FOREST MANAGEMENT GUIDELINES AND PRACTICES IN FINLAND, SWEDEN AND NORWAY

Tiia Yrjölä

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FOREWORD

According to the recent UN-ECE/FAO Forest Resources Assessment, forest and other wooded land cover altogether some 216 million hectares in Europe (UN-ECE/FAO 2000). The area that is available for wood supply has been estimated at 149 million hectares. In contrast to tropical regions, the area of forest in Europe is expanding, as a result of abandonment of agricultural lands and incentives provided by recent international commitments to reduce net emissions of greenhouse gases through afforestation and reforestation activities exceeding deforestation. The ownership pattern is also changing, in particular in countries whose economies have been in transition towards a market economy.

Forests in Europe can be classified as semi-natural with regard to their "naturalness", as only relatively small areas can be classified as either undisturbed by man or as plantations. Therefore, it is fair to say that forests in Europe are mostly managed. However, the management objectives and intensity vary. There is a continuously increasing trend towards managing forests as ecosystems, taking into account both the economic benefits and environmental values. In sustainable forest management, various pressures and demands, both environmental and societal, need to be considered (e.g. climate change, air impurities, land use changes, protection, biodiversity, certification, timber production and water resources). How energy will be produced in the future will become an increasingly important question, and in this respect forestry can also play an important role in providing renewable material for energy production.

This report belongs to a series of reports on forest management guidelines and practices in various European countries. These reports provide valuable information about the country specific characteristics, and such information can be utilised, for example, when trying to assess future development of forest resources under various forest management scenarios. One tool that is extensively developed and used at the European Forest Institute for such analysis is the European Forest Information Scenario Model EFISCEN (Pussinen et al. 2001). These reports have been initiated to provide a sound basis for defining the current, so-called baseline management scenarios in the EFISCEN, as well as for modifying these baseline scenarios for various purposes. Individual country reports, each by their own author, are being grouped and will be published as separate Internal Reports. This is the first such report covering Finland, Sweden and Norway.

I would like to thank the authors of the country reports for their contribution on comprehensive library of forest management guidelines and practices in Europe.

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1. FINLAND

1.1 INTRODUCTION TO FINNISH FORESTS

1.1.1 Forestry area

Finland is situated in northern Europe and reaches from the Baltic Sea to above the Arctic Circle. Therefore, the climate varies greatly from south to north. The average summer temperature in the southern Finland is 15.6 ºC and the winter average is –8.9 ºC. In northern Finland the temperature can drop to below –30 ºC (FAO 2002). The climate is semi-maritime in the whole country (Kuusipalo 1996). The average altitude is only 120–180 metres above sea level and there are 60 000 lakes scattered throughout the country. Ecological zones include hemi boreal, south boreal, mid boreal and north boreal. About three-quarters of the total land area is covered by forests (Table 1.1). Forestry land is divided into forestland (volume increment 1.0 m^3/ha/yr or more), scrub land (volume increment more than 0.1 m^3/ha/yr but less than 1.0 m^3/ha/yr), waste land (volume increment less than 0.1 m^3/ha/yr) and roads. However, forestland and most of the scrub land internationally defined (10% canopy cover) enter into forestland. Site is classified as mire if the coverage of peat forming plants is more than 75%. Minimum thickness of peat is not required. In the whole country 53.4% of mires has been drained: 76.7% in southern Finland and 40.2% in northern Finland (Finnish Forest Research… 2000) Soil is more fertile in the south than in the north (Table 1.2).

Table 1.1. Forestry land area per regions 1987–1999. Forestry land can be divided either by productivity[1] (forestland, scrub land, waste land and roads, depots etch.) or by soil type[2] (mineral soil sites and mires).

1 000 ha

Land use	Northern Finland	Southern Finland	Whole Finland
Total land area	14 992	15 466	30 459
Forestry land	14 219	12 006	26 225
• Forestland[1]	8 962	11 065	20 027
Scrub land[1]	2 427	490	2 916
Waste land[1]	2 761	362	3 123
Roads, depots[1]	69	90	158
• Mineral soil sites[2]	8 407	8 708	17 115
Mires[2]	5 744	3 208	8 952

Source: The national forest inventory (Finnish Forest Research Institute 2000).

Table 1.2. Mineral soils by Finnish soil site classification 1977–1984. OMT is the most fertile site.

% of area

	Site classes						
	Grass herb type	OMT	MT	VT	CT	CIT	Rocks and sands
Southern Finland	1.4	23.0	45.1	25.6	2.6	0.1	2.2
Northern Finland	0.2	2.3	40.0	47.5	9.0	0.3	0.7
Whole Finland	0.9	14.2	42.9	34.9	5.3	0.2	1.6

Source: The national forest inventory (Kuusipalo 1996).

1.1.2 Forest structure

Pine (*Pinus sylvestris*) and spruce (*Picea abies*) dominate Finnish forests (Table 1.3). Some 46.5% of the growing stock is pine, 35.1% spruce and 18.3% deciduous trees – mostly silver birch (*Betula pendula*) and downy birch (*Betula pubescens*). The proportion of pine is still increasing. Forests are also quite pure, in the whole country 43.4% of forestland area has more than 95-percentage dominance of one tree species. In southern Finland the figure is 39.9% and in the northern part of the country it is 47.7%. The forests are quite young: almost 70% of the forests are under 80 years old (Table 1.4). Old-growth forests (more than 141 years old) are only found in northern Finland (Finnish Forest Research… 2000). Forests are also to a very large extent even-aged due to the management practices.

Table 1.3. Tree-species dominance on forestland area 1987–1999. To form 100% of forestland there should be included treeless area and other trees – category. There is about 1.5% treeless forestland.

% of forestland

	Dominant tree species of forest stand			
	Pine	**Spruce**	**Birch**	**Other deciduous**
Southern Finland	56.9	31.6	8.6	1.1
Northern Finland	74.8	15.6	8.0	0.2
Whole Finland	64.9	24.4	8.3	0.6

Source: The national forest inventory (Finnish Forest Research Institute 2000).

Table 1.4. Age structure of stands 1987–1999.

% of forestland

	Age class (yr)								
	treeless	**–20**	**21–40**	**41–60**	**61–80**	**81–100**	**101–120**	**121–140**	**141+**
Southern Finland	1.6	17.6	21.2	16.2	16.6	14.0	7.8	3.2	1.7
Northern Finland	1.4	13.1	14.1	17.5	15.4	8.5	5.8	5.7	18.5
Whole Finland	1.5	15.6	18.0	16.8	16.1	11.6	6.9	4.3	9.2

Source: The national forest inventory (Finnish Forest Research Institute 2000).

1.1.3 Growing stock, increment and drain

Growing stock is 1959.6 million m^3 o.b (Table 1.5). The annual increment of the growing stock has been bigger than drain since the 1970s, in the 7^{th} (1977–1984) and 8^{th} (1986–1994) national forest inventories. The annual increment is 78.3 million m^3 o.b. per year (1986–1998), and the growing stock drain was 69.4 million m^3 o.b. per year in 1999 (Finnish Forest Research… 2000).

Table 1.5. Growing stock volumes by tree species on forestry land area 1987–1999 and mean growing stock volume by dominant tree species on forestland 1987–1999. Annual increment by tree species 1982–1998 and growing stock drain in 1999. Growing stock drain includes fellings, silvicultural measures and natural mortality. Other deciduous trees in growing stock column include birch. Volumes expressed as a stemwood overbark, excluding stump.

		Growing stock (*million m^3 o.b.)*	**Mean growing stock** (*m^3/ha)*	**Annual increment** (*million m^3/yr)*	**Growing stock drain** *(million m^3/yr)*
Southern Finland	Pine	556.4	101	22.5	18.5
	Spruce	559.4	172	23.3	26.7
	Birch	194.8	99	9.5	.
	Other deciduous	55.5	139	3.8	10.3
	Total	1 366.1	122	59.1	55.5
Northern Finland	Pine	355.6	58	11.6	8.5
	Spruce	129.2	88	3.4	2.5
	Birch	98.0	60	3.9	.
	Other deciduous	10.5	89	0.5	2.9
	Total	593.4	62	19.2	13.9
Whole Finland	Pine	912.1	79	34.0	27.0
	Spruce	688.6	148	26.7	29.1
	Birch	292.8	82	13.4	.
	Other deciduous	66.0	133	4.3	13.2
	Total	1 959.6	95	78.3	69.4

Source: The national forest inventory (Finnish Forest Research Institute 2000).

