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Scots Pine Forest Management Case Study 5:

Growing high quality timber, Lannevesi at Saarijärvi, Finland

HIGHLAND BIRCHWOODS Coille Beithe na Gàidhealtachd
skog+landskap
METLA
SKOGSSTYRELSEN
NORTH KARELIA POLYTECHNIC
Forest Research An agency of the Forestry Commission

Forest management recommendations in Finland

In Finland, silvicultural treatments are usually based on forest management practice recommendations, published by the Forestry Development Centre Tapio[1]. These recommendations, which have been prepared in collaboration with researchers and representatives of forestry organisations, aim to promote silviculture and forest use. The annual growth of Finland's forests has risen from 55 million m? to 95 million m? in the space of 50 years.

The recommendations are based on the economically, ecologically and socially sustainable management and use of the forests. Forest treatment regimes are planned at the stand level. A stand is defined as a contiguous part of a forest in terms of site type, treatment or the growing stock's stage of development. Other factors to be considered when determining stand boundaries include forest regeneration, forest biodiversity, landscape values, and multiple-use needs. Valuable habitats are marked out according to their natural boundaries.

At the time of felling the recommended practice is to set aside specific "retention" trees. Groups of such trees are left standing on regeneration sites, on average 5–10 live trees per hectare. The retention trees are left standing, to eventually die and produce coarse decaying debris. Regardless of species, old and dead trees are important for maintaining biodiversity.

Regeneration maturity is determined primarily by the growing stock's mean diameter. Stem size development is the result of accumulated temperature, site type, tree species, number of thinnings and type of thinning. A stand is considered to be economically mature once its annual relative yield falls permanently below the target level set by the forest owner.

Increment models are based on the principle that the majority of the growing stock in a stand that has reached regeneration maturity is composed of sawtimber. If a stand fails to reach the minimum limit set for regeneration maturity, e.g. due to its treatment history, such a stand can be regenerated on the basis of its age alone. The aim is to establish a new generation of trees on the regeneration site as soon as possible, and for these trees to be composed of one or more species that are well suited to the site conditions and will gwo well.

The general practice is to prepare the soil to promote forest regeneration: various mounding or scarification techniques are employed. Soil preparation increases the chances of successful regeneration, it improves the soil's permeability to water and its porosity. The preparation method employed depends on the soil type, regeneration method, and the need to drain excess water from the site.

Scots pine is regenerated mainly by seeding (Table 1). The resultant young stands require 4,000–5,000 seedlings per hectare to ensure the growth of high-quality saw timber. Cleaning the seedling stands is generally necessary in Scots pine when a height of 1–2 metres is reached. The actual timing of a young stand's tending treatment and the density of the stand depend on the objectives set for the forest. The basic model prescribes that young pine stands, on reaching a top height of 5–7 metres, should be thinned to 1,800–2,000 trees per hectare.

[1] Finnish Forest Management Practice Recommendations, http://www.tapio.fi/finnish_forest_management_practice_recom

Thinning treatments improve the quality of the timber, speed up diameter growth and produce revenue for the forest owner. The thinning models use the stage of development of the stand (top height, in metres) and the stand density (basal area, m?/ha) to indicate the need for thinning and the amount of growing stock to be retained. The number of thinnings varies from one to three depending on the growing stock, site type, thinning intensity, and the forest owner's economic objectives.

The volume of the growing stock is reduced to the level indicated by the thinning model that is selected. Trees characterised by poor quality, defects, a secondary position, or trees hindering the growth of dominant trees, are removed in thinnings. When following the models, the temporary loss in growth and risk of storm damage remain within reasonable limits.

The stemwood removed when tending young stands, which may not be suitable for industrial wood markets, is well suited to energy generation. The logging residues and stumps left on the site following final cutting may also be made use of. Energy-wood harvesting is appropriate in those young stands where tending has been inadequate and where there is relatively little wood that meets industrial wood criteria. The harvesting of energy wood improves the profitability of the first thinning of industrial wood. Energy-wood harvesting is part of the tending chain when the objective is the production of high-quality pine.

Pruning is a means of increasing the proportion of clearwood in the butt log and of increasing the stand's economic yield. Pruning is appropriate only when dealing with healthy stands with at least medium timber quality.

