assumption is also supported by the lime stone veins going from east to west on the northern side of Solböle.

Moraine is the most common loose material. It varies in quality; it is coarse-grained in the more fertile sites. Pure clayey soil is very uncommon in the area. There is often sand and gravel on hilltops.

Vegetation

The number of plant species in the area is high, primarily due to the herb-rich forest sites in Solböle. For example, 211 vascular plant species have been observed in these forests; 60 of these do not usually grow outside herb-rich forests.

Besides the tree species common in Finland, also oak, maple, small-leaved lime and mountain elm have natural habitats in Solböle. The main oak stands grow in the western parts of the Solböle lot and on the island of Knopö, which belongs to the Knopkägra lot. Maple, lime and ash stands have concentrated in the western parts of the Solböle lot as well. With respect to mountain elm, only a few solitary trees grow in the Knopkägra lot. These deciduous species have also been planted in the experimental area.

Of the shrubs that grow naturally in the Solböle area should be mentioned at least hazel, mountain currant, honeysuckle and short pedicelled rose. Hazel grows so abundantly in places that it disturbs general forest management.

2. Experiments with exotic tree species

The research programme of the Finnish Forest Research Institute has included experiments with exotic tree species ever since the institute's establishment in 1917. In the 1920's and 30's, under the leadership of Professor Olli Heikinheimo, experimental plantations with 69 exotic conifer species and 41 broad-leaved species were established in the different experimental areas that belonged to the institute. In the Solböle experimental area, experiments have been established with 109 of these species.

The exotic conifers have performed better in Solböle than the broad-leaved species. Most of the broad-leaved species were destroyed during the exceptionally cold winters of 1939-'40 and 1940-'41. Few of these species have survived, now growing as injured solitary trees. Conifer species have performed satisfactorily when compared to broad-leaved species. The plantations are now from 65 to 70 years old, and 49 species of the originally planted 69 still survive. Altogether 6 species were destroyed in the nursery already; they will not be reported here.

3. Results from 1996 inventory

The development of the Solböle exotic conifer plantations has been reported twice (Heikinheimo 1956 and Lähde et al. 1984). The third inventory was carried out in 1996. This report deals with the results of that inventory. The objective of the inventory was to assess the development of the plantations with respect to their growth and yield, quality and condition as well as damage involved.

The results of measurements and observations are given both in text and table form. The text deals with the species hardiness, habit, pests and diseases, and tree and stand damage. Furthermore, an evaluation of the commercial value and reproduction is given, as well as the dimensions of every species' largest tree in Solböle.

In the growth and yield table, the stands' origin or provenance is given first (country, region, geographical position). The first number from the left refers to the stand number given at the time of planting.

Stand type is indicated by letters S+, S, S-, G and D.

- S+** = Plantation area > 0.1 hectare. Measurement has been done on a permanent sample plot.
- S** = Plantation area is between 0.05 - 0.1 hectare. Measurement has been done on a temporary sample plot.
- S-** = A damaged plantation, where solitary trees remain or trees are in small groups scattered over the original plantation area. Measurement has been done on the dominant trees.
- G** = Original plantation area < 0.05 hectare. Measurement has been done on the dominant trees.
- D** = Destroyed plantation.

Site quality and type are indicated by asterisks (*).

- ***** = Herb-rich forest site type
- **** = Mesic mineral soil forest site type
- *** = Dry mineral soil forest site type

The stand age is calculated from the year of seed germination (biological age).

- H** = Stand dominant height
- D** = Stand dominant diameter (cm at 1.3 m)
- N** = Stand stocking (stems/hectare)
- V** = Stand volume (m³/hectare)

Abies species

The number of known *Abies* species is about 40. In Solböle, experiments have been made with 21 of these species. At the moment, 15 species survive, four of which are European, six of Asian and five American origin. Five of the destroyed species were from Asia and one from North America.



Abies sibirica

Abies alba

Frost hardy only in the coastal areas of southern Finland. Growth rate fast at young age on fertile sites, later the growth rate declines. Short clear length of stem, thick branches and wide crown. Frosting typical in the establishment phase. Needle cast, butt rot and stem cracks have been the main causes of stand destruction. Sawlogs (1-2 lengths/stem) of poor quality due to thick branches can be obtained from most trees. Coning and natural regeneration abundant. The dimensions of the largest tree were 60.5 cm in diameter and 23.0 m in height.

Sweden, Omberg

42 / S- / *** Age 71 H 22.8 m D 55.6 cm

150 / D / **

Abies amabilis

Hardiness uncertain, but the species may endure the climatic conditions in southern Finland. The plantation was established with few trees only. Growth has been poor due to frost damage and needle cast. Cones have been observed, but no natural regeneration. The dimensions of the largest tree were 45.3 cm in diameter and 16.6 m in height.

Uncertain

290 / G / *** Age 63 H 16.6 m D 45.3 cm

Abies balsamea

A frost hardy species throughout Finland. Growth rate has been moderate on fertile soils, but quality poor due to crooked stems. Sawlogs (1-2 lengths/stem) of poor quality can be obtained. Butt rot and needle cast, especially severe in stands over 50 years, have been the main causes of stand destruction. Coning and natural regeneration abundant. The dimensions of the largest tree were 51.2 cm in diameter and 20.1 m in height.

Canada, New Brunswick, St. John (46°N)

215 / S- / *** Age 68 H 16.7 m D 37.8 cm

216 / S- / *** Age 68 H 19.4 m D 44.7 cm

Uncertain

30 / D / ***

Abies cephalonica

Hardiness uncertain. Plantation established with few trees only. Frost, needle cast and butt rot have been the main agencies of damage. The dimensions of the largest tree were 20.7 cm in diameter and 11.9 m in height.