1.1.4 Share of forest sector of the GDP

In 1997 the value of the forest sector (value added gross at basic prices + taxes on production – subsidies on production) was 7183 million € (7.7% of the GDP). The proportion of forestry of the GDP was 2.5%, the proportion of wood-products industry 1.4% and the proportion of pulp and paper industry 3.8% (Finnish Forest Research… 2000).

1.1.5 Employment

The forest sector employs 95 000 persons (1999), which is 4.1% of the national total. The number employed in forestry is 23 000, and the number employed in the forest industries is 72 000. The forest sector's unemployment rate (1999) was 8.1% (8000 persons), 1.9% lower than average unemployment rate (Finnish Forest Research… 2000). The National forest programme predicts that the number of employees will drop in the future. If the prediction is correct, the number will drop to 80 000 by 2010, but this will still be 10 000–15 000 more than if the programme is not implemented (Maa- ja metsätalousministeriö 1999).

1.1.6 Current EFISCEN data structure

Finland is divided into 2 areas, northern (1) and southern (2) Finland, which correspond to national forest inventory areas and area distribution used in this report (Figure 1.1). Forest owners are not divided. Mineral soils have four site classes from fertile to poor site class, according to the Finnish site classification (Kuusipalo 1996). Site class 1 is grass herb forest, site class 2 *Myrtillus* or *Hylocomium-Myrtillus* type, site class 3 *Vaccinium* or *Empetrum-Myrtillus* type and site class 4 *Calluna* or *Cladina* type. Peat soils are classified similarly from

fertile to poor (site classes 1–4 equivalent to mineral soil types). The correspondence of mineral and peat soil types is found in Laine and Vasander (1998). Besides pine (1), spruce (2) and birch (3), there is a fourth class of trees, other deciduous trees (4) (Schelhaas et al. 1999).

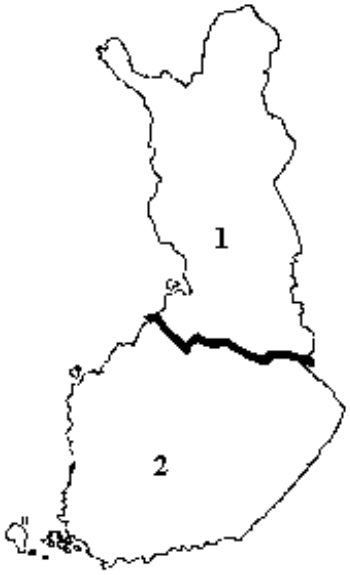

Figure 1.1. Regions by EFISCEN data structure. 1 is northern Finland and 2 southern Finland.

1.2 MAIN GOALS OF FOREST MANAGEMENT

1.2.1 General

According to OECD/Eurostat environmental inquiry (1995) forested land area was estimated to fall into four categories by its main function: (1) 19.3 million ha of forestry; (2) 1.7 million ha of reindeer husbandry; (3) 1.3 million ha of protection; and (4) 0.7 million ha of recreation (Finnish Forest Research… 2000). Finland completed the 1999 National forest programme to guide forest policy during the next decade. One of the main goals is to increase roundwood production. The state subsidies to forest management and protection will increase. The production increase is to be attained without losing ecological sustainability. The preliminary estimate of influence of increased wood production to the environment is assessed to be small in the National forest programme. The degree of influence is dependent on the forest management practices, and not the managed area (Maa- ja metsätalousministeriö 1999).

1.2.2 Protection of biodiversity

Protection areas and guidelines in production forests ensure that biodiversity is protected. Forest management in production forests is controlled by forest law and nature conservation law. Nature conservation law defines nine protected nature types, and forest law defines seven environments of special importance and five other valuable environments. Those areas must be treated with special care (Metsätalouden kehittämiskeskus Tapio 2001). Different protection levels are shown in Table 1.6. Most of the protection areas are situated in northern

Finland: 9.8% of the forested area (forestland and scrub land) is protected in the north and 0.7% in the south. Most of the protection areas are situated on waste land (55.5%) (Finnish Forest Research… 2000).

Some 21.90 million ha of Finnish forests have been certified in the Finnish Forest Certification Scheme (FFCS), which is part of the Pan European Forest Certification (PEFC) –system (FFCS 2002).

Table 1.6. Areas of protected forests. Forested land area includes forestland and scrub land. Total area of protected forests and forests with felling restrictions on forested area is 2 440 000 ha.

	Forestland area		**Forested land area**	
	%	*1 000 ha*	*%*	*1 000 ha*
Strictly protected areas	3.6	714	6.6	1 528
Forests where restricted forest management possible	0.8	170	0.9	211
Forests with felling restrictions	2.1	425	3.0	700

Source: The report of the working group for areas of protected forests (Finnish Forest Research Institute 2000).

1.2.3 Timber and peat production

Other than the protected area, the forest area is in timber production. According to the FAO definition most of the forests are semi-natural (FAO 2002). In Lapland poor growing conditions and reindeer husbandry set restrictions to timber production. According to the National forest programme the main goal in wood production is to increase annual roundwood production to 63–68 million m^3 per year. The Finnish Forest Research Institute has made a calculation with different felling figures. The maximum sustainable roundwood production is 67 million m^3 per year and it increases first to 69 million m^3 per year and then to 74 million m^3 per year by 2030. Even roundwood production of 100 million m^3 per year is possible (maximum potential) for the first ten years, but it would not be sustainable in the long run and would lead to a decrease in annual increment and growing stock (Maa- ja metsätalousministeriö 1999).

In 1999 fuel peat production was 23.5 million m^3 and production of horticultural and bedding peat was 2.4 million m^3 (Finnish Forest Research… 2000).

1.2.4 Carbon sequestration

Finland has agreed to decrease emissions of greenhouse gasses to 1990 levels. In 1990 the carbon net sink was 23.8 Mtonnes CO_2 in Finnish forests and greenhouse gas emissions were 75.3 Mtonnes CO_2 (Maa- ja metsätalousministeriö 2000a). In 1999 emissions were 76.2 Mtonnes CO_2 excluding forestry and land-use change (Ministry of the Environment 2001). Forestry net carbon sink has decreased since 1990 and the National forestry programme (goal: roundwood production 63–68 million m^3/yr) will influence it significantly (Table 1.7).

Table 1.7. Carbon balance in Finnish forests according to annual increment of the growing stock and drain. The estimates of 1996–2005, 2006–2015 and 2016–2025 are annual average.

CO_2 Mtonnes/yr

Year	Sink	Source	Balance
1990	95.9	72.1	23.8
1998	100.1	90.4	9.7
Maximum sustainable wood production			
1996–2005	100.3	98.1	2.2
2006–2015	103.6	101.2	2.4
2016–2025	113.4	103.3	10.1
Wood production: 60 million m^3/yr			
1996–2005	100.4	90.1	10.3
2006–2015	104.4	89.1	15.3
2016–2025	114.6	89.3	25.3
Wood production: 70 million m^3/yr			
1996–2005	99.0	101.9	–2.9
2006–2015	100.1	99.2	1.0
2016–2025	109.2	93.2	16.0

Source: 1990 and 1998 figures from Maa- ja metsätalousministeriö 2000b and future estimates from Maa- ja metsätalousministeriö 2000c.

1.2.5 Non-wood forest products and recreation

Finland like other Nordic countries has public rights of access to both public and private forests. It includes picking berries, mushrooms and herbs from the forests. However, it does not include the collection of all non-wood forest products (NWFPs): all parts of growing trees, lichens and moss are excluded. All forests except areas under the strictest protection are used for picking NWFPs. The annual biological yield of wild berries is 500–1000 million kg (collectable 30%), with lingonberry (*Vaccinium vitis-idaea*), billberry (*Vaccinium myrtillus*), and cloudberry (*Rubus chamaemorus*) being the most popular and economically significant berries (Saastamoinen et al. 1998). However, only 5–10% of the yield is annually picked. Annual market supply of wild berries (1999) is 5.7 million kg. In southern Finland it is 1.4 million kg and in northern Finland it is 4.3 million kg (Finnish Forest Research… 2000). The biological crop of edible mushrooms is 400–2000 million kg and 5–10% is collected (Saastamoinen et al. 1998). Commercial use of mushrooms is much smaller than that of berries; in 1999, 195 000 kg of mushrooms were collected. Almost all gathered lichen is exported. Lichen export was 313 000 kg in 1999 (Finnish Forest Research… 2000).