***Table 1:** Silvicultural regimes for Central Finland[2].*

Alternative	Site fertility and regeneration method	Density and treatment of seedlings	Thinning	Quality and limit for regeneration
Basic model	Medium fertility: planting Rather poor or poor fertility: seeding	4,000–5,000 seedlings/ha (planting 2,000 seedlings/ha) Cleaning of seedlings Tending treatment at top height of 5-7 meters, goal density 1800-2000 trees/ha	First thinning from below or thinning for quality at dominant height of 13-15 m, goal density 900-1,000 trees/ha Second thinning from below Third thinning (if needed) from below or from above	Average quality, rather large pulpwood from first thinning Minimum average diameter at breast height 23 cm
Growing of quality	Rather poor fertility: seeding or natural regeneration.	4,000–5,000 seedlings/ha (planting 2,000 seedlings/ha) Cleaning of seedlings Tending treatment at top height of 5-7 meters, goal density 1800-2000 trees/ha	Pruning, if needed First thinning from below or thinning for quality at dominant height of 11-13 m, goal density 1,000-1,200 trees/ha Second thinning from below Third thinning from below or from above	Good quality, large saw logs Minimum average diameter at breast height 27 cm
	Poor fertility: seeding or natural regeneration	4,000–5,000 seedlings/ha Tending treatment and cleaning of seedlings at top height of 5-7 meters	First thinning from below or thinning for quality at dominant height of 11-13 m, goal density 1,000-1,200 trees/ha Second thinning from below Third thinning from below or from above	Good quality, large sawlogs Minimum average diameter at breast height 25 cm
Intensive growing	As in basic model	As in basic model	Pruning First thinning for quality at dominant height of 10-12 m, goal density 700 trees/ha Second thinning from below	Branchless large sawlogs

[2]Hyvän metsänhoidon suositukset (in finnish):
http://www.metsavastaa.net/files/metsavastaa/pdf/15FHyvan205Fmetsanhoidon5Fsuositukset2Epdf.pdf

Sample Plots at Lannevesi

In the EU funded project "Laatupuu" (Figure 2), which was conducted by the Regional Forest Centre of Central Finland and the Finnish Forest Research Institute, the aim was to activate forest owners towards silvicutural management and promote methods to produce high quality timber. The project activities included the establishment of demonstration sample plots in the Saarijärvi-Viitasaari region at central Finland. Most of the sample plots were located in first thinning stands to demonstrate different management options.

Figure 2: The logo of Laatupuu –project.

The sample plot area at Lannevesi is a privately owned forest that was regenerated by direct seeding. At the beginning of the experiment in 2007 the age of the stand was 32 years. Four experimental sample plots were established to represent four different silvicultural regimes, according to Finnish Forest Management Practice Recommendations (Table 2 and 3, Figures 3 to 6);

1) **Thinning from below**
2) **Thinning form below and high pruning**
3) **Thinning for quality**
4) **Intensive growing**

All trees in the sample plots were measured for dbh, length, taper and lower limit of living crown. In addition, the occurrence of technical defects was recorded and vertical zones for external quality, from the viewpoint of potential for saw timber or other valuable products, were identified.

Table 2: *Stand characteristics after first thinning for the sample plots.*

	Sample plot			
	1	2	3	4
Number of (stems/ha)	810	1250	1030	590
Dominant height (m)	14.7	12.1	14.1	13.7
Average diameter at breast height (cm)	16.0	11.8	13.6	14.0
Basal area per hectare (m2/ha)	14.6	12.3	13.4	8.5
Volume per hectare (m3/ha)	103	71	90	56

***Table 3:** Silvicultural regimes for the sample plots*

	Sample plot			
	1	**2**	**3**	**4**
First thinning	810 stems/ha	1250 stems/ha	1030 stems/ha	590 stems/ha
High pruning	no	yes	no	yes
Time of second thinning	50 years	50 years, thinning for quality	55 years, thinning for quality	60 years, 400 stems/ha
Time of third thinning		70 years, thinning from below	75 years, thinning from below	
Fertilizing		160 kg N/ha at the age of 60 and 75 years		160 kg N/ha at the age of 40, 50, 65 and 75 years
Clear felling options	75, 80, 85 or 90 years	80, 85, 90 or 95 years	85, 90, 95 or 100 years	80, 85, 90 or 95 years

The MOTTI stand simulator[3] was used to estimate the development of the growing stock and to determine the individual trees cut at each cutting stage in a stand for each silvicultural regime. The simulator provides the output for growth and yield of the stand as averages and sums during given periods of the rotation, and removals from cuttings. The effects of different interventions, such as thinning, fertilisation, pruning and length of rotation, were included in the analysis.

Figure 3: Example of output from the MOTTI simulator in a stand of Scots pine. The red line indicates the development of basal area.

[3] MOTTI stand simulator: http://www.metla.fi/metinfo/motti/index-en.htm

Figure 4: Sample plot 1 after first thinning from below.

Figure 5: Sample plot 2 after first thinning from below and high pruning (only selected trees).

Figure 6: Sample plot 3 after first thinning for quality.