Greece, Pindos (39°33'N, 1200 m)

307 / S- / ** Age 64 H 11.9 m D 20.7 cm

Abies concolor

Frost hardy up to central Finland. Growth rate on fertile soil is moderately fast but stem quality poor. In stands over 50 years many trees are crooked, forked, and leaning. Butt rot and needle cast cause the main damage at older age. Sawlogs (1-2 lengths/stem) of poor quality can be obtained. Natural regeneration varies from fair to poor. The dimensions of the largest tree (stand no 19) were 50.9 cm in diameter and 21.4 m in height.

USA, Colorado

247 / S / *** Age 67 H 19.4 m D 39.6 cm N 380 trees/ha V 280 m³/ha

19 / G / *** Age 73 H 21.1 m D 41.8 cm

39 / G / *** Age 73 H 20.6 m D 32.4 cm

Abies faxoniana

Hardiness uncertain. Five plantations of China, Kansu (2700-2800 m) origin were established in Solböle in 1928. The plantations were destroyed already in the establishment phase due to severe frost damage.

Abies grandis

Hardiness poor even in coastal regions. One plantation of Br. Columbian origin (stand no 141) was established in 1929. The main part of the plantation failed already at seedling stage. In 1980 a single stunted tree remained. Frost and winter cold have most likely been the cause of failure.

Abies holophylla

Planted in Solböle only, so hardiness uncertain elsewhere in Finland. A healthy and relatively well growing species. Stem straightness good, but branches thick. Sawlogs

(2 lengths/stem) of moderate quality can be obtained from most trees. Coning good but regeneration poor. The dimensions of the largest tree (stand no 243) were 51.6 cm in diameter and 18.9 m in height.

Korea, Hosen (37°55'N, 127°10'E)

306 / S- / ** Age 65 H 19.3 m D 41.0 cm

Uncertain

243 / S / *** Age 68 H 21.3 m D 38.9 cm N 420 trees/ha V 332 m³/ha

Abies homolepis

A single stand (no 219) of uncertain origin established in Solböle in 1928. Two stunted trees remained in 1995.

Abies koreana

Moderate hardiness up to central Finland. Slow growth rate, but trees usually healthy.

Only pulpwood properties. Coning good, but natural regeneration poor. The dimensions of the largest tree (stand no 308) were 35.6 cm in diameter and 14.9 m in height.

Korea, Chiizan, (35°20'N, 126°50'E, 1700 m)

289 / G / *** Age 63 H 14.3 m D 29.8 cm

308 / G / *** Age 65 H 15.8 m D 31.8 cm

Abies lasiocarpa

A frost hardy species throughout Finland. Growth rate slow. Stem straightness good, but forked and leaning stems common. Especially the USA origins showed signs of poor health already at the age of 45 years. Butt rot and needle cast are the main causes of stand destruction. Only pulpwood properties. Coning good, but natural regeneration poor. The dimensions of the largest tree (stand no 41) were 42.0 cm in diameter and 21.0 m in height.

Canada, Br.Columbia

41 / S / *** Age 72 H 19.2 m D 35.1 cm N 480 trees/ha V 220 m³/ha

43 / G / *** Age 72 H 17.8 m D 30.0 cm

USA, Washington, Stabler, Colombia National Forest (46°N, 122°W, 1200 m)

304 / S- / ** Age 64 H 10.5 m D 28.4 cm

Abies lasiocarpa var. arizonica

Hardiness uncertain. Growth rate slow. Butt rot and needle cast are the main causes of stand destruction. Coning poor, no regeneration observed. The dimensions of the largest tree were 36.0 cm in diameter and 18.4 m in height.

USA, Arizona, Flagstaff

267 / S / *** Age 65 H 16.4 m D 28.5 cm N 560 trees/ha V 155 m³/ha

Abies mariesii

One single stand (no 246) of uncertain origin was established in 1935. The plantation was destroyed by frost during the cold winters 1939-'40 and 1940-'41.

Abies nephrolepis

Hardiness uncertain, probable up to central Finland. A relatively slow growing but healthy species. Damaged by frost at younger age, which has resulted in basal forking. Only pulpwood properties. Coning good, but natural regeneration poor. The dimensions of the largest tree (stand no 248) were 41.0 cm in diameter and 18.6 m in height.

Korea, Keizanchin (1360 m)

248 / G / *** Age 67 H 18.0 m D 30.8 cm

Abies nordmanniana

Hardiness poor in Finland even in coastal conditions. Frost, needle cast and butt rot have destroyed the plantation almost completely. Coning poor, no natural regeneration observed. The dimensions of the largest tree were 41.0 cm in diameter and 17.0 m in height.

Russia, Kaukasia (800-2000 m)

242 / S- / *** Age 68 H 15.0 m D 30.6 cm

Abies recurvata

Hardiness uncertain. One single plantation (no 226) of China, Kansu origin was planted in 1935. Most of the trees died during the cold winters 1939-'40 and 1940-'41 due to severe frost damage.

Abies sachalinensis

Hardiness uncertain, but probable up to central Finland. The fastest growing abies species in Solböle. Stem straightness good, but thick branches weaken quality. Butt rot and frost cracks have been observed. Sawlogs (3-4 lengths/stem) of moderate quality can be obtained from most trees. Coning and natural regeneration very abundant. The dimensions of the largest tree (stand no 167) were 58.2 cm in diameter and 29.0 m in height.