Two-thirds of the gathered wild berries and mushrooms is recreational picking and for own use. Other forms of forest recreation are, for instance, hiking, cross-country skiing, hunting and orienteering. There are 7950 nature-based recreation sites in Finland (2000). Also timber production area is used for recreation. Land owners have the hunting rights but they are not paid for leasing land. National game licence and local hunting permission is required for hunting. The most important game species is moose; the total bag of moose was 6.3 million kg (1999) (91.5% of the total game bag) with a value of 32 million € (Finnish Forest Research… 2000).

1.2.6 Reindeer husbandry

Reindeer husbandry is an important activity in the northernmost part of Finland. There is also a cultural value as most of the reindeer owners are Sami people. It is also the only form of forest grazing in Finland. In Lapland all forests should be managed in a way that reindeer herding is taken into account. In 1999 the size of the winter herd was 203 000 reindeers and the total reindeer population was 295 000 (Finnish Forest Research… 2000).

1.3 FELLING DATA

1.3.1 Tree species and timber assortments

In 1990 total roundwood production was 48.9 million m^3. The production has steadily risen to 60.9 million m^3 in 1999 (Table 1.8). The proportion of pine was 24.2 million m^3 o.b., the proportion of spruce 26.8 million m^3 o.b. and the proportion of deciduous trees 9.9 million m^3 o.b. Commercial roundwood production in 1999 was 55.3 million m^3. Commercial roundwood includes domestic roundwood delivered to industry excluding small sawmills and export and total roundwood production includes all roundwood also non-commercial (Finnish Forest Research… 2000).

Wood is classed to logs and pulpwood according to size and quality. Pine and spruce logs have a minimum top end diameter of 15 cm, and birch logs have a minimum top end diameter of 16–18 cm. The minimum top end diameter for high quality pine logs is 18 cm. Factors that affect quality include knottiness, heart rot, etc. Spruce pulpwood has a minimum top end diameter of 8 cm, pine pulpwood (or spruce pulpwood) 7 cm, birch pulpwood 6 cm (Metsäkeskus Tapio 1994).

Table 1.8. Total roundwood production in 1999.

million m^3 o.b.

		Southern Finland	Northern Finland	Whole Finland
Logs	Pine	8.4	2.5	10.9
	Spruce	15.1	0.9	16.0
	Deciduous	1.3	<0.1	1.3
Pulpwood	Pine	8.0	4.5	12.6
	Spruce	9.0	1.1	10.0
	Deciduous	4.2	1.3	5.5
Fuelwood	Pine	0.6	0.2	0.8
	Spruce	0.7	0.1	0.8
	Deciduous	2.6	0.5	3.1
Total	All	50.0	11.2	60.9

Source: Finnish Forest Research Institute (Finnish Forest Research Institute 2000).

1.3.2 Felling method

In 2000 25.6% of the of the roundwood production volume came from thinnings and 74.4% from final cuttings in forest industry and Finnish Forest and Park Service land. Forest industry and Finnish Forest and Park Service delivered 85% of the commercial roundwood (Metsäteho 2002). In private forests 65% of the felling revenue came from regeneration fellings in 2001 according to Metsätalouden kehittämiskeskus Tapio (Honkanen 2002). In private forests the average felling volume in regeneration felling areas was 177 m^3/ha and in other felling areas was 41 m^3/ha. Thus volume revenue per average felling area was 400 m^3 of which regeneration felling 250 m^3 and other fellings 140 m^3.

1.3.3 Timber use

Roundwood consumption is given in Table 1.9. Total consumption in 1999 was 73.46 million m^3 o.b. Finland imported more roundwood than it exported (Finnish Forest Research… 2000).

Table 1.9. Domestic and imported roundwood consumption in Finland and roundwood exports in 1999. Total consumption in Finland 73.5 million m^3 o.b.

Million m^3 o.b.

	Domestic roundwood	Imported roundwood	Exported roundwood
Pine	24.3	2.4	0.7
Spruce	27.4	1.5	0.3
Deciduous	10.0	7.0	0.1
Unspecified	-	0.9	-
Total	61.7	11.7	1.0

Source: Finnish Forest Research Institute (Finnish Forest Research Institute 2000).

1.3.4 Industrial timber use

Industrial wood consumption in different branches of industry is in Table 1.10. Total industrial consumption of domestic roundwood in 1999 was 57.11 million m^3 o.b. (Finnish Forest Research… 2000).

Table 1.10. Industrial wood consumption in 1999. Total industrial domestic roundwood consumption was 57.11 million m^3 o.b. and total use of imported roundwood was 11.72 million m^3 o.b.

Million m^3 o.b.

Branch of industry	Wood source	Roundwood			Sawmill chips
		Pine	Spruce	Deciduous	
Wood products industry					
Industrial saw milling	Domestic	11.9	14.5	0.2	-
	Imported	0.7	1.1	0.0	-
Small sawmills	Domestic	1.0	0.8	0.1	-
Plywood and veneer industry	Domestic	0.0	1.6	1.0	-
	Imported	-	0.1	0.4	-
Other board industry	Domestic	0.0	-	-	-
	Imported	-	-	-	-
Other industry		0.3	<0.1	<0.1	-
Pulp industry					
Mechanical pulp	Domestic	-	9.0	0.7	12.4
	Imported	-	0.1	0.3	0.4
Chemical pulp	Domestic	11.3	1.5	5.1	27.0
	Imported	1.7	0.2	6.2	8.9

Source: Finnish Forest Industries Federation and Finnish Forest Research Institute (Finnish Forest Research Institute 2000).

1.3.5 Bioenergy

The fuelwood (roundwood) production for private use in 1999 was 4.66 million m^3. The amount of pine was 0.80 million m^3, of spruce 0.78 million m^3 and of hardwoods 3.07 million m^3 (Table 1.9) (Finnish Forest Research… 2000). Solid fuel consumption is 13–15 million m^3 per year (Maa- ja metsätalousministeriö 1999). In Finland 20.7% of energy is produced with wood. Black liquor and other concentrated liquors produced 11.0%, industrial wood fuels 6.3% and small combustion of wood 3.5% of the total energy consumption in 2000 (Tilastokeskus 2001). The use of forest chips is 0.8 million m^3 per year but there is potential to increase consumption to as much as 10 million m^3 per year. The aim of the National forest programme is to increase use of energy wood by 5 million m^3 (Maa- ja metsätalousministeriö 1999).

1.4 MANAGEMENT

1.4.1 Ownership

The majority of the Finnish forest owners are private owners. Some 62.2% of the private forest holdings are the size of 5–100 ha. In southern Finland private owners own 73.5% of the forested area (forestland and scrub land), companies 12.2% and the state 8.2%. In northern Finland the state owns 54.6% of the forest, but more than half of the area is situated in scrub land. Private owners own 37.1% and companies 4.2%. All together private and company forests are situated on more fertile soil and state owned forest on poor soil and in Lapland. In addition to that a considerable part of state-owned forests is under conservation (Finnish Forest Research… 2000).

1.4.2 Management practices

Management practices do not differ considerably by forest owner. Metsätalouden kehittämiskeskus Tapio provides private owners forest management guidelines, which are based on forest law and certification requirements. Companies and Finnish Forest and Park Service have they own management guidelines but they are quite similar to the guidelines of Metsätalouden kehittämiskeskus Tapio.

Annual felling area has varied in the 1990s from 237 00 ha to 525 000 ha. Approximately 0.6% of the forestry land area has been annually clear felled. In 1999 the total felling area was 525 030 ha (Table 1.11) (Finnish Forest Research… 2000). The mean felling area on private land in 2001 was 4.9 ha in the whole country and of that 1.4 ha was regeneration felling area. In Lapland felling areas were bigger, 10.6 ha and 3.5 ha, respectively (Metsätalouden kehittämiskeskus Tapio 2002). Areas are also bigger on company and state land.

If the roundwood production grows to 63–68 million m^3 per year, as the National forest programme plans, the clear felled area increases from 130 000 ha to 135 000–150 000 ha per year in the first decade and then decreases back to 120 000–130 000 ha per year. The area of first thinnings has been less than 100 000 ha per year in the 1990s. According to the programme the need for first thinnings is annually 250 000 ha until 2010 and after that 200 000 ha. Other thinnings should be increased to 200 000 ha per year (Maa- ja metsätalousministeriö 1999).

