The potential for quality production in birch stands in north-eastern China using different precommercial thinning strategies

(Photo by Fredrik Samuelsson)

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Abstract

China constitutes 20% of the world's population. China is a large importer of forest products and a great consumer of paper and the consumption tends to increase with the growing Chinese economy. China will also become an important producer of forest products. Therefore it is important for the Swedish forest sector to learn more about China. The purpose of this thesis was to investigate the potential for using Swedish precommercial thinning strategies as an instrument to influence the properties of white birch (*Betula platyphylla*) stands in north-eastern China, with emphasis on quality related properties. The quality related properties were defined in cooperation with IKEA to investigate if it is possible to produce birch of a quality that follows the requirements of IKEA. The investigation was done with simulated precommercial thinning experiments in young birch stands in north-eastern China, along with a study of Swedish and Chinese literature within the subject. The field work was carried out within the Ta He forest bureau in the Heilongjiang province. The stand age in the investigated stands ranged from 9 to 18 years and the majority of the stands were naturally regenerated with white birch after a big forest fire. The stem density after the simulated precommercial thinning were set to1500 and 3000 stems per hectare in order to cover the greater part of the recommendations used for birch in Sweden. The results indicate that it is possible to influence the quality through selective precommercial thinning, but it should be noticed that the quality improvements were minor. Before precommercial thinning the share of stems with quality faults were 40 % and after the simulated thinnings to 1500 and 3000 stems per ha the corresponding numbers were 34 % and 36 %, respectively. The simulated thinnings also resulted in an increased mean height and diameter and the quotient between height and diameter was reduced. However, this study only deals with the immediate effects of stem selection and does not consider the long-term effects on stand development. The conclusion is that there are both knowledge and potential for quality production of birch, but the interest for birch is rather sparse in this part of China due to logging bans, inferior volume production and to the forest ownership structure.

Key words: Betula platyphylla, China, forestry, Heilongjiang, precommercial thinning, release thinning, white birch.

Foreword

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1. Introduction

The natural regenerated birch forests in north-eastern China have been subjected to several investigations. Yuying (2000) has studied suitable management programmes for secondary white birch *(Betula platyphylla)* forests and constructed recommendations for commercial thinning. Shitougou (1995) has done similar investigations also resulting in recommendations for how to manage white birch by commercial thinnings. However, there seem not to have been made much research about the management of young forests. Usually the stands are left unthinned until it is possible to cut utility wood.

China constitutes 20% of the world's population. China is a large importer of forest products and a great consumer of paper and the consumption tends to increase with the growing Chinese economy (Roos et al. 2005). China will also become an important producer of forest products. This is especially true concerning furniture, but there are also big plans for the development of the pulp and paper industry (Roos et al. 2005). China is the country with the largest area of plantations (Roos et al. 2005). The plantations gives both raw-material and environmental benefits. Deforestation has since millennia been a problem in China. Recently big sandstorms that affected Beijing and flooding along the big rivers have showed the problems of deforestation in China. To prevent the deforestation logging bans have been imposed in large areas.

Swedish forest companies constitute a significant part of the global wood market. Despite this fact the interest and engagement in the global forest arena is unexpectedly small in Sweden. This is true also for the forest faculty at the Swedish University of Agricultural Sciences. Sweden, as a developed forestry country, has the responsibility to actively participate in the development of the forestry sector in developing countries. Therefore, it seems self-evident that Sweden as an important forestry country must start to learn more about the Chinese forest sector. Furthermore, an increased knowledge makes it easier for Swedish companies to meet an increased competition and to open new market possibilities.

The Faculty of Forestry at SLU has developed a strategy to increase research in Global Forest Analysis. Analyses about which research issues should be given priority in the expansion of the programme have been conducted. The two top-priorities are China and fast-growing plantations. This program has generated contacts with Chinese organisations. Chinese Academy of Forestry (CAF) is the local partner in China. CAF is the best known research organisation within forestry in China and acts also as an umbrella for the different universities.

Sweden has both great knowledge and a long tradition of nurturing young forest. For a company like IKEA it would be of great importance to be able to produce timber of desirable qualities by using rational and well-tested Swedish silvicultural methods. IKEA is therefore financing this project. By investigating the potential quality outcome from Swedish precommercially thinning methods in birch stands in China, it would be possible to serve IKEA with valuable information about future possibilities and development opportunities of products and raw material. Furthermore, IKEA has shown interest in global forestry issues. IKEA is today using large amounts of wood for their production of furniture and large amounts of this are birch wood, which is a popular and well used species in many products. IKEA tries to procure their wood material from both sustainable and productive well-managed forests, without affecting the environmental negative (http://www.ikea.com).

The area in focus for the project is North-eastern China and mainly the Heilongjiang province which has large areas of naturally regenerated birch forests. Since white birch is the most common birch species in the region (Anon, a), the potential for quality production in this species is most interesting. The research area in China has been selected based on its large areas of natural birch forest mainly consisting of white birch.

To investigate the potential for quality production in young birch stands in north-eastern China using Swedish precommercial thinning strategies, the project consists of two parts; a simulated precommercial thinning experiment with Swedish strategies applied to young Chinese white birch stands and a study of Chinese and Swedish literature about silvicuture in young forests. During the Chinese field research young birch stands shall be identified and their potential for quality production by using Swedish precommercial thinning strategies will be evaluated. The main purpose of the field research was to study the possibility to select vital main stems of good quality at precommercial thinning. Along with the literature study and experiences from China concerning the conditions for forestry and particular precommercial thinning in white birch will give IKEA, the Swedish forestry sector and the faculty an increased insight and knowledge, both in general and in a more specialised competence concerning Chinese forestry, birch and precommercial thinning.

2. Theory background

2.1. Precommercial thinning in Sweden

Precommercial thinning is defined as a stand nursing thinning of plant or young forests where the cut trees are left at the site or is used as bio fuel (Håkansson, 2000). Selective precommercial thinning is the common strategy in Sweden. At selective thinning either the stems that should be left after thinning (positive selection) or stems that should be removed are selected (negative selection). At geometric precommercial thinning trees are removed in a defined pattern; rows, corridors etc, and no consideration is taken to the quality of individual trees (see for instance, Söderström, 1980).

The Swedish literature mainly describes precommercial thinning in coniferous stands, since Norway spruce *(Picea abies)* and Scots pine *(Pinus silvestris)* is the most important tree species in Sweden from a commercial point of view. Birch is often seen as a problem when it grows in conifer stands and is usually removed before the first commercial thinning. Different strategies to remove birch in coniferous stands involve for instance total removal and point cleaning (e.g. Karlsson *et al.*, 2002). However, there is also research and literature about precommercial thinning in stands of silver *(Betula pendula)* and downy birch *(Betula pubescens)* (see for instance, Raulo, 1987 and Almgren, 1990).

The Swedish literature suggests many different reasons for precommercial thinning, such as; regulation of tree species composition, increasing the growth of the remaining tree, decreasing the future risk of damages, improvement of the future timber quality and as a tool to create and preserve high environmental values (Söderström, 1980).

To decide if and when a precommercial thinning should be done some parameters to describe the situation is needed. In Sweden these parameters normally are mean height and number of stems per hectare.

Precommercial thinning in Sweden is performed manually, motor-manually or by machine (mechanical). Earlier chemical treatments for precommercial thinning were used but the active substances were forbidden 1977. Manual precommercial thinning is performed by hand with axe or knifes. Motor-manual precommercial thinning, which is most frequent used, is carried out by cutting the stems close to the base with a brush saw. Mechanical precommercial thinning uses machines like harvesters and forwarders, equipped whit small grappler saws to select trees or larger circular cutting or striking devises, usually used at geometric thinning.

<u>Precommercial thinning in birch stands</u>
In Sweden there are two commercially interesting birch species, silver and downy birch. They have similar characters but in general downy birch has better quality but lower production than silver birch. The character that gives downy birch better quality in general is straighter wood fibres (Ekström, 1989).

