Timber assortments and selected aesthetic wood properties of Nordic Scots pine

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Key words
CIE L*a*b*, knot angle, knot size, Pinus sylvestris, saw timber recovery, stem defects, UV-A radiation, whorl interval

Introduction

The specific wood properties of Nordic Scots pine (*Pinus sylvestris* L.) applicable for further processed end-use products, as well as their variation and the affecting factors are not well known, demonstrated or fully utilized in the marketing argumentation. Pine wood tends to have large variations in the material properties related to silviculture and growth region. Additionally, the level and variation in the properties are most probably different compared to other competing species and non-wood materials in the main market segments.

The aim of this study was to determine the timber assortment distributions and the technical defects affecting them in five regions in Finland and Sweden, and to clarify the level and variation of selected properties influencing the visual impression of Scots pine wood.

Materials and methods

A sample of 60 mature Scots pine dominated stands from mineral soils was collected in three regions in Finland (Northern, South-Eastern and Inland Finland) and two regions in Sweden (South-Central and Southern Sweden), 12 stands from each. The stands were selected to represent different forest sites and age classes, as well as to cover the geographical variation of pine stands. In Finland, the sampling was based on the latest National Forest Inventory (NFI), in Sweden on the records of the Sveaskog Ltd.

In each stand, eight Scots pine trees covering the diameter range of conventional saw log and small-diameter log trees (DBH > 14 cm) were felled for sampling. In each sample tree, the dimensions and external limits for knottiness, as well as the visible stem defects affecting the saw log recovery, were recorded. The timber assortment distributions of the stands were calculated on the basis of the measurements of the dimensions and visible stem defects, using the value maximising bucking simulator (Kilpeläinen 2001). In total, the material consists of 60 stands and 480 sample trees.

For the wood analyses of this study, 70-cm bolts were cut from the sections of butt log, middle log and top log from three sample trees. The bolts, 540 of them, were first sawn through-and-through into approx. 30-mm thick boards, and the boards were slowly dried at room temperature. The boards were numbered ascending from the pith outwards, so that 0-board was the middle, pith enclosed board, 1-boards were the first boards outwards from both sides of the pith etc. From these boards, the location, size, shape and type of each knot was recorded. In addition, 10 boards were randomly selected to preliminarily measure the heartwood and sapwood colours, before and after UV-A exposure (peak wavelength 340 nm), by the spectral reflectance method with a spectrophotometer in the CIE L*a*b* colour space (Anon. 1994, Hunt 1998).

Results

Timber assortment distributions

The average timber volume of the stands ranged from 126 m^3/ha in Finnish Lapland to 272 m^3/ha in Southern Sweden. Moving from the north to the south, the volumetric proportion of butt logs and other logs increased from 64 to 80 %, and, simultaneously, the proportion of small-sized logs decreased from 9 to 2 %. In addition, the proportion of pulpwood decreased from the north to the south. The proportion of wood rejected from saw timber for quality (jump butts, offcuts) ranged between 1.0 and 3.2 %, being highest in South-Central Sweden and lowest in South-Eastern Finland (Fig. 1).

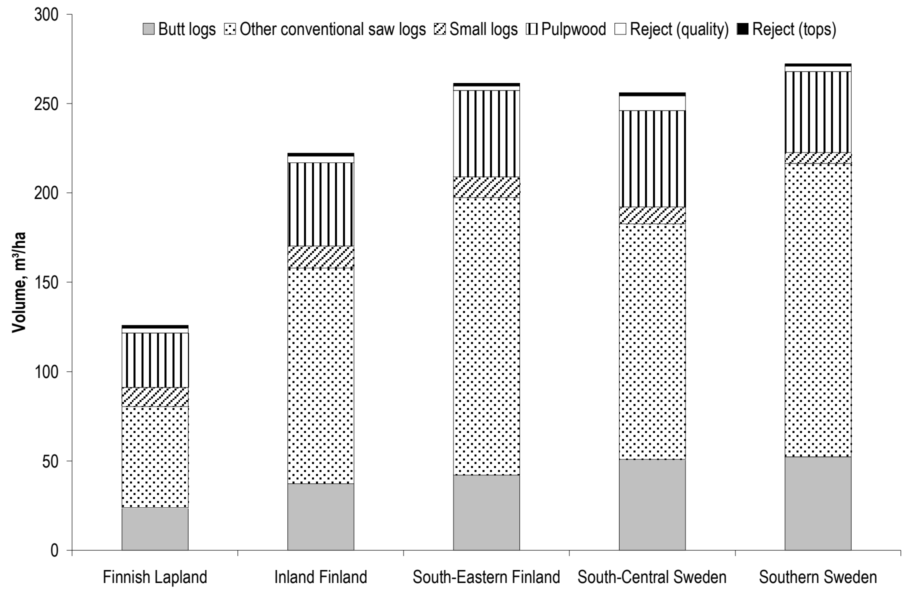

Fig. 1. Timber assortment distribution by region: butt logs 18+ cm, 31–40 dm; other conventional saw logs 15+ cm, 37–61 dm; small logs 12+ cm, 31–46 dm; pulpwood 7+ cm, 25–55 dm; reject from saw logs for quality (offcuts, jump butts); reject from tops.