Japan, Hokkaido

245 / G / ** Age 68 H 21.7 m D 44.5 cm

Japan, Hokkaido (43°15'N, 142°30'E)

168 / G / *** Age 72 H 25.5 m D 33.0 cm

217 / G / *** Age 67 H 24.4 m D 50.9 cm

Japan, Hokkaido, Kottoni (43°4'N, 141°15'E)

167 / S / *** Age 70 H 25.5 m D 48.4 cm N 380 trees/ha V 508 m³/ha

Uncertain

202 / S- / *** Age 67 H 23.0 m D 36.0 cm

Abies sachalinensis var. mayriana

Hardiness uncertain, probably similar to that of the main species. Stem quality, natural regeneration and damage also similar. Very rarely cultivated. The dimensions of the largest tree were 44.6 cm in diameter and 24.7 m in height.

Japan, Hokkaido, Teshio

169 / G / *** Age 71 H 25.1 m D 41.3 cm

170 / G / *** Age 71 H 19.9 m D 31.8 cm

Abies sibirica

A frost hardy species throughout Finland. Growth rate is moderately fast, but cannot compete with native spruce or best growing exotics. Stems very straight with little taper and thin branches. At older age, upper stems often forked. Sawlogs (2 lengths/stem) with high quality can be obtained from most trees. Coning and natural regeneration abundant. The dimensions of the largest tree (stand no 18) were 40.4 cm in diameter and 23.7 m in height.

Russia, Valamo

244 / S+ / *** Age 67 H 22.2 m D 34.0 cm N 463 trees/ha V 272 m³/ha

Finland, Punkaharju

18 / S+ / *** Age 72 H 22.8 m D 34.4 cm N 433 trees/ha V 306 m³/ha

Abies sutchuensis

Hardiness uncertain. One single stand (no 223) of China, Kansu origin was established in Solböle 1935. The plantation was destroyed by frost during the cold winters 1939-40 and 1940-41.

Abies veitchii

The species has proved reasonably hardy in southern Finland. Growth rate has been slow. Stem straightness good, but thick branching weakens quality. Butt rot, needle cast and frost cracks have caused the main destruction in the stands. Sawlogs (1-2 lengths/stem) of

poor quality can be obtained from most trees. Natural regeneration abundant even in the densest stands. The dimensions of the largest tree (stand no 218) were 40.1 cm in diameter and 18.5 m in height.

Japan, Hokkaido

218 / S+ / ***	Age 68	H 19.6 m	D 34.0 cm	N 300 trees/ha	V 192 m ³ /ha
280 / S / **	Age 68	H 23.5 m	D 33.9 cm	N 460 trees/ha	V 291 m ³ /ha
252 / G / ***	Age 68	H 19.4 m	D 33.4 cm		
274 / G / ***	Age 68	H 19.7 m	D 29.4 cm		

Larix species

According to Krüssmann, larch species amount to ten. Apart from these, there are many subspecies and interspecific crosses. In Solböle, seven species or subspecies have been experimented with; all of these survive. Two of them are of European, four of Asian and one of North American origin.



Larix gmelinii var. *japonica*

Larix decidua

A hardy species to the Arctic Circle and a promising exotic forest tree for Finland. On rich and well drained forest site types, the growth of the species exceeds that of the native spruce. Stem quality fair, crooked upper stems and leaning stems typical. Healthy, but damage caused by larch cancer, spring frost and voles is common especially in young stands. Sawlogs (1-2 lengths/stem) of good quality can be obtained from most trees. Natural regeneration poor. The dimensions of the largest tree (stand no 71) were 63.4 cm in diameter and 27.1 m in height.

France, Briancon (44°54'N, 6°38'E, 1500 m)

72 / S / **	Age 69	H 24.3 m	D 34.5 cm	N 320 trees/ha	V 235 m ³ /ha
80 / S- / ***	Age 69	H 20.0 m	D 38.2 cm		
154 / D / ***					

Germany, Jägerndorf (600+ m)

71 / S+ / **	Age 69	H 27.0 m	D 47.8 cm	N 217 trees/ha	V 325 m ³ /ha
78 / D / ***					

Great Britain, Scotland

68 / S+ / **	Age 69	H 25.3 m	D 30.9 cm	N 317 trees/ha	V 190 m ³ /ha
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Larix gmelinii

The species is frost hardy throughout Finland. Growth good, but cannot compete with European larch. Log quality is reduced by thick branches and crooked stems. Natural regeneration varies from fair to poor. Healthy, but damage caused by frost and voles is common at young age. The dimensions of the largest tree (stand no 64) were 41.4 cm in diameter and 25.2 m in height.

Russia, Sakhalin

63 / S+ / **	Age 70	H 23.0 m	D 32.4 cm	N 233 trees/ha	V 151 m ³ /ha
64 / S+ / **	Age 70	H 24.3 m	D 38.7 cm	N 233 trees/ha	V 240 m ³ /ha
67 / S / **	Age 70	H 21.1 m	D 34.2 cm	N 320 trees/ha	V 187 m ³ /ha
45 / G / **	Age 70	H 20.0 m	D 33.0 cm		
47 / G / **	Age 70	H 25.1 m	D 34.6 cm		
75 / S- / ***	Age 70	H 15.0 m	D 26.0 cm		
76 / D / ***					
79 / D / ***					

Larix gmelinii var. japonica

Hardiness, volume production, quality, condition and natural regeneration similar to those of *Larix gmelinii*. Healthy, but young stands often suffer from frost and vole damage. The dimensions of the largest tree (stand no 70) were 49.6 cm in diameter and 22.6 m in height.