A main rule for birch silviculture is to have dense stands initially and then successively widening the spacing between the stems (Almgren, 1990). The green crown should never be smaller than half the stem length (Tegelmark et al. 2000), since shade intolerant species like birch has a strong relationship between tree crown diameter and growth (Dawkins 1963). Birch stands with less than 50 % of living crown will have small possibility to respond positive to future thinnings (Mielikäinen, 1991). The Swedish recommendation for birch is to produce large diameters with few knots, which are quality characters that are considered as valuable. For a company like IKEA few knots are not necessary an advantage. From IKEAs point of view the knot type is of greater importance. The birch growth culminates early and therefore rather low stem densities are recommended to reach required timber diameters.

Almgren (1990) recommends one precommerial thinning for birch stands. Dense young birch forests should be precommercially thinned at 3 m stand height or at 4-6 m if the risk for browsing is high. The number of stems left after thinning is considered as high if 3000-5000 stems per ha is remaining and normal if 1600-2000 stems per ha is remaining. Raulo (1987) recommends precommercial thinning to a density of 2000 stems per ha at an average height of 2 m. If it is possible to commercially use week dimensions at future thinnings a sparse thinning to 6000-7000 stems per ha is recommended.

There are also several precommercial thinning recommendations in birch were two or three precommercial thinnings are performed. According to Alriksson (2003) the first precommercial thinning should be carried out at an average height of 3-5 m, leaving 3500-4000 stems per ha. The next step is carried out at 6-9 m height and the number of stems is reduced to 1500-2000 stems per ha. At 10-12 m height, about a third of the remaining stems are cut and at this stage it is possible to cut utility wood.

Johansson (2001) describes a strategy where naturally regenerated birch is used as a shelter to prevent frost damages in young spruce stands. Johansson (2001) refers in his article to Tham (1987) that constructed series of field experiments 1983-1984 to investigate the potential to grow both birch and spruce in the same stand at different height levels. According to Johansson (2001) there are several advantages with mixed forests, such as frost protection for the spruce and higher total production. The first precommercial thinning according to this silvicultural program is carried out at an average birch height of 3-5 m and the number of birches is reduced to 2500-3000 stems per ha. When the birches are 7-9 m they are reduced again to 1000-1500 stems per ha. At 10-12 m height the birches are thinned to 500-800 stems per ha. The birches are then left until they are 30-40 years depending on the site and the development of the spruce. Precommercial thinning is also carried out in the under-growing spruce at the different stages.

Biological effects from precommercial thinning
Generally, denser stands results in a higher total production, but the growth of the individual trees is hampered (se for instance Andersson, 1985). A high volume production is favoured by high stem densities, which constitutes to week or non precommercial thinning. The increased volume production can though easily be lost trough damages caused by wind or snow (Pettersson, 1996). With increased number of stems the dimension decreases, while the volume concentrates in weaker dimensions (Pettersson, 1996). The utility wood production will on the other hand increase with lower stem densities (Illomäki et al. 2003). When precommercial thinning is performed competition for light and nutrition will decrease and the single stem will have the possibility to increase its diameter growth (Illomäki et al. 2003). According to Swedish literature quality related properties are influenced by the intensity and the timing of precommercial thinning. Enhanced competition effects quality parameters such as branch diameter and lifetime of branches. In precommercial thinning experiments in Norway spruce results shows that the branch diameter significant decreases if the stem density is increased (Andersson, 1985). According to Fahlvik et al. (2005a) a similar correlation is existing in Scots pine experiments but the decreased branch diameter is minor with higher stem densities (>3000 st/ha) left after precommercial thinning. Further Fahlvik et al. (2005a) says that the stand height at precommercial thinning significantly effects the branch diameter. A late thinning reduced the diameter of the thickets branch. Crown ratio also decreased with increased stand height, number of stems and height at precommercial thinning.

2.2. The forest and forestry in China and Heilongjiang province

According to statistic from 1995 China consists of 119 millions ha of forest land which constitutes 13 % of the total land area (Bergsten, 1995). The Chinese forest can be divided into three classes: timber forests (58%), economic forests (21%) and protection forests (12%) (Roos et al. 2005). The protection forests protect the land against erosion, sandstorms and landslides, which are serious problems in many parts of China. Large natural forest areas are located in north-eastern China in Heilongjiang, Jillin and Inner Mongolia. These areas have 32 millions ha boreal forest land which corresponds to 30 % of the Chinese forest land. In the end of the 1980s the consumption of the domestic wood industry was estimated to exceed the annual growth with 100 million m^3 (Bergsten, 1995). Since then the forested area and stocking volume has increased: in 1998 the forest area was 158 million ha and the stocking volume 11600 million m^3, in 2005 the forest area was 175 million ha and the stocking volume 12500 million m^3. In the latest inventory the annual growth now exceeds the harvested volume with 178 million m^3 (Roos et al. 2005).

The Chinese forests are controlled by the State Forestry Bureau that is supervised by the Forest Ministry. Every Chinese province has a forest bureau that answers to both the State Forestry Bureau and to the Province Government, which is responsible for the forestry in the province. Below the Province Forest Bureau there is City Forestry Bureaus that governs the County Forestry Bureaus. Every County Forestry Bureau has a number of forest farms that are responsible for silviculture and logging (Zhihai, pers. comm.).

Heilongjiang

Heilongjiang province is located in north-eastern China bordering to Russia. It is located in the temperate coniferous forest belt and has four distinctive seasons. The annual precipitation is 250-700 mm. The spring is dry, the summer wet and the winter cold. Harbin is the province capital and the population of the province was 36,7 millions in 1994.

The forestry is an important resource for the province. Heilongjiang has 17,8 million ha, which is 15 % of Chinas entire forest land (Bergsten, 1995). Heilongjiang province has the largest area of forest land and annual logging volume in China. The standing volume is calculated to 1,5 billion m³ which is 15,4 % of Chinas entire standing forest volume (Bergsten, 1995). The number of tree species is more than 120 and about 20 of these are used commercially. Important species are *Pinus koraiensis*., *Larix* spp., *Pinus sylvestris* var. *Mongolica*, *Picea* sp. and *Abies* sp.. Heilongjiang has a different management structure for the forest resources than other Chinese provinces. The Forestry Industrial General Bureau has the main responsibility, while the Forestry Bureau of Heilongjiang mainly handles silvicultural issues. Daxingaling Mountain has its own bureau that answers directly to the forest ministry in Beijing (Bergsten, 1995). It is difficult to find accurate statistic about the tree species composition and the standing volume in Heilongjiang. In Daxingaling Mountain, which is the biggest forest area in Heilongjiang, accurate statistics are available (Anon, a). Table 1 shows the most frequent tree species in this area. Dahurian larch *(Larix olgensis)* and white birch *(Betula platyphylla)* are the most common tree species in Daxingaling.

Table 1. Tree species composition of Daxinganling Mountain. Includes only the nine most common tree species.

Tree species	Area (thousands ha)	Volume (million m³)	Percentage
Larix. olgensis	4002,1	340,3	67,2
Betula. platyphylla	1910,2	127,8	25,2
Pinus. sylvestris var. mongolica	147,8	15,8	3,1
Quercus. mongolica	280,4	10,5	2,1
Populus. tremuloides	85,2	6,5	1,3
Betula.dahurica	61,9	2,2	0,5
Salix. spp	19,3	1,3	0,3
Populus. spp	12,2	1,1	0,2
Picea. as perata	9,4	0,9	0,2
Total	6528,4	506,4	100

The forest in Heilongjiang province has suffered from heavy over cutting for many years. Over cutting in corrupt forest farms exist and it is not an insignificant problem today (Li, pers. comm.). In spite of these problems, the over-cut volume is decreasing (Li, pers. comm.). In 1984 a new regulation that forbids clear cutting as a logging method was approved in Heilongjiang and in many other provinces (Li, pers. comm.). Today all logging in natural forests are carried out as selection cuttings to prevent a further reduction of the standing volume. The forests that are defined as natural are natural regenerated but not unaffected by earlier human activities. At selection cutting the regeneration cutting is carried out in several steps and seedlings are naturally regenerated underneath the shelter. Selection cutting prevents erosion which is a common problem in hilly landscapes when the forest is clear-cut. According to Anon (1995) selection cutting mainly should be done in stands which have high natural regeneration ability, but still it is the only allowed final cutting method in natural forest. The regulation says that a natural forest with canopy density < 0,6 and good natural regeneration abilities should be harvested in two steps. Canopy density is defined as the relation between the area of the tree crowns and the area of the stand (Zhihai, pers. comm.). As an example; canopy density 0,8 means that the tree crowns covers 80 % of the stand area (the ground). At the first thinning 50 % of the standing volume is cut, and when the canopy of the young trees closes, the remaining shelter trees are harvested. If the canopy density is > 0,7 and the natural regeneration ability is modest the selection cutting is carried out in three steps. During the first step 30 % of the standing volume is harvested while step two and tree follow the description above (Anon, c). Before it is possible to harvest a natural forest by selection cutting it has to reach the maturity age. There are regulations about maturity age for all commercial important species in Heilongjiang and it varies depending on species and site index.