Table 1.11. Forest areas managed with fellings in 1999.

ha

	Area
Intermediate fellings and first thinnings	148 674
Other thinnings	143 642
Removal of seed trees and shelterwood trees	52 587
Regeneration fellings and clear fellings	130 419
Seed tree and shelterwood fellings	44 900
Non-forestry fellings	4 808
Total fellings	525 030

Source: Finnish Forest Research Institute (Finnish Forest Research Institute 2000).

According to the National forest programme improvement of young stands has decreased in the 1990s from 250 000 ha to 150 000 ha. It aims to increase it back to 250 000 ha per year. The annual need for ditch cleaning and supplementary ditching is 110 000 ha (Maa- ja metsätalousministeriö 1999). In the 1990s the emphasis on forest drainage turned from first-time drainage to ditch cleaning and supplementary ditching. First-time draining was carried out on 113 400 ha in 1980, and on 41 100 ha in 1990 (Finnish Forest Research… 2000). In 1999 only 3400 ha was first-time drained (Table 1.12).

Table 1.12. Forest management practices other than fellings in 1999. The most popular artificially (seeding and planting) regenerated tree species was pine (55.%). Over 95% of drainage was ditch cleaning and supplementary ditching, 81 400 ha.

ha

	Area
Seeding	36 200
Planting	78 800
Afforested arable land	6 163
Tending of seedling stands and improvement of young stands	210 264
Pruning	3 761
Forest fertilisation	21 519
Forest drainage	84 814

Source: Finnish Forest Research Institute (Finnish Forest Research Institute 2000).

1.4.3 Management guidelines

Precommercial thinnings are based on number of stems at a certain dominant age. Recommendations are shown in Table 1.13 (Metsätalouden kehittämiskeskus Tapio 2001).

Table 1.13. Number of stems after precommercial thinning.

	Pine	**Spruce**	**Silver birch**	**Downy birch**	**Larch**	**Aspen**
Southern Finland						
Dominant height, *m*	5–8	4–5	5–8	5–8	4–7	6–8
Trees after thinning, *stems/ha*	2 000–1 800	1 800	1 600	2 000	1 300	2 000–1 600
Northern Finland						
Dominant height, *m*	4–6	3–6	3–7	5–8	2–5	6–8
Trees after thinning, *stems/ha*	2 500–1 800	2 000–1 800	1 600	2 500–2 000	1 000–900	2 000–1 600

Source: Metsätalouden kehittämiskeskus Tapio 2001.

The first thinning is based on the number of stems. It is recommended in 12–18 m dominant height and not later than in 15–20 m dominant height. The timing of the first thinning depends on the tree species, the site class and the number of stems after tending the seedling stand (Metsätalouden kehittämiskeskus Tapio 2001).

Other thinnings are based on basal area and dominant height of the stand. There are different thinning models for southern Finland and northern Finland, different tree species (pine, spruce, silver birch and downy birch) and site classes (OMT, MT, VT, CT and peat soil). There are three curves in thinning models. When the upper curve is exceeded (basal area in certain dominant height), thinning is recommended. The basal area after thinning should be between the two lower curves (Metsätalouden kehittämiskeskus Tapio 2001). There are 1–3 thinnings, including the first thinning, during the rotation length.

Final cuttings are based on stand age by dominant species or mean diameter, depending on which criteria is exceeded first (Table 1.14) (Metsätalouden kehittämiskeskus Tapio 2001).

Table 1.14. Timing of final cutting. One of the two criteria, mean diameter at breast height or stand age, has to be exceeded.

		Southern Finland		Northern Finland	
Tree species	**Site class**	**mean diameter** (*cm)*	**Age** (*yr)*	**mean diameter** (*cm)*	**Age (***yr)*
Pine	MT	29–31	80–90	26–29	100–140
	VT	27–29	90–100	24–27	110–150
	CT	25–27	110–120	23–25	130–160
Spruce	OMT	28–30	80–90	23–26	100–130
	MT	26–28	90–100	23–26	100–130
Silver birch	OMT	28–30	60–70	23–24	60–70
	MT	26–28	70–80	23–24	60–70
Downy birch	OMT, MT	23–24	60–70	23–24	60–70

Source: Metsätalouden kehittämiskeskus Tapio 2001.

1.5 HARVESTING

1.5.1 Felling

Only the commercial part of trees is harvested. The cut-to-length method is used. Trees are felled, delimbed and cross-cut into logs in the forest. In 2000, 94.5% of the fellings by the forest industries and Finnish Forest and Park Service was mechanised and only 5.5% was motor-manual. Some 96.5% of the final cuttings and 88.6% of thinnings were mechanised. Private entepreneurs harvested 33% of that amount but the volume is not divided into mechanised and motor-manual cutting. All together industry, Finnish Forest and Park Service and private entepreneurs deliver 85% of the commercial roundwood (2000) (Metsäteho 2002). Tapani Honkanen, from Metsätalouden kehittämiskeskus Tapio, estimates that of the total volume felled about 25% is motor-manual and about 75% mechanised (Honkanen 2002).

1.5.2 Haulage

According to Metsäteho (2002) almost all hauling is done with forwarders and only a few percent with farm tractors.

1.5.3 Long distance transportation

Most of the long distance transportation is made by truck. The mean long distance transportation distance in 2000 was 138 km (Table 1.15) (Metsäteho 2002).

Table 1.15. Long distance transportation sequences in 2000, volume, percentage of the total volume and average transportation distance by different sequences. Includes commercial wood transported by the forest industry and Finnish Forest and Park Service.

	Volume *(1 000 m^3)*	**Volume** *(% of total)*	**Average distance (***km)*
Truck	38 381	79.8	101
Rail sequence	7 630	15.9	294
Truck	7 308	15.2	43
Rail	7 630	15.9	251
Floating sequence	1 308	2.7	271
Truck	1 256	2.6	33
Floating	1 308	2.7	238
Barge sequence	747	1.6	225
Truck	633	1.3	30
Barge	747	1.6	195
Total	48 066	100	138

Source: Metsäteho 2002.

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2. SWEDEN

2.1 INTRODUCTION TO SWEDISH FORESTS

2.1.1 Forestry area

Sweden is located on the Scandinavian Peninsula between Norway and Finland. Other than the Kolen Mountains in the northwest, terrain is quite flat. South-central Sweden is hilly lowland with many lakes. In southern Sweden the climate is temperate, and in northern Sweden it is north boreal. Climate has oceanic features and is quite mild considering the latitude. Five-sixths of the forest is classified semi-natural and the rest is undisturbed by man (FAO 2002). Forestland area can be defined in several ways (Table 2.1). In the national forest inventory statistics, forestland is defined according to productivity. The FAO definition is based on area and canopy cover.

Soil sites are classified either by site index class or site productivity class. Soil site index class is based on dominant height at a certain age (H_{100}) and is determined according to a dominant height curve. Swedish site classes are based on productivity (m^3/ha/yr) (Skogsstyrelsen 2000). The soil is more fertile in southern Sweden (Table 2.2).

Table 2.1. Forestry land area. Forestland [1] and Forest and other wooded land [1] are comparable to ECE/FAO definitions: Forestland = area bigger than 5 ha, canopy cover over 10% and other wooded land = area bigger than 0.5 ha, canopy cover 5–10%, minimum 5 m height in maturity. Forestland [2] is the national forest inventory figure (1994–1998), volume increment more than 1 m^3/ha/yr.

1 000 ha

	Northern Norrland	Southern Norrland	Svealand	Götaland	Whole country
Total land area	15 387	8 980	8 033	8 638	41 039
Forestland [1]	-	-	-	-	27 264
Forest and other wooded land [1]	-	-	-	-	30 259
Forestland [2]	6 727	5 651	5 304	4 931	22 163

Sources: [1]TBFRA 2000 (UN-ECE/FAO 2000)
[2]The national forest inventory (Skogsstyrelsen 2000).

Table 2.2 Forestland area by site productivity class (m^3 standing volume over bark from stump to tip) 1994–1998. Site classes indicate mean annual growth per hectare when it culminates.

	Site quality class (m^3/ha/yr), *% of forestland*														Mean site Quality,
	1-	2-	3-	4-	5-	6-	7-	8-	9-	10-	11-	12-	13-	14-	*(m^3/ha/yr)*
N Norrland	13	37	32	14	3	0	0	0	-	-	-	-	-	-	3.0
S Norrland	3	16	29	26	15	6	4	1	0	0	-	0	-	-	4.2
Svealand	2	7	11	10	18	12	16	11	6	4	2	0	0	0	6.2
Götaland	0	2	5	4	10	9	9	11	8	19	13	3	4	2	8.7
Whole Sweden	5	17	21	14	11	6	7	5	3	5	3	1	1	0	5.3

Source: The national forest inventory (Skogsstyrelsen 2000).