Korea

66 / S / **	Age 70	H 23.9 m	D 35.8 cm	N 320 trees/ha	V 266 m ³ /ha
73 / D / ***					

Russia, Sakhalin

70 / S / **	Age 70	H 24.3 m	D 34.9 cm	N 300 trees/ha	V 251 m ³ /ha
46 / G / **	Age 70	H 24.7 m	D 36.7 cm		
74 / S- / ***	Age 70	H 17.6 m	D 40.1 cm		

Larix gmelinii var. olgensis

Hardiness, volume production, quality, condition and natural regeneration similar to those of *Larix gmelinii*. Healthy, but young stands often suffer from frost and vole damage. The dimensions of the largest tree (stand no 65) were 36.0 cm in diameter and 23.5 m in height.

Korea, Hosan (40°49'N, 126°59'E, 1600 m)

65 / S / **	Age 69	H 23.5 m	D 33.0 cm	N 360 trees/ha	V 262 m ³ /ha
77 / D / ***					

Larix kaempferi

Frost hardy probably up to central Finland. Growth rate is fast on fertile and well-drained sites. Stem straightness is good; curved and leaning trees can, however, be found. Frost injuries observed at establishment phase. Windfalls common at present age, no other notable damage. Sawlogs (3-4 lengths/stem) of good quality can be obtained from most trees. The dimensions of the largest tree (stand no 205) were 67.5 cm in diameter and 32.5 m in height.

Japan, Hondo

205 / S+ / *** Age 67 H 30.3 m D 52.3 cm N 267 trees/ha V 532 m³/ha

Finland, Mustila

140 / S / ** Age 68 H 25.1 m D 34.1 cm N 340 trees/ha V 302 m³/ha

Larix occidentalis

Very rarely cultivated in Finland, so hardiness is uncertain. In Solböle one single tree of unknown origin remains with a height of 21.8 m and dbh 36.3 cm.

Larix sibirica

Frost hardy to Arctic Circle; the most promising exotic forest tree in Finland. Competes well in terms of growth rate and quality with native spruce (*Picea abies*) on fertile and well-drained sites. Sawlogs (3-4 lengths/stem) of good quality can be obtained from most stems. Older stands susceptible to windfall, otherwise little notable damage. The species, especially the provenance from Raivola is widely used in Finnish commercial forestry. It is estimated that the total area planted with Siberian larch is now about 15 000 hectares; new plantations are established 2000 hectares annually. Coning fair, natural regeneration poor. The dimensions of the largest tree (stand no 155) were 64.3 cm in diameter and 31.0 m in height.

Russia, Arkhangel (64°N, 40°E)

155 / S+ / *** Age 67 H 29.9 m D 43.2 cm N 200 trees/ha V 313 m³/ha
156 / D / ***

Russia, Novosibirsk

69 / S / ** Age 67 H 24.8 m D 33.3 cm N 280 trees/ha V 199 m³/ha

Russia, Raivola

157 / S+ / *** Age 68 H 29.2 m D 44.3 cm N 263 trees/ha V 390 m³/ha
17 / S / ** Age 68 H 25.6 m D 35.2 cm N 320 trees/ha V 233 m³/ha
36 / G / ** Age 71 H 27.6 m D 37.5 cm

Picea species

The number of defined *Picea* species is appr. 50 (depending on the interpretation, the number of species varies from 36 to 80), half of which are native of China. In Solböle, eleven of these species have been cultivated and 10 of them still survive. Of these, one is of European, three of Asian and six of North American origin. The destroyed species was of Chinese origin.



Picea engelmannii

Picea asperata

Planted in Solböle only, hardiness likely up to central Finland. The plantation has failed, probably because of frost. The remaining trees are straight, but suffer from needle cast. The dimensions of the largest tree were 35.0 cm in diameter and 17.3 m in height.

China, Kansu (2000 m)

250 / S- / *** Age 68 H 15.8 m D 28.7 cm

Picea engelmannii

Frost hardy up to the Arctic Circle. Growth moderate at young age, but declines rapidly when the stands exceed the age of 50 years. Many stands partially failed, due to beetle attack, needle cast and butt rot. Especially at older age, snowbreak and windfalls are common. Sawlogs (2 lengths/stem) of good quality can be obtained from most trees. Coning moderate, natural regeneration poor. The dimensions of the largest tree (stand no 203) were 40.1 cm in diameter and 23.9 m in height.

Canada, Crow's Nest Pass (49°39'N, 114°40'W)

124 / S / *** Age 69 H 23.5 m D 31.3 cm N 360 trees/ha V 209 m³/ha

203 / G / *** Age 69 H 19.7 m D 30.0 cm

197 / S- / *** Age 68 H 24.5 m D 29.7 cm

Canada, Br. Columbia, Luis Creek (51°7'N, 120°7'W, 780 m)

12 / S- / ** Age 72 H 24.4 m D 34.4 cm

37 / D / ***

Canada, Br. Columbia, Trout Lake (50°41'N, 117°30'W)

13 / S- / ** Age 72 H 22.6 m D 32.1 cm

Canada, Br. Columbia, Valemount (52°55'N, 119°20'W)

314 / S / ** Age 59 H 24.0 m D 29.3 cm N 540 trees/ha V 262 m³/ha

Picea glauca

Frost hardy up to the Arctic Circle. Growth and damage very similar to that of *Picea engelmannii*. Sawlogs of good quality (2 lengths/stem) can be obtained from most trees. Coning good, but natural regeneration poor. The dimensions of the largest tree (stand no 121) were 46.0 cm in diameter and 25.4 m in height.