<u>Ta He bureau</u>
The field work was performed within Ta He Forestry Bureau which belongs to Ta He county located north-east of Daxinganling Mountain, in northern Heilongjiang. Ta He forestry bureau is located in Ta He city which has a population of 96 500 citizens. Most of these people are directly or indirectly dependent on the forests as a source for income. The bureau covers a land area of 923 000 ha. Ta He forestry bureau consists of 9 forest farms, one selling office handling the utilisation of all forests products and four wood stores. The main part of the field research was performed within Xiu feng forest farm that manage 107 000 ha forest land.

Most area of Ta He forestry bureau is low hill and even land .The average altitude is 554 m.a.s.l. The highest mountain is Baikalu mountain altitude (1396 m.a.s.l) and the lowest altitude is the bank of Heilongjiang River (230 m.a.s.l). Ta He forestry bureau belongs to the frigid temperate zone and has a continental and seasonal wind zone .There is a frigid seven months winter and a very short summer. The average annual temperature is -3ºC. The annual accumulated temperature is 1500-1700ºC and the average precipitation is 428 mm per year. The frosty days begin in September and end at mid-May, resulting in a frost-free period of about 100 days per year. The dry climate makes the area sensitive to forest fires and forest fires are frequent. In spring 1987 the Greater Hingan Forests fire began. The serious fire hurled down 100 square kilometres of forest and destroyed 1,2 million ha forest, in 31 farms in two counties within 28 days (Liu, a). After the fire big areas with naturally regenerated forests consisting of white birch, aspen *(Populus tremuloides)* and *Populus* spp has appeared.

The main soil types according to commonly used soil type classifications in northern China (Anon, 2005) are brown coniferous forest soil, brown soil, meadow soil, swamp soil and river bank forest soil. The typical soil type is brown coniferous forest soil.

The total work area (forest land including non productive land such as swamps and water) is 918 000 ha, of which 913000 ha is land and 5000 ha is water. The forest land are composed of youth forest 265000 ha (35,4%), mid-age forest 367000 ha (49,2%), near mature forest 54000 ha (7,3%) and mature and over mature forest 61000 ha (8,1%).

The total standing volume is 49,5 million m^3, composed of: conifers 25,5 million m^3 (52,9%), broad-leaved trees 12,5 million m^3 (25,8%) and mixed forest 10,3 million m^3 (21,3%). The official annual harvested volume the latest years has a clear decreasing trend: in1998 the cut volume was 470 000 m^3, in1999 455 000 m^3, in 2000 380 000 m^3 and in 2001 the cut volume was 290 000 m^3 (Anon, 2005).

2.3. Birch in north-eastern China (Heilongjiang)

Heiljongjiang province has four birch species: white birch, ribbed birch *(B.costata)*, Ermans birch *(B.ermanii)* and Dahurian birch *(B.dahurica)* (Anon, a). White birch is the second largest tree species in Daxingaling Mountain, according to standing volume (Table 1). White birch is distributed in mountain areas over big parts of China; in north eastern China including Daxingaling Mountain, Xiaoxingan Mountain, Changbai Mountain and Taihang Mountain, in northern China including Yan Mountain and TaiHang Mountain, in north western China including Qin Mountain, Tian Mountain and Artai Mountain. Ermans birch is distributed in north-east China including Changbai Mountain and Xiaoxingan Mountain. Dahurian birch has as similar distribution in Xiaoxingan Mountain, Daxingaling Mountain and Changbai Mountain.

<u>White birch in Heilongjiang</u>
White birch in Heilongjiang is commercially used as pulp, match, furniture, plywood and firewood. The standing volume of white birch in Daxingaling Mountain is 127,8 million m^3 distributed on 1910000 ha which respond to 25,23 % of the total standing volume. There are difficulties to find accurate information concerning the volume production of white birch. In Ta He forestry bureau the standing volume per hectare varies between 100 m^3/ha and 260 m^3/ha for white birch (Li, pers. comm.). This can be compared with larch that has a standing volume per hectare between 103 m^3/ha and 339 m^3/ha in this area (Li, pers. comm.). The maturity age for natural birch in Heilongjiang is 51-70 years and 31-40 years for artificial regenerated birch depending on site index. This can be compared with natural larch that has a maturity age between 101-130 years (Anon, 1995).

2.4. Tending of young forest in China

The Chinese literature concerning the management of young birch stands seems sparse. Probably depending on several reasons, like that the commercial interest for birch has been insignificant or that the definition “precommercial thinning” differs between China and Sweden.

After reading the Chinese literature and discussing with the Chinese associates it became clear that the term precommercial thinning responds to what the Chinese defines as release thinning. According to Cutting and Regeneration Design Regulations for Northern and Inner Mongolia National Forest Area, release thinning is carried out in young forest in the two lowest age classes which means that the forest should be less than 20 years (Anon, 1995). The release thinning definition does not include any restrictions about the utilization of the felled trees, like Swedish definition of precommercial thinning, but it is allowed to leave felled trees in the stand.

According to Anon (b) there is four main reasons for released thinning: to adjust the species composition, to improve growth of the main stems, to remove damaged trees and thereby improve the quality of the stand and to shorten the rotation length.

In order to determine the need for release thinning, canopy density is used as parameter. In naturally regenerated birch or larch forest release thinning is carried out when the canopy density is > 0,8. For planted larch or birch forest the limit is > 0, 9. At release thinning 5-15 % of the standing volume should be removed in naturally regenerated forest. The canopy density should not be reduced below 0,6. In planted forest the recommended removal is 10-15 % of the standing volume. In this case the canopy density should not be reduced below 0,7. A second release thinning is recommended after 4-7 years for naturally regenerated forests if the canopy density exceeds the threshold value. For planted forest the corresponding interval is 5-8 years (Anon, 1995).

Equipment for release thinning

The Chinese forest worker uses brush saw, knifes or axes for released thinning. The common tools for release thinning are axes and knifes.

Local knowledge

To see how well the knowledge at the local forest civil servant corresponds with the theory, questions were asked to employees within Ta He bureau and Xin Feng forest farm. The knowledge at the local forest civil servant corresponds well with the basic theories found in literature. In Xin Feng forest farm the average annual release thinning area is approximately 400 ha (410 ha in 2004) (Yushu, pers. comm.). This is less then 0,5 % of the total forest land area within the farm. Notice that this number is for the entire bureau and not specifically for Xin Feng farm. Release thinning is carried out in all commercially important species such as white birch, larch and pine and it is done in the two first age classes (< 20 years) (Yushu, pers. comm.). Canopy density is used to decide the need for released thinning (Yushu, pers. comm.). The used equipment for thinning is brush saw and axe. The reasons for release thinning correspond to the one found in Chinese literature described earlier (Yong, pers. comm.). The removal at release thinning should be < 20 % of the standing volume. The thinnings are carried out from below, removing the smallest trees. Main stems are selected according to the following characteristics: large dimension, good shape, free from forks and big knots and a good health status (Yushu, pers. comm.). The cost for release thinning in the farm varies from 100-300 RMB per ha (Yong, pers. comm.). White birch from this region is mainly used for eating sticks, tooth picks, ice cream sticks and floors.