2.1.2 Forest structure

Some 4.8% of forest land area is bare land, 26.0% seedling stands or young stands, 35.4% of forests in thinning age, 12.9% older forest not yet mature for final felling and 21.0% of forests mature for final felling (Table 2.3) (Skogsstyrelsen 2000). Forests are mostly even-aged.

Table 2.3 Forestland area by age class 1994–1998.

1 000 ha

	Age class (yr)							
	0–20	**21–40**	**41–60**	**61–80**	**81–100**	**101–120**	**121–140**	**141+**
N Norrland	1 505	1 088	828	805	707	685	658	492
S Norrland	1 539	943	479	549	668	654	487	331
Svealand	1 459	1 170	605	612	589	451	250	168
Götaland	1 153	1 085	786	958	553	277	86	34
Whole Sweden	5 658	4 285	2 699	2 923	2 476	2 067	1 481	1 025

Source: The national forest inventory (Skogsstyrelsen 2000).

Some 44.4% of the growing stock is spruce (*Picea abies*), 38.4% pine (*Pinus sylvestris*), 10.2% birch (*Betula pendula*, *B. pubescens*), 1.4% aspen (*Populus tremula*), 0.9% oak (*Quercus robus*, *Q. petraea*) (in Svealand and in Götaland), 0.5% beech (*Fagus sylvatica*) (only in Götaland), 2.1% other deciduous trees and 2.0% dead or windthrown trees (Skogsstyrelsen 2000). Lodgepole pine (*Pinus contorta*) plantations in the northern part of the Sweden form the largest use of exotics in Scandinavia. Planting started in the 1970s, but has decreased since that time. By 1991 the planted area was over 500 000 ha (Hytönen and Blöndal 1995). In 1994–1998 the growing stock was 6.2 million m^3 o.b. (Skogsstyrelsen 2000).

The proportion of deciduous trees is estimated to increase from less than 16% to 17–18% by 2010 and 18–25% by 2100 according to Forest Impact Analyses 1999 (FIA99) (Gustafsson and Thuresson 2001). There are 11 scenarios for the future in FIA99 and the 25% proportion is likely to be an overestimate. Table 2.4 shows the proportions of coniferous and deciduous (and mixed coniferous) dominance on forestland.

Table 2.4 Forestland area of mono species forests (95% of the basal area is single species or combination of species for instance coniferous) with an average height of 7 meters (1994–1998).

1 000 ha

	N Norrland	**S Norrland**	**Svealand**	***Götaland***	**Whole country**
Coniferous	2 090	1 925	2 206	2 106	8 327
Pine	1 073	649	636	408	2 765
Spruce	225	403	348	669	1 645
Deciduous	66	31	76	273	445

Source: The national forest inventory (Skogsstyrelsen 2000).

2.1.3 Growing stock, increment

According to TBFRA-2000 growing stock was 2 566.5 million m^3 o.b. and net annual increment 85.4 million m^3 o.b. in forests available for wood supply (UN-ECE/FAO 2000). According to the national forest inventory growing stock was 2 773.0 million m^3 o.b., net annual increment 94.6 million m^3 o.b. (Table 2.5). In FIA99 annual gross increment is estimated to increase to 107–109 million m^3 o.b. during 2000–2009, to 113–116 million m^3 o.b. during 2010–2019, and to 110–116 million m^3 o.b. by 2100 (Gustafsson and Thuresson 2001).

Table 2.5. Growing stock, mean growing stock per hectare and mean annual increment on forestland 1994–1998. Growing stock excludes dead or wind thrown trees and increment includes growth on felled trees.

		Growing stock *(million m^3 o.b.)*	**Mean growing stock** *(m^3 o.b./ha)*	**Annual increment** *(million m^3 o.b.)*
N Norrland	Pine	279.1	.	8.1
	Spruce	180.4	.	4.7
	Deciduous	93.7	.	3.6
	Total	553.2	85	16.3
S Norrland	Pine	264.5	.	7.6
	Spruce	335.4	.	9.3
	Deciduous	90.8	.	4.2
	Total	690.7	125	21.4
Svealand	Pine	297.4	.	10.1
	Spruce	303.3	.	11.5
	Deciduous	90.7	.	3.8
	Total	691.4	133	25.3
Götaland	Pine	246.5	.	7.9
	Spruce	436.6	.	17.9
	Deciduous	154.4	.	5.8
	Total	837.5	172	31.5
Whole Sweden	Pine	1 087.6	.	34.1
	Spruce	1 255.7	.	43.3
	Deciduous	429.7	.	17.3
	Total	2 773.0	125	94.6

Source: The national forest inventory (Skogsstyrelsen 2000).

2.1.4 Share of forest sector of the GDP

The processing value of forest industry and forestry was 3.6% of the GDP (68 593 million SEK) (1998). The export value was 13.5% of the total export value and 4.8% of the GDP (91 457 SEK) (Skogsvårdorganisationen 2002 and Statistiska centralbyrån (SCB) 2002).

2.1.5 Employment

The Forest sector directly employed 98 000 persons in 1999. Forestry employed 16 500 persons, of which 7700 were permanent employees, 2500 were temporary employees, and 6300 were employers and unpaid family workers. The wood processing industry employed 38 100 persons, of which 31 000 were permanent employees, 3000 were temporary employees, and 4100 were employers and unpaid family workers. The pulp, paper and paper goods

industry employed 43 500 persons, of which 39 800 were permanent employees and 3700 were temporary employees (Arbetskraftundersökning SCB, Skogsstyrelsen 2000).

2.1.6 Current EFISCEN data structure

Sweden is divided into 5 regions: northwest Sweden (1), northern part of central Sweden (2), southern part of central Sweden (3), southern Sweden (4) and southwest coast and islands (5) (Table 2.6). EFISCEN regions and regions used in this report are combined in Figure 2.1. There are two categories of ownership: private owners (small-scale forestry) and public/industrial owners. Site classes are divided according to soil productivity: poor productivity under 3.5 m^3/ha/yr (1), medium productivity 3.5–7.0 m^3/ha/yr (2) and rich productivity over 7.0 m^3/ha/yr (3). Stands include pine (1), spruce (2), deciduous (3), mixed coniferous (4) and mixed coniferous and deciduous (5) (Schelhaas et al. 1999).

Table 2.6. Regions by EFISCEN data structure: W = the western part of the county and E = the eastern part of the county.

Region	Counties
Region 1	Norbotten (W), Västerbotten (W)
Region 2	Norbotten (E), Västerbotten (E), Jämtland, Dalarna:Särna Idre, Västernorrland
Region 3	Gävleborg, Dalarna, Värmland
Region 4	Uppsala, Västmanland, Stockholms county and city, Örebro, Södermansland, Östergotlands, Skaraborgsland, Älvsborg, Jonnköping, Kronoberg, Kalmar
Region 5	Halland, Skåne, Blekinge, Gotland

Source: Schelhaas et al. 1999 and Skogsstyrelsen 2000.

Figure 2.1. Regions by EFISCEN data structure (bold lines, numbers) and regions used in this report (colours, names).

2.2 MAIN GOALS OF FOREST MANAGEMENT

2.2.1 General

According to the 1994 Forestry Act, Swedish forest policy has two equal goals: protection of environment and timber production (Skogsstyrelsen 2002).

2.2.2 Protection of biodiversity

Biodiversity is protected with protection areas and regulations in timber production area. Most of the protection areas are in the north (Table 2.7). In addition to them there are 230 000 ha (areas >0.5 ha), where nature is taken voluntarily into consideration. There are also smaller areas (habitats of 0.01–0.5 ha), where nature is taken into consideration either voluntarily (3000 ha) or by law (7000 ha) when logged. Forest companies and Skogsvårdstyrelsen defines 0.8% of forestland area as key biotopes defined in law in practical silvicultural inventories. However, in control inventories 4.4% of the forestland area in the north and 2.1% in the south was defined as key habitat (average 3.6%) (Balsiger 1998).

Table 2.7. Protection areas on forestland in 1996. Acquired for protection means forestland area acquired by the Swedish Environmental Protection Agency, but where a legal protection as a nature reserve is not yet decided. After 1996 about 12 000 ha per year is reserved for protection.