Figure 7: Sample plot 4 after first thinning.

Results of simulation

Total timber recovery (Figure 8) was greatest from silvicultural regime 2, thinning from below with high pruning and two applications of fertiliser. The greatest value recovery (Figure 9), however, was achieved from silvicultural option 4, intensive growing, which featured a heavier first thinning, high pruning and four applications of fertiliser. The increased net present value for this option was largely due to the high yield of valuable Grade A butt logs.

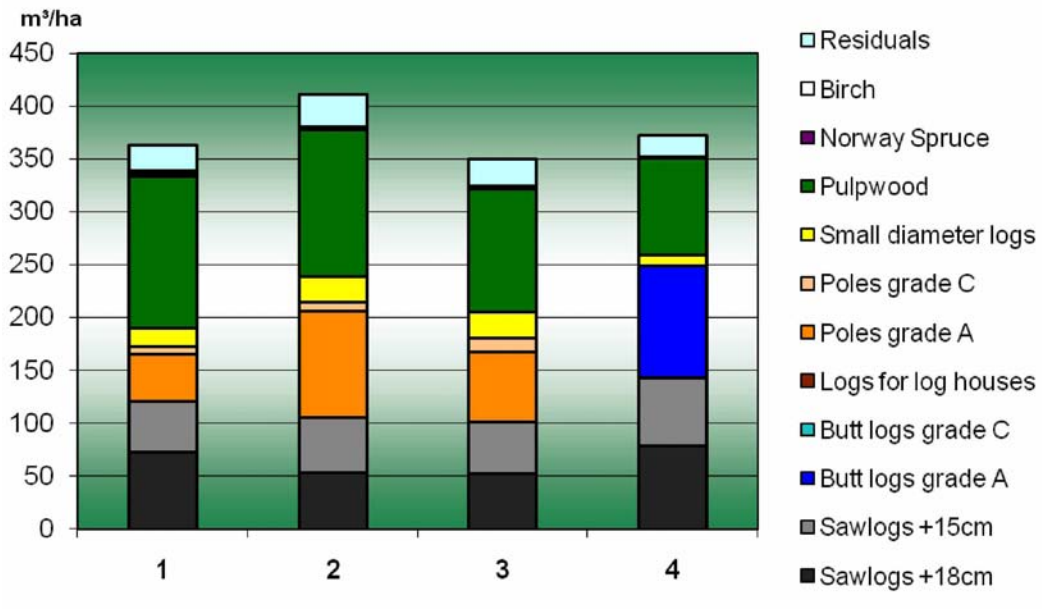

Figure 8: Timber recovery over one rotation period for different silvicultural regimes

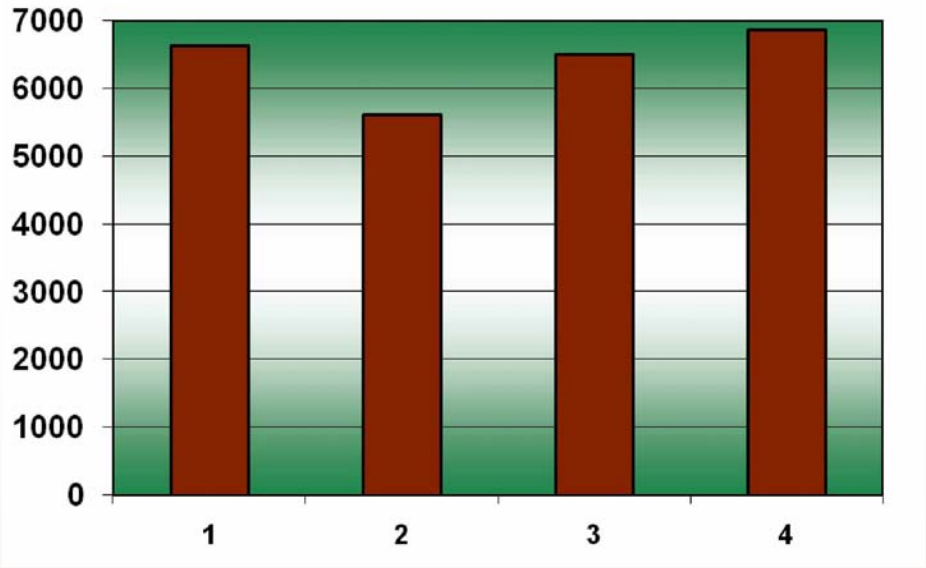

Figure 9: Net present value with 3% interest rate for different silvicultural regimes

Contact information

Dr. Jukka Malinen
Finnish Forest Research Institute, P.O. Box 68, FI-80101 JOENSUU, FINLAND
e-mail: **Jukka.Malinen@metla.fi**