Canada, Alberta, Olds

121 / S+ / *** Age 69 H 26.5 m D 34.9 cm N 242 trees/ha V 225 m³/ha

Canada, New Brunswick, John River valley

200 / G / *** Age 68 H 17.7 m D 21.3 cm

Picea glauca var. albertiana

Hardiness uncertain, but probably similar to that of the main species. Stem quality, natural regeneration and damage also similar. The dimensions of the largest tree (stand no 123) were 41.6 cm in diameter and 27.0 m in height.

Canada, Alberta, Olds

122 / G / *** Age 68 H 26.2 m D 37.5 cm

123 / G / *** Age 68 H 26.8 m D 37.7 cm

196 / S- / *** Age 68 H 22.1 m D 24.9 cm

Uncertain

195 / S- / *** Age 68 H 24.7 m D 29.2 cm

Picea glehnii

Plantations survived in Solböle only, so hardiness uncertain, probably limited to south coastal regions only. The growth and health of the remaining stands are good. Sawlogs (2 lengths/stem) of moderate quality can be obtained from most of the remaining trees. Coning good, but natural regeneration poor. The dimensions of the largest tree (stand no 204) were 51.4 cm in diameter and 23.0 m in height.

Japan, Hokkaido

204 / S / *** Age 68 H 23.3 m D 41.4 cm N 560 trees/ha V 507 m³/ha

172 / G / *** Age 72 H 20.2 m D 27.7 cm

Picea jezoensis

Hardy only in the southern parts of the country. Slow growth, straight stems and good crown condition are typical features. Few stems have attained sawlog size. Frost damage common at seedling stage. The dimensions of the largest tree (stand no 270) were 37.8 cm in diameter and 20.0 m in height.

Japan, Tokio

171 / G / *** Age 72 H 20.4 m D 29.7 cm

Japan, Hokkaido, Kotoni (43°4'N, 141°15'E)

270 / S / *** Age 70 H 19.7 m D 33.5 cm N 500 trees/ha V 278 m³/ha

279 / D / **

Japan, Hokkaido, Shikari

110 / S / *** Age 71 H 20.0 m D 28.9 cm N 460 trees/ha V 223 m³/ha

199 / G / *** Age 71 H 18.4 m D 24.7 cm

Korea, Keizanchin (1960 m)

305 / G / ** Age 64 H 16.3 m D 28.8 cm

Picea mariana

The species is frost hardy throughout Finland. Growth is very slow and stem quality poor. Very few trees attain sawlog dimensions. Beetle attack, needle cast and butt rot have been the main causes of stand destruction. Coning abundant, but natural regeneration poor. The dimensions of the largest tree (stand no 120) were 33.6 cm in diameter and 19.6 m in height.

Canada, Alberta, Olds

120 / S- / *** Age 69 H 18.6 m D 28.1 cm

198 / G / *** Age 69 H 16.8 m D 19.1 cm

Canada, New Brunswick, St. John

173 / S- / *** Age 68 H 17.6 m D 26.2 cm

Picea omorica

The species is frost hardy close to the Arctic Circle. Growth moderate, stem quality good. Sawlogs (2 lengths/stem) of good quality can be attained from most trees. No major damage, only some butt rot observed. Coning abundant, but natural regeneration limited due to high stocking densities. The dimensions of the largest tree (stand no 220) were 36.2 cm in diameter and 22.4 m in height.

Balkan (1600-1800 m)

220 / S / *** Age 67 H 22.6 m D 30.5 cm N 600 trees/ha V 329 m³/ha

241 / G / *** Age 67 H 21.7 m D 30.2 cm

Picea pungens

Frost hardy up to the Arctic Circle. Slow growth, bowed stems and poor natural pruning are typical features. Few trees attain sawlog (1 length/stem) dimension and quality. Needle cast and butt rot have been the main causes of stand destruction. Coning and natural regeneration poor. The dimensions of the largest tree (stand no 269) were 32.4 cm in diameter and 19.3 m in height.

USA, Colorado

269 / S / ***	Age 66	H 18.0 m	D 27.6 cm	N 480 trees/ha	V 131 m ³ /ha
282 / S- / ***	Age 66	H 16.4 m	D 21.0 cm		

Picea sitchensis

Hardy probably in the south coastal regions only. Growth moderate, quality reduced by thick branching. At young age (under frost level) frequent frost injuries. Sawlogs (1-2 lengths/stem) of moderate quality can be obtained from most trees in the best stands. Coning good in some years, natural regeneration poor. The dimensions of the largest tree (stand no 268) were 58.2 cm in diameter and 23.1 m in height.

USA, Alaska, Sealewer

286 / S / ***	Age 65	H 26.9 m	D 42.0 cm	N 280 trees/ha	V 323 m ³ /ha
256 / S / ***	Age 64	H 22.0 m	D 31.8 cm	N 960 trees/ha	V 313 m ³ /ha
257 / S / ***	Age 64	H 23.8 m	D 36.0 cm	N 780 trees/ha	V 333 m ³ /ha
258 / S / ***	Age 64	H 21.5 m	D 29.0 cm	N 1140 trees/ha	V 306 m ³ /ha
287 / G / ***	Age 64	H 26.0 m	D 41.5 cm		
259 / S- / ***	Age 64	H 14.6 m	D 19.5 cm		
268 / S- / ***	Age 64	H 22.4 m	D 44.7 cm		
285 / D / **					

USA, Alaska, Kanai Peninsula

336 / D / ***

Canada, Queen Charlotte Islands, Sidegrade

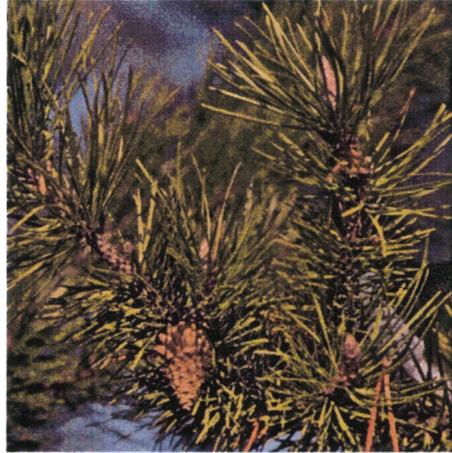
163 / D / **

Picea wilsonii

One single stand (no 249) of China, Kansu (2000 m) was established 1932. The stand was destroyed at an early age due to frequent frost damage.