External stem defects

In all regions, the stem form defects were the biggest group of visible stem defects affecting the saw timber recovery. In South-Central Sweden, at least one kind of stem form defect, such as crook or fork, occurred in over 90 % of the sample trees, whereas in Finnish Lapland the proportion was approx. 40 %. Depending on the region, 20–35 % of the trees were affected by big dry/dead knots, and 10–30 % by big sound knots. Surface defects and other defects occurred in approx. 10–30 % of the trees in each region (Fig. 2).

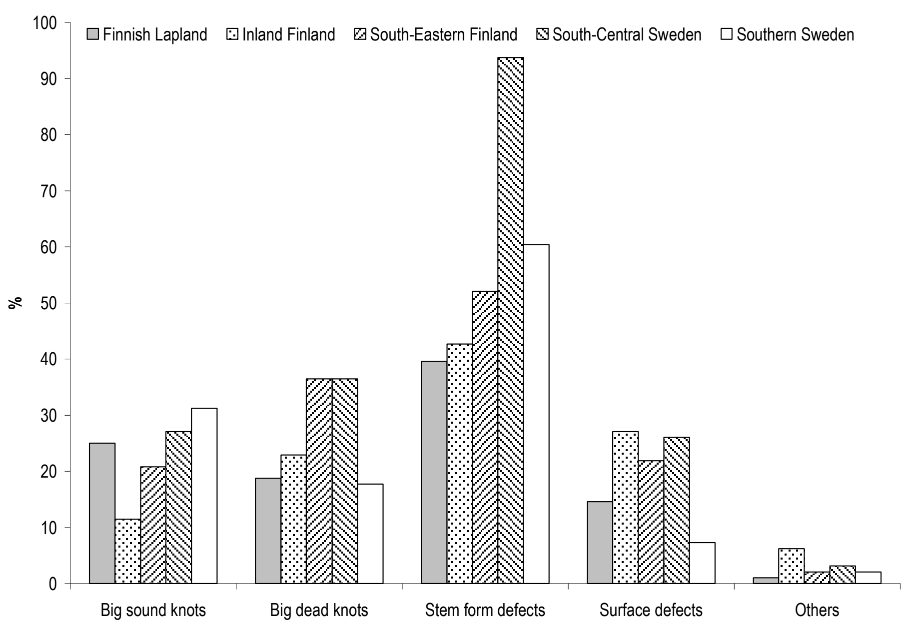

Fig. 2. Proportion of sample trees with visible stem defects affecting the saw log recovery, by defect group and region. Several defects may occur in a single tree.

Aesthetic properties, knottiness properties

Visual impression and aesthetic properties affect people's choices, when they are buying, for instance, interior materials or furniture. The problem is how to measure people's preferences towards different looks of wood and which are the properties that actually affect in decision-making processes. According to Marchal and Mothe (1994), the overall criteria that affect people's choice are knottiness, cut orientation, tint, and annual ring width. Broman (2000) mentioned that the two qualitative gross features, the overall blend of wood features and the presence or absence of divergent features that mismatch in the surface, are of importance for people's impression and valuation of wood. Accordingly, he concluded that for knotty wood surfaces, it is the blend of knot shapes, knot directions, knot colours and knot sizes that are significant for people's overall impression of wood.

Knottiness of wood is of importance when producing homogeneous wood products free from defects. Also in finger jointing industry, and in billet production for joinery, furniture and interior products the knottiness properties play a great role. In addition to the visual impression, knottiness affects essentially the strength and stiffness of wood products.

By region, in all boards (length approx. 700 mm) the average length of the defect-free wood zone between two adjacent whorls (whorl interval) ranged from 156 mm in Finnish Lapland to 276 mm in Southern Sweden. The regional variation of whorl intervals was statistically significant in boards 0, 1 and 2. Based on the pair-wise comparisons (Tukey HSD), the regions could be put into homogenous subsets by whorl interval and by board as follows:

0-board	Subset 1	Subset 2	Subset 3
Northern Finland	—		
Inland Finland		—	
Central Sweden		—	
Southern Sweden		—	
South-Eastern Finland			—

1-board	Subset 1	Subset 2	Subset 3
Northern Finland	—		
Central Sweden		—	
Inland Finland		—	—
Southern Sweden			—
South-Eastern Finland			—

2-board	Subset 1	Subset 2
Northern Finland	—	
South-Eastern Finland		—
Inland Finland		—
Central Sweden		—
Southern Sweden		—

Within a subset the variation of whorl intervals was statistically insignificant, and a significant variation could be found between the subsets.