1 000 ha

	N Norrland	S Norrland	Svealand	Götaland	Whole Sweden
National parks	23.7	4.6	2.1	6.0	36.3
Nature reserve	382.1	75.0	80.4	15.4	552.9
Forest Service reserve	176.6	13.1	5.0	2.3	197.0
Acquired for protection	28.1	5.1	6.3	6.6	46.1
Total	610.5	97.8	93.8	30.3	832.3
% of forestland	8.4	1.7	1.8	0.6	3.6

Source: Swedish Environmental Protection Agency, Forest Service (Skogsstyrelsen 2000).

Forests of large industry owners are certified with Forest Stewardship Council -certification (FSC). According to the FSC working group, nationwide application of FSC-standards would have led to 13.4% lower wood production (Balsiger 1998). At the end of 2001 10 million ha have been FSC-certified (FSC 2002). Some forests of private forest owners have been certified in the Swedish Forest Certification Scheme, which belongs to the Pan European Forest Certification-system (PEFC). By now 1.67 million ha of forests have been PEFC-certified (PEFC 2002).

In 1995 the standing volume not available for timber production was estimated to be 360 million m^3 (Gustafsson and Thuresson 2001). Preservation of old-aged forests is important for maintaining biodiversity. According to FIA99 the old-aged forests (older than 120 years in Götaland, older than 140 years in the rest of the country) will increase in almost all future scenarios, but the amount of middle-aged forests (60–120 years in Götaland, 80–140 in the rest of the country) will decrease. The proportion of old-aged forestland area is estimated to increase from 5.5% in 2000 to 7.5–10.5% by 2100. The standing timber volume in forests older than 140 years increases from 145 million m^3 in 2000, to 385 million m^3 by 2050, and then to 925 million m^3 by 2100.

2.2.3 Timber production

Most of the forests are timber production forests. Based on the calculated increments in FIA99 the highest sustainable annual harvesting levels have been calculated (Gustafsson and Thuresson 2001). During the period 2000–2009 it is 82–87 million m^3, during 2010–2019 it is 89–98 million m^3 and until 2100 it is 95–104 million m^3. The growing stock is estimated to increase to 3200–3400 million m^3o.b. during the period 2000–2100. The greater part of the increase will take place within the new strictly protected areas and on forestland managed using environmentally adapted methods.

2.2.4 Carbon sequestration

The European Union has agreed to cut down carbon emissions by 8%. Sweden can increase its emissions 4% from the 1990 level (Ministry of Environment 2001). Forests act as a net CO_2 sink, uptake due to the net annual increment exceeded emissions by 45% (1990–1999) (Eurostat 2000). In 2000 uptake by forests was 27.31 Mtonnes CO_2 (Forsgren 2001).

2.2.5 Non-wood forest products and recreation

Multiple-use considerations were taken into account in law in the 1975 Forestry Act. In 1994 they got the same status as timber production goals. There are similar public rights of access to all forests in Sweden as in Finland. All forests are, therefore, used for collecting berries and mushrooms (Saastamoinen 1999). Only living parts of trees, logging waste, lichen and moss are excluded. According to a survey made in 1975–1980, 5–7% of the total 350–450 million kg bilberry (*Vaccinium myrtillus*) and lingonberry (*Vaccinium vitis-idaea*) yield was collected (Skogsstyrelsen 2000). The third important berry is cloudberry (*Rubus chamaemorus*) with an annual yield of 75.7 million kg (1978–1980) (Salo 1995). The edible mushroom yield is estimated to be 40 kg/ha (1974–1977) (Skogsstyrelsen 2000). Swedes collected 13 million kg of mushrooms per year during the survey period (Salo 1995).

Collecting berries and mushrooms is also a form of recreation. In 1977 75.3 million litres of berries and 21.8 million litres of mushrooms were collected for own use. In 1997 the figures were 23.0 million litres and 15.3 million litres, respectively. Other forms of recreation are, for instance, hiking, cross-country skiing, hunting, and orienteering. There are over 320 000 hunters in Sweden. The most important game species is moose and the number of animals shot in hunting season 1998/1999 was 101 930, of which 18 534 were shot in Norra Norrland, 27 473 in Södra Norrland, 30 440 in Svealand and 25 483 in Götaland (Skogsstyrelsen 2000).

2.2.6 Reindeer husbandry

There are about 250 000 reindeers in Sweden. Only the Sami people can herd reindeer in Sweden according to Reindeer Husbandry Act. In the forested area herding is stationary but there are also “mountain Sami”, who have their summer pastures on high mountains and winter pastures on boreal woodland. The reindeer herding range is 137 000 km^2, 35% of the area of Sweden. Forest owners are not allowed to change the land use in a way that makes reindeer breeding impossible (Baer 1996).

2.3 FELLING DATA

2.3.1 Tree species and timber assortments

Gross fellings are estimated in two different ways in Swedish national statistics: by stump enumeration in the national forest inventory (stumps over 5 cm) or calculated by Skogsstyrelsen. Total gross fellings according to the former were 59.6 million m^3 o.b. in 1997–1998 (20.1 million m^3 o.b. pine, 33.0 million m^3 o.b. spruce, 4.9 million m^3 o.b. deciduous trees and 1.6 million m^3 o.b. dead or windthrown trees), and according to the latter total gross fellings were 72.4 million m^3 o.b. in 1999 (Skogsstyrelsen 2000). The five felling season mean annual fellings by stump enumerations (1993/1994–1997/1998) are slightly higher, 63.3 million m^3 o.b. (Table 2.8). During that period 10.9 million m^3 o.b. were annually felled in Northern Norrland, 15.1 million m^3 o.b. in Southern Norrland, 15.7 million m^3 o.b. in Svealand, and 21.5 million m^3 o.b. in Götaland (Skogsstyrelsen 2000).

The proportion of deciduous trees in fellings is estimated to increase from 10% to 20% of the total fellings by the end of the 20th century (Gustafsson and Thuresson 2001). In 1999 the calculated net fellings excluding bark were 58.7 million m^3: coniferous logs 30.3 million m^3, non-coniferous logs 0.5 million m^3, pulpwood 21.5 million m^3, fuelwood of stemwood 5.9 million m^3 and other roundwood 0.5 million m^3 (Skogsstyrelsen 2000).

Table 2.8. Fellings according to stump enumerations, annual average 1993/1994–1997/1998. Includes all land use classes.

million m^3 o.b.

	Gross fellings
Pine	19.3
Spruce	34.8
Deciduous	7.2
Dead and windthrown	2.0
Total	63.3

Source: The national forest inventory (Skogsstyrelsen 2000).

2.3.2 Felling method

About 60% of the gross felling volume (felling season 1997/1998) came from final fellings (Table 2.9) (Skogsstyrelsen 2000). Some 48% of the thinnings are first thinnings (Bäcke 1998).

Table 2.9. Fellings on forestland by felling method according to stump enumerations in 1997/98.

million m^3 o.b.

	Volume
Final felling	35.9
Thinning	17.4
Precommercial thinning	0.3
Other felling	5.3
Total	59.0

Source: The national forest inventory (Skogsstyrelsen 2000).

2.3.3 Industrial timber use

According to the Joint forest sector Questionnaire (2000) production of industrial roundwood in 1999 was 52.8 million m^3 o.b. Exports were 1.3 million m^3 o.b. In addition to that Sweden imported 10.3 million m^3 o.b. roundwood (Zanatta and Mikkola 2001). Table 2.10 shows the industrial consumption of roundwood and by-products according to Skogforsk.

Table 2.10. Industrial consumption of roundwood and by-products in 1995. Includes only enterprises, which have at least 20 workers engaged. In pulp- and papermills by-products are mostly sawmill chips, in the fibreboard industry sawdust is also used, and in the particle board industry most of the wood raw-material is sawdust.

million m^3 u.b.

	Pine	Spruce	Deciduous	Total
Wood-processing industry				
Logs	8 310	11 841	179	20 330
Fibreboard industry				
Pulpwood	11	41	0	52
By-products	.	.	.	268
Particle board industry				
Pulpwood	36	97	9	142
By-products	.	.	.	805
Pulp- and paper industry				
Pulpwood	11 888	11 785	5 774	29 447
By-products	.	.	.	8 085

Source: Statiska centralbyrån (SCB) 2002 and Svenska träskivor (Skogsstyrelsen 2000).