Pinus species

There are over 100 known *Pinus* species. In Solböle, trials have been established with nine of these species. Of the surviving six species, three are of European, one of Asian and two of North American origin. Two of the destroyed species came from Europe and two from North America.



Pinus contorta var. *latifolia*

Pinus banksiana

Rarely cultivated, hardiness probable close to the Arctic Circle. Slow growth rate, stems very crooked and poor natural pruning. Needle cast and snowbreak common injuries. Pulpwood properties only. Coning abundant, but no natural regeneration observed. The dimensions of the largest tree (stand no 106) were 29.8 cm in diameter and 18.2 m in height.

Canada, Saskatchewan, Prince Albert (53°12'N, 105°48'W)

139 / G / * Age 68 H 16.4 m D 24.1 cm

106 / S- / ** Age 69 H 18.3 m D 28.4 cm

Pinus cembra

Hardy throughout Finland. Slow growth rate. Forked and leaning stems with rapid tapering and thick branching are common. Living crown very short and natural pruning very poor. Needle cast has caused the main destruction in the stands. In Solböle, few cones and no regeneration observed. Sawlogs (1 length/stem) of very poor quality can be obtained. The dimensions of the largest tree (stand no 16) were 40.4 cm in diameter and 19.3 m in height.

Finland

15 / S- / ** Age 72 H 18.9 m D 34.4 cm

16 / S- / ** Age 72 H 19.5 m D 34.6 cm

Finland, Punkaharju

38 / D / ***

Pinus contorta var. latifolia

Hardy up to the Arctic Circle. Growth in favourable conditions even better than that of native pine. Straightness good, dead lower branches prune poorly. Notable early damage due to Pine shoot blight infection. Pine sawfly larvae outbreaks and windfalls have caused the main destruction in advanced stands. Coning good, but no regeneration observed. The dimensions of the largest tree (stand no 104) were 47.1 cm in diameter and 25.4 m in height.

Canada, Alberta, Olds

104 / S+ / **	Age 69	H 23.3 m	D 34.0 cm	N 417 trees/ha	V 262 m ³ /ha
165 / S / peat	Age 68	H 21.6 m	D 28.4 cm	N 520 trees/ha	V 226 m ³ /ha

Canada, Alberta, Olds + Calgary (1050 m)

164 / S / peat	Age 68	H 21.0 m	D 30.1 cm	N 580 trees/ha	V 223 m ³ /ha
105 / S+ / **	Age 69	H 23.7 m	D 32.3 cm	N 465 trees/ha	V 287 m ³ /ha

Pinus koraiensis

Hardy probably in the south coastal regions only. Of two plantations, only three stunted trees remain. Needle cast has caused the main destruction in the stands. The trees have produced cones but no natural regeneration has been observed. The dimensions of the largest tree were 19.1 cm in diameter and 14.3 m in height.

Korea, Hozan (38°20'N, 127°30'E, 200 m)

251 / S- / **	Age 68	H 12.2 m	D 16.1 cm
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Pinus monticola

Two stands, no 107 (planted in 1931) of USA Washington, Colombia National forest, and no 174 (planted in 1933) of Canada, Br.Columbia, Larch Hills origin were established. In 1939, the plantings were completely destroyed mainly by frost, snow and fungal diseases.

Pinus mugo

A hardy species throughout Finland. The trees grow very slowly and have a bushy form. Only the Engadin provenance from Switzerland has a monopodial, straight stem. Survival has mainly been reduced by competition from native species. Coning moderate, but regeneration poor. The dimensions of the largest tree (stand no 14) were 21.0 cm in diameter and 13.9 m in height.

Uncertain

222 / G / *	Age 63	H 13.0 m	D 10.0 cm
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Denmark

48 / S- / ** Age 72 H 4.0 m D 11.0 cm

201 / S- / * Age 72 H 12.0 m D 10.0 cm

Switzerland, Engadin (1660 m)

14 / S- / ** Age 71 H 13.5 m D 18.5 cm

Switzerland, Moutta da Champ Seck (1900 m)

25 / D / **

Switzerland, Munsterthal

26 / D / *

Pinus nigra

One plantation of Czechoslovakian origin was planted in 1938. Most of the seedlings died during the first season due to drought.

Pinus peuce

Frost hardy up to central Finland. Growth rate on fertile and well-drained soil moderately fast. Stem quality is reduced by thick branching. Susceptible to frost at young age, otherwise a healthy species. Sawlogs (1 length/stem) of moderate quality can be obtained. Coning abundant and natural regeneration exceptionally good. The dimensions of the largest tree (stand no 151) were 45.2 cm in diameter and 22.6 m in height.