By region, the distribution of whorl intervals had quite small differences in the pith enclosed boards (0-board), but from the pith outwards (1-, 2- and 3-boards) the differences became clearer (Fig. 3).

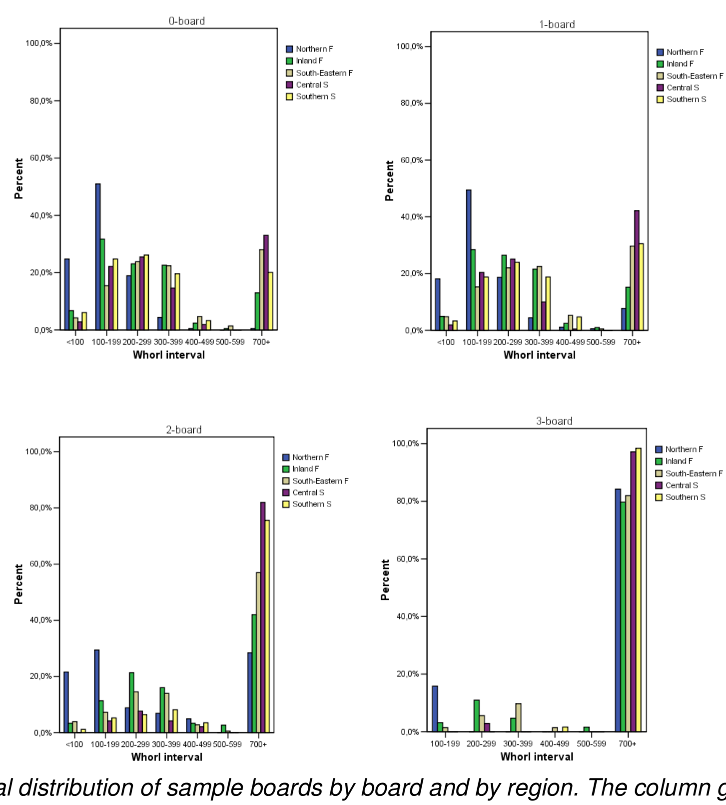

Fig. 3. Whorl interval distribution of sample boards by board and by region. The column groups on the right represent totally whorl-free boards.

The average diameter of sound knots was approx. 14,0 mm, with no significant variation between the regions, contrary to the larger variation in the diameter of dry/dead knots (average 12,4 mm) and decayed knots (average 20,6 mm) (Fig. 4). Moving from the north to the south, the average knot angle (0°=vertical, 90°=horizontal) decreased from 77° to 59° (Fig. 5). The results of this study are slightly different compared to the earlier study by Pietilä (1989b), where the average knot angle was 70° in six stands in Central and Southern Finland and in one stand in South-Central Sweden (Pietilä 1989a).

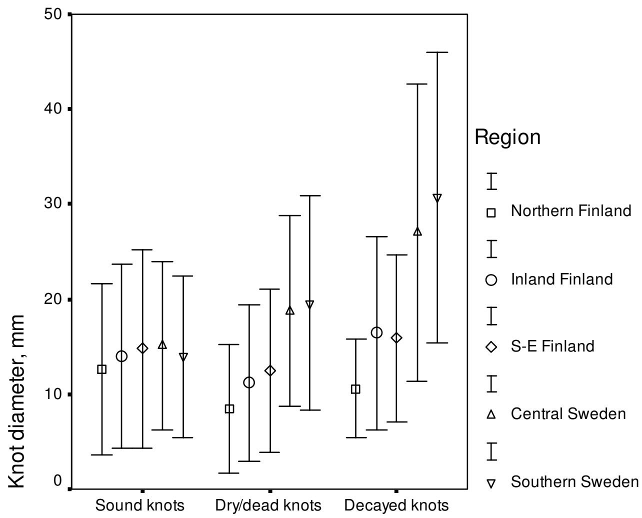

Fig. 4. The average values (markers) and the standard deviations (bars) of knot diameters by knot type and by region.

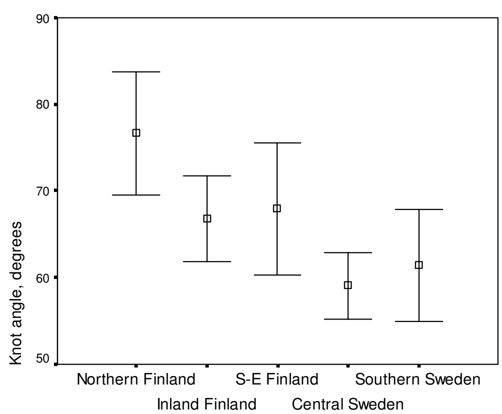

Fig. 5. The average values (markers) and the standard deviations (bars) of knot angles by region (0°=vertical, 90°=horizontal).