Release thinning in white birch stands

The Chinese literature about release thinning in white birch stands is sparse. There are, however, some recommendations concerning thinning in stands of naturally regenerated white birch. According to the Swedish definitions these recommendations must be considered as commercial thinnings. The recommendation does not follow the common Chinese definition of release thinning since the thinnings usually occurs at stand ages greater than 20 years.

Yuying (2000) recommends one thinning and it should be carried out when the stand is 40-50 years. The thinning should be carried out from below, removing the suppressed trees. After thinning the canopy density should be close to 0,7. The recommended number of stems left after thinning depends on the mean breast height diameter (Dbh) of the stand:

Dbh 8-9 cm	1500-1800 stems per ha
Dbh 10-12 cm	1130-1500 stems per ha
Dbh 12-14 cm	930-1130 stems per ha
Dbh 14-16 cm	660-930 stems per ha

Shitougou (1995) recommends two thinnings for naturally regenerated birch forest. The first thinning is carried out when the stand is 20-25 years and the second at 30-40 years. The thinning should be carried out from below, removing the suppressed trees. The canopy density should be close to 0,7 after thinning.

The recommended number of stems left after thinning depends on the mean breast height diameter (Dbh) of the stand:

Dbh 8-10cm	2250-2700 stems per ha
Dbh 10-12cm	1695-2205 stems per ha
Dbh 12-14cm	1395-1695 stems per ha
Dbh 14-16cm	990-1395 stems per ha

3. Materials and methods

3.1. Swedish field research

The purpose of the Swedish field research was to get familiar with the well used Swedish precommercial thinning strategies and to find suitable IKEA quality indicators. Therefore a number of precommercial thinning experimental sites was visited. The purpose was also to evaluate different quality aspects in field and to discuss quality's that is interesting from IKEAs point of view. During the Swedish field trip suitable quality indicators for Chinese birch were discussed and evaluated with IKEA of Sweden AB in Älmhult

3.2. IKEA quality

IKEAs quality indicators for birch was discussed and defined in co-operation with Bernt-Ove Karlsson, Project leader at IKEA of Sweden AB in Älmhult. IKEA uses four classes to classify birch quality. Quality class 1 timber is free from knots and other markings. Quality class 2 timber includes timber with fresh knots. Quality class 3 and 4 allows dead knots, insect damages and discoloured core to some extent. According to Bernt-Ove a majority of the timber (70 %) used by IKEA belongs to quality class 2. Consequently, in this study the requirement of quality class 2 are in focus. According to Bernt-Ove the main problem with Chinese birch is black markings in the wood, caused by the birch cambium fly (*Photopia betulae)* that attacks the white birch.

The discussion with Bernt-Ove gave these quality indicators:

- Minimize the number and size of dead (black) knots
- No limitations concerning the numbers and size of living knots.
- Minimize damages made by the birch cambium fly
- Minimize the red core

A discussion with Benson Yu, Forestry Manager, IKEA Trading Hong Kong LTD gave further criteria's that are interesting from IKEAs point of view. These criteria's are mainly about increasing the dimension of the trees and thereby increase the production of commercial wood and shortening of the rotation length as well.

3.3. Field work in China

3.3.1. Location for Chinese field study

The location for the field study was recommended by our associates at CAF in Beijing and at Northeast Forestry College in Harbin. The field study was carried out within the Ta He forest bureau located at latitude 52,5 Nº.

3.3.2. Experimental sites

To start with suitable stands of white birch were identified. The stands should represent different stages of development situated on similar sites. Two height classes 2-4 m and 5-7 m on similar sites were searched fore. Within each height class three different stem density classes should be defined. Most birch forest within the research area was regenerated after the big forest fire 1987 and it was difficult to find young stands. This means that differences found in stand height represents differs in site characters instead of ages. This gives the consequences that the effect of different timing of precommercial thinning was difficult to investigate.

Eleven stands were identified (Table 2). All stands except one were naturally regenerated after the forest fire in 1986. The hydrology were either mesic our dry and most stands were dominated by rise and grass vegetation. In three stands traces of earlier treatments were registered. In stand 7 and 11 there were 2 meter wide stripes, where birches had been removed. The distance between these stripes were approximately 8 meter and the area between the stripes was untreated. In these stripes larch had been planted or naturally regenerated. In stand 2 there were damages caused by machines in old stripe roads.

Table 2. Site description for the stands.

Stand	Altitude (m)	Fire observation	Hydrology	Soil type
1	448	Yes	Mesic	Brown
2	570	Yes	Mesic	Brown
3	526	Yes	Mesic	Brown
4	510	Yes	Mesic	Brown
5	491	Yes	Dry	Brown
6	405	Yes	Mesic	Brown
7	398	Yes	Dry	Swamp
8	410	Yes	Mesic	Brown
9	408	Yes	Mesic	Brown
10	424	Yes	Dry	Brown
11	466	No	Dry	Brown

Brown = Brown coniferous forest soil, Swamp = Swamp soil

3.3.3. Experimental design

In every stand three survey plots was measured. The location of every plot centre was identified with GPS and the centre was marked with a blue plastic stick and a larch pole. Each site was described according to the Swedish instructions for measurements of permanent experiments (Anon. 2002). The following site descriptions were registered on every plot: elevation (m), topography, regeneration, traces of forest fire, earlier treatments, stand age, hydrology, soil type and site index.

The age of the two dominate trees on each plot was determined by using an increment core. The site index was calculated using a model with stand height and age as parameters (Appendix 1) (Li, 2005). The soil type was determined according to the Xiu feng forest farm map using their classification, which consists of five main classes.

In every stand the location of the centre plot was selected randomly. The two remaining plots were placed in an angle of 90° or 180° degrees, depending on the shape of the stand. The distance between the plot centres was 15 or 30 m, depending on the size of the stand. The radius of the circular plots was 5,64 m (100 m^2).

Inside the survey plots main stems was marked according to two simulated precommercial thinning treatments. All plots were photographed after the main stems had been marked (Appendix 6.). The treatments were thinning to 1500 (PCT1500) and 3000 (PCT3000) remaining stems per ha, respectively. This interval in thinning grade was chosen to cover the range of recommended stem numbers found during the Swedish literature study. In stand 4 and 11 the stem density was to low to carry out PCT3000. The selection of main stems was done according to certain criteria's, which were followed in every possible case. If the stems that fulfilled all these criteria's were not enough, other stems that fulfilled some of these demands was chosen instead.

The following criteria's for stem selection were used:

- The smallest distance between main stems should be more then 1 meter for PCT1500 and 0,7 PCT3000.
- The main stems should be stable and vital, with a green crown > 50 % of the tree height.
- The main stems species should be white birch.
- Main stems should be free from quality faults and damages.

Measurements

Trees below breast height were not considered at the measurements. In plots with a mean height greater than 5 m, diameter was only measured on stems with a diameter greater than 30 mm in order to fasten the field work. Tree species and regeneration origin was registered for all trees on the plot. The registration of regeneration was done by deciding if the stem was vegetative regenerated (from stump) or not. The most obvious way to decide the origin was when several stems grow like a cluster with their stem bases close together or when the old stump was visible. In all stands, tree height was measured for all trees on the centre plot. On the other two plots height was only measured on main stems. Heights for all stems in these plots were estimated based on the relationship between height and diameter calculated for the first plot. For all main stems the height to the lower part of the living crown was measured and main stems with one-sided crowns was registered. The crown ratio was calculated as the quotient between the length of the living crown and tree height. For all stems on the plot above breast height, quality faults were registered. In plots with a mean height greater than 5 m, quality faults were measured on stems with a diameter greater than 30 mm. The quality registration was elaborated according to the Swedish instructions for measurements of permanent experiments (Anon. 1991) and from IKEAs quality indicators for birch.

Table 3. Quality fault parameters.