2.3.4 Bioenergy

Some 19% of the total energy supply in Sweden comes from bioenergy and peat (1998). Some 39% of that is black liquor in the pulp industry, 19% is from district heating plants, 13% fuel wood in dwellings, 12% refuse, peat etc., 10% wood fuels in sawmills and 7% wood fuels in pulp- and paper industry. Production of wood fuels (forest fuel, fuel from coppice and recycled wood fuel) is 22 985 GWh and the total production of bioenergy is 92 TWh (1998). The annual consumption of firewood in individual houses in 1990–1998 was annually 4.6 million m^3 piled volume. Additionally 0.2 million m^3 piled volume chips and 31 000 tons pellets were used (Skogsstyrelsen 2000).

2.4 MANAGEMENT

2.4.1 Ownership

Some 51% of the forest land area is owned by private forest owners. It consists of 250 000 holdings and 350 000 owners. Companies own 39% of the forest land, state 3% and other public forest owners 7% (Skogsstyrelsen 2000). There are differences in management practices between forest owners. Companies tend to manage forests more intensively. For instance they thin forests to lower volume and basal area than small-scale forest owners (Bäcke 1998). Felling areas on private land are on average 3 ha and on company and state

land 11 ha (Skogsstyrelsen 1998). Skogsvårdstyrelsen has management guidelines for private owners.

2.4.2 Management practices

Mean annual final fellings, precommercial and commercial thinnings are shown in Table 2.11. Recent (1997/1998) final felling and thinning areas are higher, 203 000 ha and 309 000 ha, respectively. During the same felling season the area of precommercial fellings was 120 000 ha (Skogsstyrelsen 2000). Regeneration felling areas bigger than 0.5 ha have to be reported to the authorities by law. In 1999 the average size of those reported areas was 4.7 ha. The size of the felling area increases to the north (Skogsstyrelsen 1998). Other forest management practices are shown in Table 2.12.

Thinnings are divided into different forms by the quotient of diameter of thinned trees and diameter of trees left. In 1997, 74% of the thinning area was thinned from below (quotient <0.9), in 18% quotient was 0.9–0.99, 6% was crown thinned (quotient 0.99–1.1), and 2% was thinned from above (quotient >1.1) (Bäcke 1998).

In FIA99 calculations of thinning areas in the future can be increased in the short term to 375 000–400 000 ha per year, and in the latter part of the century to 450 000–500 000 ha per year. This is due to the limited precommercial thinning. The regeneration felling area in the future can be between 200 000–270 000 ha per year (Gustafsson and Thuresson 2001).

Table 2.11. Area of annual fellings and thinnings on forestland 1993/1994–1997/1998.

1 000 ha

	Final fellings	Thinnings	Precommercial thinnings
N Norrland	49	39	26
S Norrland	51	48	34
Svealand	50	86	44
Götaland	49	99	36
Whole Sweden	199	271	140

Source: The national forest inventory (Skogsstyrelsen 2000).

Table 2.12. Area of annual planting, pruning, fertilisation and draining. Area for planting is mean annual from years 1996–1998, area for pruning is from 1998 and excludes private forests and area for fertilisation is from 1998. Drained area (1996) does not include protective ditching.

1 000 ha

	Planting [1]	Pruning [1]	Fertilisation [2]	Draining [3]
N Norrland	31.2	.	3.3	.
S Norrland	37.6	.	8.0	.
Svealand	28.8	.	8.0	.
Götaland	35.0	.	0.1	.
Whole Sweden	132.5	0.6	19.3	0.4

Source: [1]Skogsstyrelsen and SCB, [2]Skogsstyrelsen and [3]Skogstyrelsen: naturvårdsverket (Skogsstyrelsen 2000).

2.4.3 Management guidelines

Precommercial thinning should be made at a stand height of 2–4 m for conifers. Table 2.13 shows the recommended number of stems after precommercial thinnings for pine and spruce stands (Skogsvårdsorganisation 2002). If a birch stand has more than 6000 trees at 2–3 m height, it should be thinned to 3000–4000/ha; at 4–5 m height the number of stems after thinning should be 1500–2000/ha; and at 6–7 m height the number of stems after thinning should be 1300–1800/ha. Common alder (*Alnus glutinosa*) should be thinned to 2000–2500/ha at 2–3 m height and then to 1200–1400/ha at 6–7 m height. Aspen (*Populus tremula*) should not be thinned until trees have reached a height of 4–5 m (2500–3500/ha) and at 6–7 m height the stands should be thinned to about 1300–2200/ha (Skogforsk 2002).

Table 2.13. Recommended number of stems after precommercial thinning in different parts of the country and on different sites.

Number of stems

	Poor site	Medium site	Good site
Northern Sweden			
Pine	1 600–1 900	1 900–2 300	2 200–2 700
Spruce	1 500–1 800	1 800–2 200	2 000–2 500
Central Sweden			
Pine	1 900–2 200	2200–2 600	2 600–3 100
Spruce	1 800–2 100	2 000–2 400	2 300–2 800
Southern Sweden			
Pine	2 200–2 500	2 600–3 000	2 900–3 400
Spruce	1 800–2 100	2 100–2 500	2 400–2 900

Source: Skogsstyrelsen 2002.

Timings of the thinnings and final felling are shown in Table 2.14 and intensities in Table 2.15. The recommended intensity of thinnings is 25–30% of the growing stock. No more than 40% of the basal area should be thinned in the first thinning and no more than 35% of the basal area in intermediate thinnings. Thinning intensity depends on site, on wind damage risk and on quality of timber produced. More detailed recommendations for the thinning intensity are given in thinning models, which are based on the basal area and dominant height (Skogforsk 2002). Skogsvårdorganisation has more recommendations about thinnings and fellings in Skogsstyrelsen's books "Grundbok för skogsbrukare", "Gallringsmallar, Norra Sverige" and "Gallringsmallar, Södra Sverige" and Skogforsk webpages. Management recommendations of forest companies are similar to Skogsstyrelsen's (Stora Enso 2002a and 2002b).

Table 2.14. Recommended timing of thinnings on different sites and number of thinnings during the rotation length.

	Poor site	Medium site	Good site
First thinning *(stand age)*	50	40	25
Last thinning at latest *(stand age)*	90	75	65
Final felling *(stand age)*	120	100	80
Number of thinnings	1–2	2–3	3+

Source: Skogforsk 2002.

Table 2.15. Different intensities of thinnings. The recommended intensity of thinnings is 25–30% of the growing stock.

Intensity	**Removal** *(% of the basal area)*	***Removal*** *(% of the growing stock)*
Low	20	15–20
Medium	30	25–30
High	40	35–40

Source: Skogforsk 2002.

The actual fulfilment of recommendations was studied in a SUS-project (Skogsstyrelsen 1998). Precommercial thinning is often low in intensity, the number of stems afterwards exceeds Skogsstyrelsen's recommendations and, therefore, it has to be usually repeated before the first thinning. The amount of deciduous trees after precommercial thinning has increased because of changing attitudes. Thinnings are not made in the recommended time or intensity, especially the first thinnings. Almost half of the thinnings are too intensive, especially in northern Sweden. Partially, this is a result of increased use of harvesters and, therefore, increased area of logging roads. The final felling stand age has decreased after the law change in 1994, which decreased the minimum final felling stand ages by about 25%. The decrease is mostly due to the fellings of younger spruce stands in southern Sweden.

2.5 HARVESTING

2.5.1 Felling

The cut-to-length method is used. Only in 1% of the thinnings are the full- or part tree logging methods used (Bäcke 1998). According to Schwaiger and Zimmer (2001) Sweden is the most mechanised country in tree felling in Europe and only a few per cent of the fellings is motor-manual.

2.5.2 Haulage

Most of the hauling is carried out with forwarders. The proportion of all hauling varies depending on source: according to Schwaiger and Zimmer (2001) everything is hauled by forwarders; according to Berg and Karjalainen (2002) 72% is hauled by forwarders heavier than 10 tons; and according to Bäcke (1998) 93% of thinnings is hauled by forwarders.

2.5.3 Long distance transportation

Floating ended in Sweden 1991 but some shipping still exists (Skogsstyrelsen 2000). Most of the transportation is made by trucks (Table 2.16).

Table 2.16. Long distance transportation volumes, percentages and mean transportation distance by the means of transportation.

	Volume *(1 000 m^3)*	**Volume** *(% of total)*	**Mean distance** (*km)*
Truck	53 805	88	81
Rail	7 337	12	302

Source: Berg and Karjalainen 2002.