Bulgaria, Rino Planino

40 / S+ / ** Age 72 H 19.6 m D 34.8 cm N 386 trees/ha V 247 m³/ha

44 / G / ** Age 69 H 21.3 m D 37.0 cm

151 / G / *** Age 72 H 22.1 m D 40.4 cm

Pinus ponderosa

Two stands, no 109 of USA, Bitterroot National Forest, origin and no 108 of Canada, Br. Columbia, Dear Park origin were established in 1931. In 1941 the plantings were completely destroyed mainly by frost and fungal diseases.

Other conifer species

Other exotic conifers planted in Solböle represent 13 species from five genera. The genera are; *Pseudotsuga* one species, *Taxus* one species, *Thuja* three species, *Tsuga* five species (one destroyed) and *Chamaecyparis* three species (two destroyed). Those survived, four species originate from Asia and six from North America.



Pseudotsuga menziesii

Chamaecyparis lawsoniana

Two plantations (no 21, no 34) of uncertain origin were established in 1929. The plantations suffered great damage during the cold winters 1939-'40 and 1940-'41 and died consequently.

Chamaecyparis obtusa

Altogether four plantations of Japanese origin were established 1931-'37 (no 185 from Toehiki, no 111 and no 186 from Kiso and no 262 from central Japan). The plantations were destroyed during the cold winters 1939-'40 and 1940-'41 by severe cold.

Chamaecyparis pisifera

Hardiness poor even in coastal regions. Growth rate slow. Most stems are crooked or forked. Coning abundant in some years, no regeneration observed. The dimensions of the largest tree were 43.6 cm in diameter and 13.8 m in height.

Japan, central Japan

261 / G / *** Age 64 H 12.6 m D 26.1 cm

Japan, Kiso

183 / S- / *** Age 71 H 2.0 m D 3.0 cm

Japan, Nogano, Suva

112 / G / *** Age 70 H 12.2 m D 33.8 cm

184 / S- / *** Age 70 H 8.0 m D 3.0 cm

Pseudotsuga menziesii

The species is frost hardy up to central Finland, probably even further north. Growth is very good on fertile and well-drained soils, even when compared to the growth of the native spruce on equal sites. Stem straightness is good; curved and leaning trees can, however, be found. Frost at early age, needle fungi and butt rot as well as poorly drained sites have reduced the growth. Sawlogs (2-(3) lengths/stem) of moderate quality can be obtained from most trees. Coning abundant, natural regeneration fair. The dimensions of the largest tree were 75.0 cm in diameter and 28.0 m in height.

Canada, Alberta, Crows Nests Pass (49°39'N, 114°41'W)

117 / S / ** Age 69 H 19.2 m D 33.5 cm N 280 trees/ha V 131 m³/ha

Canada, Br. Columbia, Craigellachie (50°58'N, 118°43'W, 420 m)

9 / S / ** Age 72 H 26.7 m D 37.0 cm N 260 trees/ha V 255 m³/ha

158 / S / *** Age 70 H 27.6 m D 46.1 cm N 220 trees/ha V 337 m³/ha

Canada, Br. Columbia, Interior (480-600 m)

8 / S / ** Age 72 H 23.7 m D 37.4 cm N 340 trees/ha V 233 m³/ha

161 / S / *** Age 70 H 28.2 m D 45.2 cm N 360 trees/ha V 510 m³/ha

Canada, Br. Columbia, Larch Hill (50°50'N, 119°W, 900 m)

118 / S / ** Age 69 H 27.8 m D 42.2 cm N 300 trees/ha V 342 m³/ha

Canada, Br. Columbia, Luis Creek (51°7'N, 120°7'W, 780 m)

6 / S+ / ** Age 72 H 28.7 m D 47.7 cm N 283 trees/ha V 436 m³/ha

160 / S / *** Age 70 H 29.9 m D 49.4 cm N 240 trees/ha V 520 m³/ha

Canada, Br. Columbia, Prince George (53°53'N, 122°46'W)

214 / S / ** Age 69 H 31.0 m D 42.8 cm N 400 trees/ha V 489 m³/ha

Canada, Br. Columbia, Salmon River (50°15'N, 126°W, 660 m)

7 / S+ / ** Age 72 H 27.2 m D 41.1 cm N 325 trees/ha V 382 m³/ha

119 / S / ** Age 69 H 27.1 m D 38.3 cm N 320 trees/ha V 294 m³/ha

162 / S / *** Age 70 H 27.4 m D 46.0 cm N 380 trees/ha V 562 m³/ha

32 / G / ** Age 72 H 30.3 m D 47.2 cm

Canada, Br. Columbia, Shuswap Lake (51°8'N, 119°7'W, 1800 m)

10 / S / ** Age 72 H 26.7 m D 34.3 cm N 380 trees/ha V 325 m³/ha

Canada, Br. Columbia, Tate Jaune

313 / S / ** Age 59 H 28.0 m D 34.3 cm N 440 trees/ha V 347 m³/ha

315 / S / *** Age 59 H 25.8 m D 37.3 cm N 300 trees/ha V 271 m³/ha

USA, Washington, Stabler Colombia National Forest (360 m)

260 / S- / *** Age 64 H 19.9 m D 24.6 cm

Uncertain

159 / S / *** Age 69 H 29.0 m D 46.6 cm N 320 trees/ha V 518 m³/ha

31 / G / ** Age 72 H 26.1 m D 45.4 cm

Taxus cuspidata

Hardy up central Finland. The growth is slow and appearance is bushy. Variable damage due to winter cold and spring frost. The dimensions of the largest tree were 18.8 cm in diameter and 4.5 m in height.