Aesthetic properties, wood colour

In addition to the knottiness properties, also the colour of wood has great influence on the overall visual impression of wood. Especially the uniformity of colour plays a great role in interior materials and furniture products, and in finger jointing industry. Besides, the uniform colour with known variation enables better control of surface treatment (painting, varnishing etc.) techniques.

According to the preliminary colour measurements, the average values of lightness (L*), redness (a*) and yellowness (b*) for the boards dried on room temperature and stored in dark were L*=85.4, a*=3.0 and b*=21.8 for heartwood, and L*=86.9, a*=2.6 and b*=19.7 for sapwood, respectively. After the UV-A exposure of 2664 hours the L* value had decreased and the corresponding a* and b* values increased considerably in both heartwood and sapwood. Also the colour difference between heartwood and sapwood had increased substantially. The total colour change during the exposure was ΔE* =27.2 in heartwood and 25.8 in sapwood, respectively (Fig. 6).

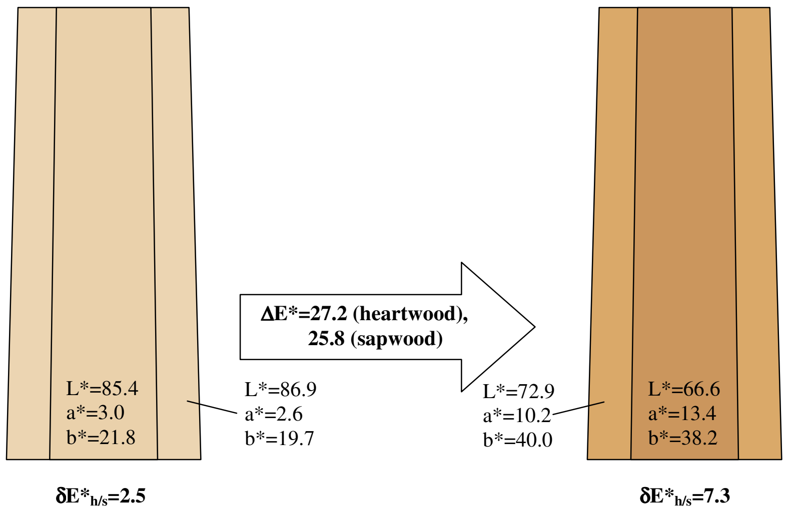

Fig. 6. The average wood colour parameters before and after the 2664 hours exposure of UV-A radiation (peak wavelength 340 nm). L=lightness, a*=redness, b*=yellowness, $\delta E^*_{h/s}$=colour difference between heartwood and sapwood, ΔE^*=total colour change during the exposure.*

Discussion

The calculated timber assortment distributions mainly agree with the results from earlier research. On the volumetric basis, the relative magnitude of small-sized logs, especially in the north, is clear, but its significance becomes even more relevant on the theoretical stumpage price basis. It is a bit surprising that relatively large proportion of trees is affected by some kind of visible stem defects reducing the saw log recovery, and simultaneously increasing the proportion of reject wood (jump butts, offcuts), or the proportion of pulpwood. Thus, in order to better study the effect of defects on the recovery of saw timber, more simulations are needed. In this study, the definitions used for each defect were quite strict, and in commercial logging the relative proportion of reject wood caused by defects might be smaller than the theoretical proportion simulated here. Concerning the southern part of Finland, the obtained saw timber percentages match with earlier observations (Mehtätalo 2002).

Northern Finland differs distinctly from other regions in the whorl interval distributions. Between other regions, the differences are not so evident, since one region may belong to different subsets in different boards. According to this, the raw material potential, for example in billet production or finger jointing industries, is the best in some of the southern regions depending on the board (distance from the pith). If the whorl intervals were measured from longer specimens, the situation could be different – the length of the board would not affect the proportion of whorl-free boards, and the true distribution of whorl intervals could be better observed. An advantage of the wood from Northern Finland is the relatively small diameter of dry/dead and decayed knots, compared to the other regions. The decrease in knot angle from the north to the south might have some influence on the quality class distributions of the sawn timber, especially if the increased number of knots were not noticed.

According to the preliminary and only trend-setting results of the colour measurements, the colour difference between room temperature dried and dark-stored heartwood and sapwood is minimal, and the heartwood-sapwood boundary might be impossible to differentiate visually. Under the exposure of UV-A radiation, the colour difference starts to increase immediately, and with the used experimental arrangements after approx. 2600 hours the colour differences and individual colour parameters did not change any more. To better examine the wood colour variations and to study the colour change in UV-A radiation, a more accurate experiment under controlled environmental conditions is in progress.

Acknowledgements

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