Quality fault parameter	Location	Comments
Wolf type		trees that are obviously bigger than the rest of the stand
Bends		pronounced bends
	below 4 meter	
	above 4 meter	
	at the base of the stem	
Fork		diameter of the fork > ¾ of the main stem
	below 4 meter	
	above 4 meter	
Spike knot		pronounced spike knots
	below 4 meter	
	above 4 meter	
Large dead knot		on the first 2 meter and diameter >2,5 centimetre
Damages		
Stem wound		< 1/8 of circumference
Stem wound		> 1/8 of circumference
Insect damages		visible on the surface of the stem
Fungi damages		visible on the surface of the stem

The reason for separating quality faults above and below 4 meter is that faults below 4 meters are considered to be more serious since they effect the most valuable part of the tree. A wolf tree is a tree with a wide crown and thick branches that is growing ahead the other stems (Nygren, 1994). In appendix 5 photos of quality faults are displayed.

3.3.4. Establishment of demonstration plots

Two stands, number 2 and 3, with different mean height were selected as demonstration plots. Within these stands, three square plots (15×15 m) were arranged with a minimum distance of 5 m between the plots. The design of the demonstration plots is presented in Appendix 2. The corners of the square were marked with poles. A circular plot with a radius of 5,64 m was placed in the centre of each square plot. Three treatments were applied; no thinning, thinning to 1500 stem per ha and thinning to 3000 stems per ha. The different treatments were randomly distributed among the three plots. The circular plots were measured according to the instruction used for the survey plots. The area of the square plots including the circle was thinned according to the randomly selected treatment. The selected treatment was also applied within a 2,5 meter buffer zone surrounding the squares. Breast height diameter was measured for all main stems inside the square. All plots were photographed (Appendix 6) and a centre pole with a sign presenting the treatment was left.

4. Results

4.1. Site characteristics for the stands before simulated thinning

Most stands were 17 years old and dominated by white birch (Table 4). In all stands and especially in stands with a high site index there was a rather dense shrub layer of *Rhododendron farrerae*. The average stem density for the eleven stands were 7500 stems per ha. In Table 4 the relation between height and diameter (H/D) are presented. The average H/D for all stands were 1,58. A large proportion of the trees were vegetative regenerated (Table 4). The average share of stems that was vegetative regenerated for the stands was 47 %.

Table 4. Stand characteristics for the eleven stands before the simulated precommercial thinning.

							Species distribution (%)[1]					
Stand	SI	Age	Stem/ha	Mean diameter (cm)	Mean height (m)	Mean H/D	B	A	P	N	O	Veg.reg share (%)[2]
1	8.68	17	9100	2,59	4,04	1,68	75	25				51
2*	14.22	18	6400	4,71	7,08	1,54	97		3			22
3*	11.25	17	12000	3,23	5,37	1,7	90	4	1	4	1	39
4*	11.81	17	4600	3,63	4,99	1,41	86	14				48
5*	11.35	17	6000	3,31	4,94	1,55	94	6				50
6*	12.15	17	4300	4,04	5,69	1,46	93	2		5		26
7*	9.18	15	9300	2,39	3,65	1,62	98	2				55
8	20.59	9	13900	2,04	3,41	1,81	95			5		57
9*	14.91	17	7700	4,92	7,41	1,55	100					65
10	12.17	12	6400	2,23	3,32	1,56	85		10		5	61
11*	13.64	17	3600	4,3	6,21	1,45	88				12	49

*Diameter, height, H/D, species distribution and the proportion of vegetatively regenerated birches are calculated for stems with a diameter > 30 mm

[1]B=Betula platyphylla, A=Populus purdomii, P= Populus tremula, N= Larix Olgensis, Pinus Sylvistris var. Mongolica, O= Salix spp, Abies spp

[2]The proportion of vegetatively regenerated birch trees.

4.2. Stand characteristics for the stands after simulated thinning

The average diameter at breast height and tree height increased after precommercial thinning in all stands (Table 4-6). The increase in diameter and height was greater for PCT1500 in relation to PCT3000. The average diameter were 14,8 % greater and the average tree height were 8 % greater for PCT1500 than for PCT3000. The average crown ratio for PCT1500 were 0,52 and 0,50 for PCT3000. The relation between height and diameter (H/D) decreased after both simulated thinning alternatives and most for PCT1500. The average H/D was 1,33 for PCT1500 and 1,47 for PCT3000. The share of main stems with one-sided crowns were 1,6 % for PCT1500 and 2 % for PCT3000. The share of vegetatively regenerated stems decreased in most stands after simulated precommercial thinning (Table 4-6). The average proportion of vegetatively regenerated stems was 47 % for unthinned, 44 % for PCT1500 and 40 % for PCT3000.

Table 5. Stand characteristics for the stands after the simulated precommercial thinning to 1500 stems/ha.

Stand	Mean brh diameter (cm)	Mean height (m)	Mean H/D	Crown ratio	Veg.reg share (%)[1]
1	3,68	5,01	1,40	0,58	31
2	5,87	8,13	1,40	0,57	16
3	4,68	6,52	1,41	0,47	51
4	4,20	5,51	1,34	0,54	38
5	4,20	5,89	1,42	0,50	49
6	4,26	5,87	1,43	0,56	27
7	3,56	4,43	1,26	0,48	62
8	2,97	4,15	1,42	0,50	67
9	6,92	8,88	0,77	0,46	42
10	3,02	4,01	1,36	0,53	60
11	4,85	6,66	1,41	0,59	40

[1]The proportion of vegetatively regenerated birch trees

Table 6. Stand characteristics for the stands after simulated precommercial thinning to 3000 stems/ha.

Stand	Mean brh diameter (cm)	Mean height (m)	Mean H/D	Crown ratio	Veg.reg share (%)[1]
1	3,13	4,53	1,53	0,56	24
2	5,34	7,66	1,48	0,55	15
3	4,21	6,19	1,49	0,47	40
4	-	-	-	-	-
5	3,67	5,37	1,49	0,49	39
6	3,89	5,56	1,47	0,52	20
7	3,10	4,14	1,38	0,47	47
8	2,63	3,86	1,51	0,48	67
9	5,96	8,36	1,47	0,43	57
10	2,69	3,64	1,40	0,53	48
11	-	-	-	-	-

[1]The proportion of vegetatively regenerated birch trees

4.3. Quality faults for the stands and treatments

The distribution of trees with quality faults on diameter classes indicates a negative skew ness (Appendix 3). For PCT1500 the proportion of trees with quality faults was reduced in 6 stands (Table 7). For PCT3000 a reduction was attained in 5 stands. The average proportion of birches with quality faults was 40 % before thinning, 34 % for PCT1500 and 36 % for PCT3000. If quality faults above 4 m height are excluded the corresponding values were 35 % before thinning, 25 % for PCT1500 and 29 % for PCT3000. The majority of the stems (95 %) before precommercial thinning had only one registered quality fault. The average proportion of stems with more than one registered quality fault was 5 % before thinning, 9% for PCT 1500 and 23 % for PCT3000.

Table 7. Proportion of birches with quality faults for the different treatments. Results are presented for the whole stem and for the stem section below 4 m from the ground.

Proportion of birches with quality faults (%)						
Whole stem				Stem section below 4 m		
Stand	Unthinned	1500	3000	Unthinned	1500	3000
1	46	49	48	46	49	48
2	45	18	37	38	13	28
3	36	33	39	32	18	28
4	38	33		34	27	-
5	42	44	52	36	27	42
6	37	13	30	35	7	27
7	44	49	39	43	42	36
8	35	20	20	35	20	20
9	31	31	32	8	7	4
10	39	27	28	39	27	29
11	47	53		36	40	-
Average	40	34	36	35	25	29

4.4. Type of quality faults and their frequency

Forks and spike knots were the most frequent quality fault types (Fig. 1-3). Before precommercial thinning the average proportion of stems with forks and spike knots was 44 % for both categories. The average proportion of stems with forks and spikes was greater for PCT1500 (39 % and 46 %) than for PCT3000 (33 % and 44 %). Large dead knots were rare before precommercial thinning and were totally eliminated in PCT1500. For PCT3000 the proportion of damaged stems was greater compared to PCT1500. The proportion of wolf trees increased after precommercial thinning for both PCT1500 and PCT3000.