Uncertain

142 / S- / **	Age 71	H 5.4 m	D 16.9 cm
143 / S- / **	Age 69	H 5.4 m	D 11.2 cm
206 / S- / ***	Age 69	H 2.5 m	D 2.3 cm

Thuja koraiensis

Hardy probably up to central Finland. Growth of the planting slow. Frost damage has occurred repeatedly. Coning abundant in some years, no regeneration observed. The dimensions of the largest tree were 24.2 cm in diameter and 11.7 m in height.

Uncertain

298 / G / ***	Age 62	H 9.6 m	D 20.4 cm
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Thuja occidentalis

Hardy up to the Arctic Circle. Growth has been slow and stem quality poor, forked trees are common in all stands. Coning very abundant in some years, but regeneration has been poor. The dimensions of the largest tree (stand no 22) were 32.2 cm in diameter and 14.0 m in height.

Canada, Ontario (49°30'N, 83°W)

56 / S+ / ***	Age 71	H 12.3 m	D 22.6 cm	N 1000 trees/ha	V 132 m ³ /ha
115 / S+ / ***	Age 71	H 14.0 m	D 20.7 cm	N 1633 trees/ha	V 164 m ³ /ha

Canada, New Brunswick

239 / S- / **	Age 67	H 10.2 m	D 20.0 cm
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Uncertain

22 / S- / **	Age 77	H 14.0 m	D 30.4 cm
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Thuja plicata

Hardiness poor even in the south coastal regions of Finland. Crooked, forked, and leaning stems common in all stands. Winter cold and spring frost have caused the main destruction in the stands. Coning abundant in some years, but regeneration poor. The dimensions of the largest tree were 34.4 cm in diameter and 24.0 m in height (sheltered site).

Canada, Br. Columbia, Cambie

29 / S- / *** Age 72 H 10.2 m D 15.8 cm

35 / S- / *** Age 72 H 13.4 m D 17.8 cm

Canada, Br. Columbia, Celista, Interior (50°57'N, 119°18'W, 900 m)

116 / S- / *** Age 69 H 7.8 m D 11.1 cm

Canada, Br. Columbia, Lemprier (52°30'N, 119°4'W)

187 / S- / *** Age 68 H 12.0 m D 19.2 cm

188 / S- / *** Age 69 H 12.2 m D 17.0 cm

Thujopsis dolabrata

Few trees (stand no 149) of uncertain origin were planted in 1932. In the inventory done in 1996, two 2.5 m tall specimens remained.

Tsuga canadensis

Hardy probably in the south coastal regions only. The diameter growth has been good, but the height growth poor. Quality poor; crooked, forked and leaning stems are common. Frost damage occurs at young age. Coning is abundant in some years, but no regeneration has been observed. The dimensions of the largest tree (stand no 20) were 50.3 cm in diameter and 16.1 m in height.

Uncertain

20 / G / *** Age 72 H 17.4 m D 47.6 cm

33 / G / *** Age 72 H 13.6 m D 25.0 cm

311 / G / ** Age 63 H 14.2 m D 41.5 cm

Tsuga caroliniana

Hardiness poor. Very rarely cultivated. Growth and stem quality poor with much damage due to repeated frosting. Coning some years abundant and some natural regeneration observed. The dimensions of the largest tree were 32.5 cm in diameter and 11.9 m in height.

USA, North Carolina (660 m)

309 / G / ** Age 64 H 12.6 m D 27.8 cm

266 / S- / *** Age 64 H 11.1 m D 23.2 cm

Tsuga diversifolia

Hardy probably in the south coastal regions only. One single plantation (no 312) of uncertain origin was planted in 1942. The growth has been slow. At the age of 54 years, the height of dominating trees was 8.2 m and dbh 17.6 cm. The stems are crooked, forked

and leaning. The dimensions of the largest tree were 22.0 cm in diameter and 9.0 m in height.

Tsuga heterophylla

Hardiness poor even in coastal regions. One plantation (no 265) of USA, Washington, Stabler, Columbia National Forest origin was planted in 1937. In the 1980 inventory, few trees (6-7 m high) had survived, in the 1996 inventory no survivals. Frost and competition from native species have been the main reason for failure.

Tsuga mertensiana

One single plantation of USA, Washington, Stabler, Columbia National Forest (1350 m) origin was established in 1937 (stand no 264). Only a few trees remain from the original plantation. Hardiness moderate in coastal regions, growth rate slow. The dimensions of the largest tree at the age of 64 years, were 24.8 cm in diameter and 14.4 m in height.

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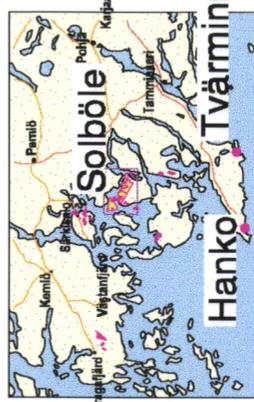
SOLBÖLE EXPERIMENTAL AREA

ARBORETUMS AND HIKING TRAILS

1:12500

Legend

- Text
- Boundary
 - communal boundary
 - village boundary
 - research park boundary
 - other boundary
- Hiking trails
 - Lövsveden
 - Storsveden
 - Käringsviken
 - Lökudden
 - Lövs
- car trail
- trail
- Roads
 - public road IIB
 - public road IIIA
 - public road IIIB
 - provisional road
- car trail
- Arboretum
 - old arboretum
 - new arboretum
- Nature conservation area
 - Bare rock
 - building
 - field
 - meadow
 - grave pit
 - sea or lake
 - Peatland
- Baumap areas
 - field
 - meadow
 - grave pit
 - sea or lake
 - Peatland



Mervi Ikonen 1997