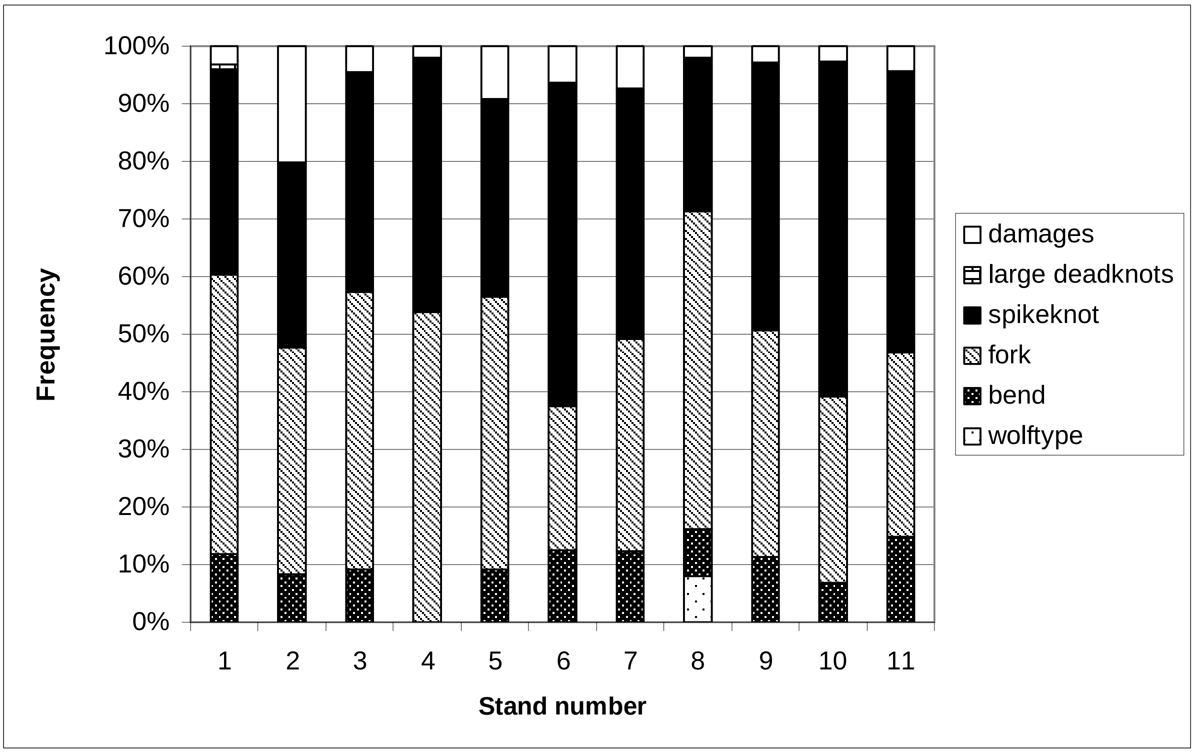

Fig.1. The frequency of different quality faults before thinning. Results for the whole stem are presented.

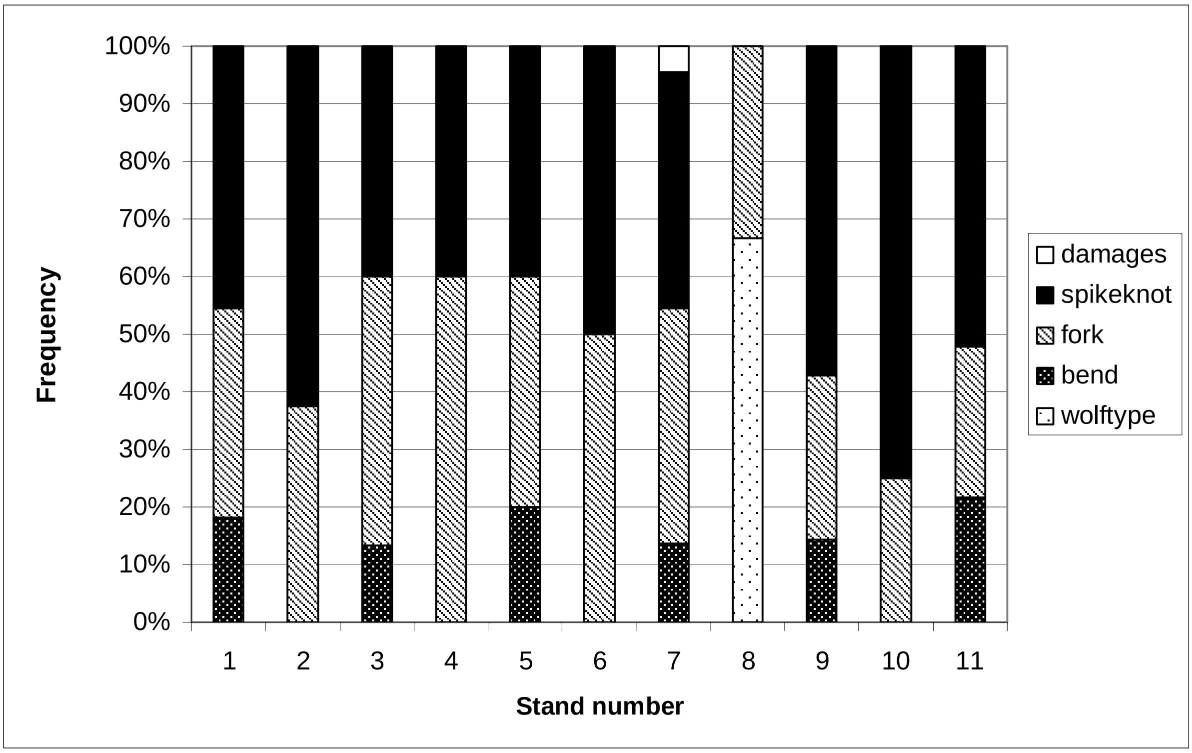

Fig. 2. The frequency of different quality faults after thinning to 1500 stems per ha. Results for the whole stem are presented.

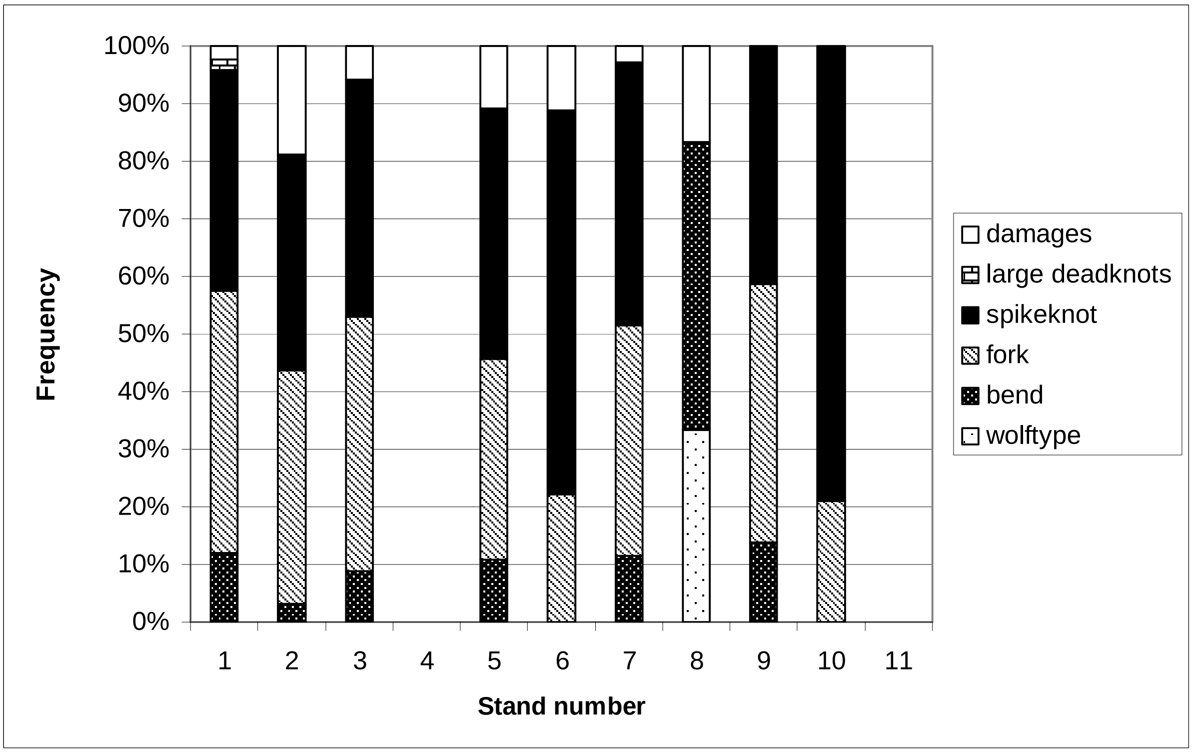

Fig. 3. The frequency of different quality faults after thinning to 3000 stems per ha. Results for the whole stem are presented.

4.5. The quality faults correlation with stand characteristics

Fig. 4 and Fig. 5 displays how the number of stems and stand height before precommercial thinning affects the frequency of quality faults of the remaining stands after the two treatments.

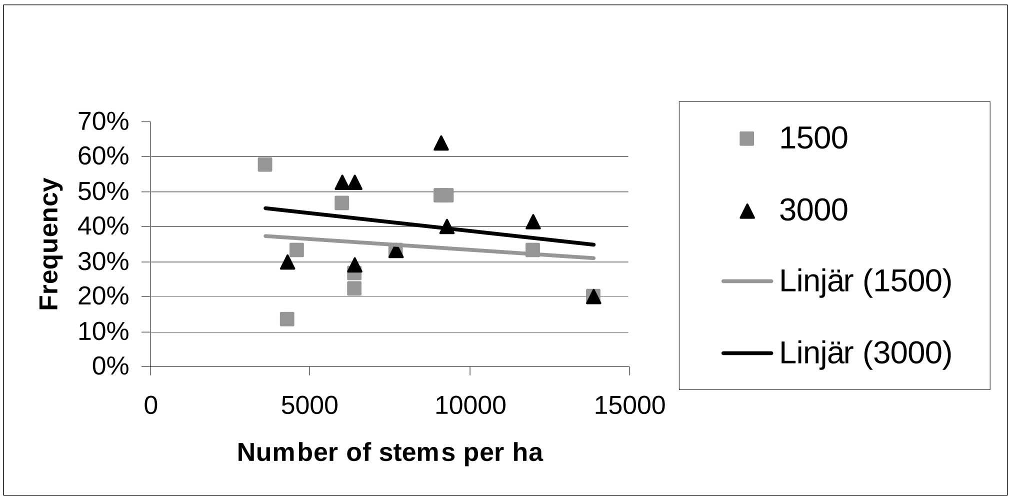

Fig. 4. The relationship between the proportion of stems with quality faults after precommercial thinning and the number of stems before thinning. The number of stems after precommercial thinning was 1500 and 3000 stems per ha, respectively.

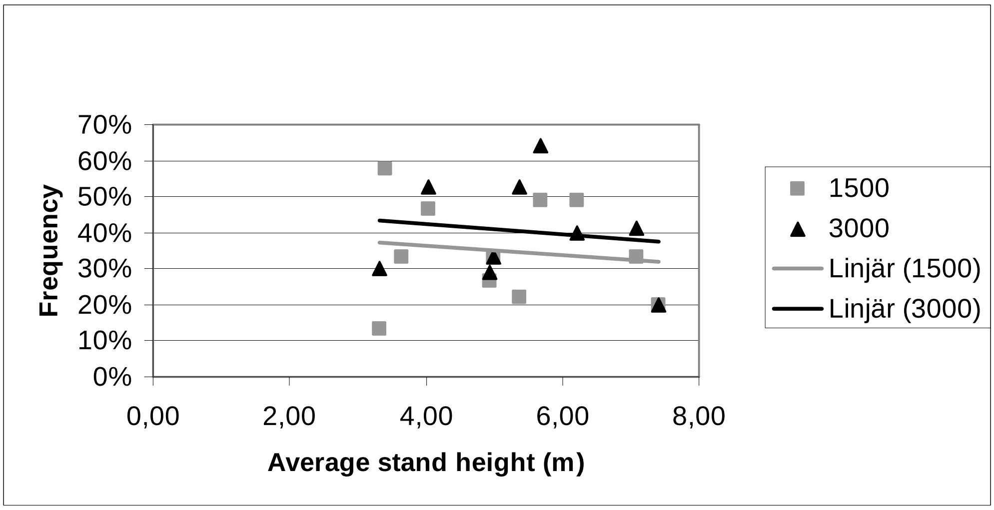

Fig. 5. The relationship between the proportion of stems with quality faults after precommercial and stand height before thinning. The number of stems after precommercial thinning was 1500 and 3000 stems per ha, respectively.

5. Discussion

<u>Quality faults</u>

The result gives a reliable picture of the types and frequency of quality faults in stands of white birch within the research area. Forks and spike knots are the outstanding most frequent quality faults for all treatments. In this study 40 % of the birches in the untinned stands have a registered quality fault. Pettersson (2001) found that approximately 50 % of the stems in a precommercial thinning experiment in Scots pine had quality faults. The most frequent fault types were spike knots and bends and they were not caused by browsing (Pettersson, 2001). The result in both this and Petterssons study indicates that large proportions of stems with quality faults such as bends, forks and spike knots has to be comprehended with during precommercial thinning.

Bends is another frequent quality fault, which probably can be related to the high proportion of sprouts found in the stands. If sprouts, regenerated from a single stump, grow together for a longer period of time, they usually develop bends at the base of the stem (Johansson, 1991). To prevent this, clusters of sprouts should be thinned at an age of 3-5 years, leaving a single stem per stump (Johansson, 1991).

A possible explanation for the high proportion of sprouts could be the forest fire. If the fire was intensive enough to kill almost all birches, only leaving the roots alive, the source for seeds would be heavily reduced at the same time as sprouts would be able to regenerate. It should be noticed that the ocular determination of origin is uncertain.

Generally, the frequency of damages is low and many damages are caused by earlier treatments. There are few registered damages caused by insects, which of course might depend on the difficulties to determine these kinds of damages. The study did not focus on damages caused by the birch cambium fly, which IKEA expressed as a serious problem with Chinese birch. However, according to Ta He bureau, damages caused by the cambium fly are not a common problem in the area (Xiao Ping, pers. comm.). The only significant insect damages affecting white birch in the area, are caused by leaf eating insects (Xiao Ping, pers. comm.). One reason for this might of course be that there is either no knowledge or interest for these kinds of damages. Another option could be that these kinds of damages have some kind of geographical distribution. The birch cambium fly demands sun and high temperatures which is a reason for that the quality for downy and silver birch in Sweden improves with increasing latitude and altitude (Åkerman, 2004). The research area is located in northern China and the climate is harsh with short frost free periods. This might explain that damages caused by the birch cambium fly are rare. Either way it must be of interest for IKEA to investigate the reasons for this fact further.

The influence of precommercial thinning on the development of red core, which is another serious quality fault according to IKEA, was not investigated in this field study. In general it is said that trees without a distinct core, such as birch, develop red core late in the rotation period as a result of low production and vitality (Rydberg et al. 2003). In Sweden, red core is a common problem in beech *(Fagus sylvatica)*. According to Rydberg et al. (2003) the development of red core could be prevented by maintaining a high growth rate of individual trees in older stands. Precommercial thinning might also decrease the development of red core since it gives possibilities to increase growth and to shorten the rotation period.

Large dead knots in the stem section below 2 m are rare in the investigated stands and are totally eliminated after precommercial thinning. The height from the ground to the green crown in most stands is more than 2 m and therefore it is not likely to believe that there will be any new development of large dead knots in this stem section. Further up on the stem living branches may develop into large dead knots in the future, depending on the future silviculture. The lack of large dead knots today most likely depends on the high stem density in the stands.

There is a tendency towards a decreasing proportion of quality faults at the lower part of the stems (< 4 m) with increasing stand height. This might indicate that many of the registered quality faults might be judged as less serious as the tree grows. This trend is clearest for stand 2 and 9, especially if stem damages caused by machine are neglected in stand 2. Näslund (1986) found that many earlier registered damages on birch in young stands were considered as less serious in a second inventory 5 years later. If this correlation exists, single quality faults on the stems in young stands should be of less importance for the future quality in the stand, since they will disappear early due to competition.

Influence of precommercial thinning on stand properties

The results indicate that it is possible to enhance the quality in young white birch stands through selective precommercial thinning. However, for most stands the proportion of quality fault are only reduced to a minor extent and for some stands the proportion even increases after precommercial thinning. It is also difficult to exclude stems with more than one quality fault by thinning. Pettersson (2001) found similar results with only small improvements in quality after precommercial (5-6%) and simulated precommercial thinning (11%). According to Pettersson (2001) the most obvious reason for the insignificant improvements after thinning is the uneven distribution of stems with good quality in the stands. It is likely to believe that this is one important reason for the minor quality improvements in this study as well. The influence of stem density and stand height before precommercial thinning on the average stem quality has not been as expected. In fig. 4 and 5 it is displayed that there is no correlation between stand height or stem density before thinning and the share of stems with quality faults after thinning which could be expected.

The simulated precommercial thinnings increased the average breast height diameter and stand height due to selection. According to both Nordic and Chinese literature this increase in dimension will result in higher shares of merchantable wood (se for instance Illomäki et al. 2003 and Anon, b). Future thinnings will also be less expensive as the dimension of the trees increases (Frohm, 1996). By increasing the growth rate of the trees, desirable dimensions could be reached within a shorter rotation period.

A large proportion of the trees in the original stands must be considered as unstable according to the average quotient between height and diameter (H/D). Fahlvik et al. (2005b) used a H/D quotient below 1.25 as an indicator for vital and stable birches. After precommercial thinning the H/D quotient is decreased as a result of selective thinning. However, it should be noticed that the risk for damages caused by snow and wind increases the first years after thinning (Persson, 1972).

The study indicates that it is possible to find main stems with a crown ratio close to 0,5, even though the thinning is considered as late. The Swedish precommercial thinning literature points out the importance of keeping the size of the green crown close to 50 % of the tree height or more in birch stands (Almgren, 1990). If the size of the living crown decreases too much, losses in production will follow rapidly (Almgren, 1990). It is difficult and takes long time to build up larger crowns once the size of the crown decreases below 50 % of the tree height.

The result shows that a large proportion of the birches originate from sprouts and that this proportion can be reduced through precommercial thinning. A lower share of sprouts will probably result in fewer bends and one-sided crowns in the future. Moreover, in a study by Johansson (2000) it was found that 33 % of the sprouts from downy birch and 43 % of sprouts from silver birch were rot infected. According to Lundh et al. (1989) vegetative regenerated silver birches have a more rapid growth than those regenerated from seeds until an age of about 16 years, when their growth rapidly decreases.

The quality in the original stand is most crucial for the quality after precommercial thinning, since it has been difficult to lower the share of stems with quality faults. This might depend on the insufficient field data, which is the inferior age structure of the investigated stand. Almost all investigated stands were 17 years old and regenerated after a big forest fire. Consequently, the difference in stand development is probably an effect of differences in site index (SCI). For all stands the average tree height are greater than 3 m. Precommercial thinnings carried out at a greater height than 3 m are considered as late precommercial thinnings according to Swedish recommendations. The fact that the precommercial thinning has been late and that most stems displays a poor relationship between height and diameter, has most likely effected the possibilities to lower the share of quality faults after precommercial thinning. Petterssons (2001) concludes that yet another reason for the small improvements in quality after thinning in his study is that larger stems has to be left benefited on smaller and more unstable stems. Further he says that the situation deteriorate with increasing stand height (Pettersson, 2001). In this study trees with large diameters and well developed crowns was selected as main stems in order to create stable and vital stands. An earlier precommercial thinning probably would have increased the possibility’s to select main stems of desirable quality. Further the high proportion of sprouts has limited the stem selection due to one side crowns.

Two different thinning grades were tested in this study, leaving 1500 and 3000 stems per ha. A precommercial thinning strategy is usually defined with respect to both its intensity and timing, i.e. the average height at thinning. The studied stands represent different mean heights but the stand age is nearly constant. Thus, it is less meaningful to discuss how timing of precommercial thinning affects quality based on this material, since the variation in height most likely was an effect of differences in site quality. I do believe that an earlier precommercial thinning where clusters of sprouts are released could be a suitable strategy in the studied stands, by doing so the stem stability and crown development could be improved. In this case a second precommercial thinning probably would be necessary.

<u>Future lack of birch in north-eastern China?</u>
The study has resulted in another interesting question which concerns the future possibilities for the white birch in north-eastern China. Within the research area it was difficult to find young birch stands. Almost every stands is 17 years old and regenerated after forest fire. This indicates that there is a lack of new regenerations of white birch in the area. One reason for this might be a lack of suitable regeneration sites. With the cutting system used in north-eastern China today, described in the literature study, the sites with good regeneration possibilities for birch must be considered as few. As a consequence of the selection cuttings there will probably only be few canopy free areas with good substrate for birch seeds to grow.

The birch is a pioneer tree that needs a lot of light and bare mineral soil in order to regenerate successfully. The lack of bigger forest fire and the conversion to selection cutting may be reasons for the lack of young birch stands. If there are similar trends all over north-eastern China, white birch will decrease in favour of other more shade tolerant species in the future.

Conclusions

From IKEAs point of view a more intense precommercial thinning like the Swedish recommendations with earlier precommercial thinnings seems to be a beneficial alternative to the Chinese recommendations. The Chinese recommendations found in this study concerning precommercial thinning in white birch stands are done later, in older and higher stands, and should therefore be less beneficial for IKEA. Since IKEA mainly requests fresh knot wood with no limitations regarding branch diameter a further reduction of the number of stems after precommercial thinning then tested in this study might be even more beneficial. A lower stem density would improve the future tree dimension and H/D relationship. By favouring the dimension growth, the future costs for commercial thinnings could be reduced (Frohm, 1996).

If IKEA wants to increase their available birch raw material in north-eastern China there are several other important questions to deal with. According to the Chinese literature there are both knowledge about the treatment of young stands and developed methods for early thinnings. Thus, there must be other reasons for why precommercial thinning is not carried out in white birch stands within the Ta He Forest bureau. The interest for birch seams to be sparse, at least within the forest bureau. Management efforts are mainly concentrated to larch forests, which are of greater commercial interest. This is a fact even though the price on birch wood has increased the latest years. A prise list from Ta He bureau wood selling office is presented in Appendix 4. It shows that the difference in prize between birch and larch is small. However, on similar sites the volume production of larch is greater than for white birch.

White birch has a shorter rotation period compared to larch. Moreover, the lowest allowed stand age at final felling is about 50 years for white birch, which is about 50 years lower than for larch. In an economical comparison based on net present values, the shorter rotation period of the birch might compensate for the lower volume production compared to larch. I am doubtful whether this kind of reasoning is used when decisions concerning species and silvicultural strategies are taken.

From a Swedish point of view the intensity in the forestry must be considered as low in China, although the number of employees is high. The government employed forest workers and forest civil servant interests for the forest and its possibility seems sparse. The number of employees must be considered as high but the results lower, again from a Swedish point of view. The reasons for this are probably many and complicated but I do believe that there are some kinds of connection with the government ownership. I think that this kind of management makes its difficult to encourage the employs to greater accomplishments, since they don’t see any correlation between their rate of working and their benefits. If this is a problem or not is difficult to say either way there is both great potential and knowledge in the Chinese forestry that is waiting to be explored.

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