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3. NORWAY

3.1 INTRODUCTION TO NORWEGIAN FORESTS

3.1.1 Forestry area

Norway is located in the Scandinavian Peninsula next to Sweden. It has a long coastline which extends from the North Sea into the Arctic Circle. There is a mountainous plateau, which is covered largely with bare rock. Norway has several mountain areas, Kolen Mountains, Dovre Mountains and Long Mountains. There is also a lowland area in the southeast of the country. It has many lakes, valleys and fjords. The climate is maritime, and the ecological zones are largely boreal mountain and boreal coniferous forest, but there are also some polar and temperate oceanic areas. Most of the forests are semi natural (FAO 2002). Norway has 7.4 million ha of productive forestland, which is about one-quarter of the total land area (Table 3.1). Productive forestland, later referred to as forestland, is defined as forest with an annual yield capacity of at least 1 m^3 o.b./ha (Tomter 1999). According to TBFRA-2000 Norway has 12 million ha of forests and other wooded land, and 8.7 million ha of forests (UN-ECE/FAO 2000).

Table 3.1. Area distribution by land use classes. Forestland, mires and other areas are below coniferous forest limit. Counties total includes all Norway except Finnmark, which has never been included in the national forest inventory. Finnmark has 83 ha of productive forestland.

1 000 ha

	Productive forestland	Non-productive forestland	Mire	Other areas	Areas above coniferous forest limit	Total
Region 1: Østfold, Akershus/Oslo, Hedmark	1 908	123	232	685	746	3 694
Region 2: Oppland, Buskerud, Vestfold	1 422	217	153	540	1 909	4 241
Region 3: Telemark, Aust-Agder, Vest-Agder	1 113	339	135	515	1 079	3 181
Region 4: Rogaland, Hordaland, Sogn og Fjordane, Møre og Romsdal	943	272	165	1 144	3 326	5 850
Region 5: Sør-Trøndelag, Nord-Trøndelag	1 019	328	427	586	1 769	4 129
Region 6: Nordland, Troms	997	451	254	835	3 891	6 428
Total	7 402	1 730	1 366	4 305	12 720	27 523

Source: The national forest inventory (Tomter 1999).

In national statistics Norway is divided into six regions excluding Finnmark province. In the following tables the regions are as in Table 3.1. Soil sites are classified by H_{40}-site classes. It is based on top height at the age of 40 years at breast height. Site quality classes on forestland are shown in Table 3.2. Forestland can also be divided by vegetation types. Some 4% of the forestland is lichen forest, 7% bog whortleberry forest, 21% cowberry forest, 32% bilberry forest, 13% small fern forest, 2% tall fern forest, 9% small herb forest, 7% tall forb forest, 2%

deciduous forest, 2% swamp forest, 1% ombrotrophic bog forest and 1% calluna heath (Tomter 1999).

Table 3.2. Forestland by productivity, which is based on top height at the age of 40 years at breast height.

% of forestland

	Site quality class H_{40}							
	6	**8**	**11**	**14**	**17**	**20**	**23**	**26**
Region 1	8	25	25	22	14	5	2	<1
Region 2	12	26	27	18	12	4	1	<1
Region 3	10	29	25	21	10	4	1	<1
Region 4	9	26	28	16	9	7	5	1
Region 5	12	29	27	21	9	2	<1	-
Region 6	21	43	25	9	2	<1	-	-
Total	11	29	26	19	10	4	1	<1

Source: The national forest inventory (Tomter 1999).

3.1.2 Forest structure

Some 59% of the forestland area is bare or under 80 years (Table 3.3). Some 58% of the forestland is either seedling stand without overstorey or one-storey forests (Table 3.4). The dominant species in Norway are spruce (*Picea abies*) and pine (*Pinus sylvestris*) (Table 3.5). The main areas of conifers are in southeast and central Norway. Elsewhere the landscape is dominated by birch (*Betula spp.*) and some patches of conifers. Other important broadleaved trees are aspen (*Populus tremula*) and alder (*Alnus* spp.) (Tomter 1999). There are also 8000 ha of planted foreign species (total 50 species). Sitka spruce (*Picea sitchensis*) has been used to replace birch and pine on the west coast and Lodgepole pine (*Pinus contorta*) has been used in harsh areas instead of native pine (Hytönen and Blöndal 1995).

Table 3.3. Forestland by age classes.

% of forestland

	Age class (yr)							
	0	**1–20**	**21–40**	**41–60**	**61–80**	**81–120**	**121–160**	**>160**
Region 1	4	15	17	17	8	21	16	1
Region 2	4	16	14	14	8	25	18	2
Region 3	4	15	12	11	9	31	15	2
Region 4	11	11	15	14	16	25	8	0
Region 5	2	18	15	10	8	25	20	2
Region 6	4	11	11	15	22	31	5	0
Total	5	15	14	14	11	26	14	1

Source: The national forest inventory (Tomter 1999).

Table 3.4. Forest structure on forestland. Development class 1 is forest under regeneration, class 2 regenerated areas and young forests, class 3 young thinning stands, class 4 advanced thinning stands and class 5 mature forests.

% of forestland

	Development class 1–2				Development class 3–5		
	Coniferous overstorey	Deciduous overstorey	Mixed overstorey	Without overstorey	One-storeyed	Two-storeyed	Multi-storeyed
Region 1	8	1	5	14	42	16	13
Region 2	6	2	7	13	44	10	19
Region 3	4	3	7	12	49	10	15
Region 4	4	8	5	11	49	11	13
Region 5	4	4	7	14	51	11	9
Region 6	1	11	3	7	47	20	11
Total	5	4	6	12	46	13	14

Source: The national forest inventory (Tomter 1999).

Table 3.5. Forestland by dominating tree species.

% of forestland

	Dominance		
	Spruce	Pine	Deciduous
Region 1	45	46	9
Region 2	56	27	17
Region 3	31	47	22
Region 4	17	39	44
Region 5	61	20	19
Region 6	20	8	72
Total	40	33	27

Source: The national forest inventory (Tomter 1999).

3.1.3 Growing stock, increment and drain

Growing stock on forestland according to national statistics is 716.3 million m^3 o.b. and annual increment 21.1 m^3 u.b. (Table 3.6). Some 67% of the total volume of deciduous trees is birch, 8% aspen, 8% grey alder (*Alnus incana*) and 17% other deciduous trees. Annual drain is about half of the increment, 11.5 million m^3 u.b (Table 3.7) (Tomter 1999). TBFRA-2000 figures are growing stock of 671.4 million m^3 o.b., annual increment of 22.0 million m^3 o.b. and annual fellings of 11.6 million m^3 o.b. on the forest area available for wood supply (UN-ECE/FAO 2000).

Table 3.6. Growing stock (over bark) and annual increment (under bark) on the forestland.

Million m^3

	Growing stock				Annual increment			
	Spruce	Pine	Deciduous	Total	Spruce	Pine	Deciduous	Total
Region 1	108.3	75.8	22.6	206.7	3.7	2.1	0.8	6.6
Region 2	93.7	42.4	22.4	158.4	2.8	0.9	0.8	4.5
Region 3	41.3	52.5	27.8	121.6	1.3	1.1	0.8	3.1
Region 4	19.6	36.1	33.1	88.9	1.3	0.8	0.9	3.0
Region 5	56.4	15.7	17.7	89.8	2.5	0.3	0.6	2.4
Region 6	12.0	4.4	34.5	51.0	0.5	0.1	0.8	1.4
Total	331.4	226.7	158.2	716.3	11.1	5.4	4.6	21.1

Source: The national forest inventory (Tomter 1999).

Table 3.7. Removals, felling residues and natural losses and total drain in 1997.

Million m^3 u.b.

	Spruce	Pine	Deciduous	Total
Removals	6.6	1.8	1.0	9.4
Felling residues and natural losses	1.1	0.4	0.6	2.1
Total drain	7.7	2.2	1.6	11.5

Source: The national forest inventory (Tomter 1999).

3.1.4 Share of forest sector of the GDP

The GDP of Norway in 2000 was 1 423 864 million NOK. The values added of different industries at basic values were: forestry and logging 2367 million NOK; wood and wood products 5296 million NOK; and pulp, paper and paper products 7175 million NOK (Statistisk sentralbyrå (SSB) 2002). In 1995 forest sector amounted to 15 600 million NOK (Levende skog… 2002).

3.1.5 Employment

In 2000 forestry and logging employed 5500 people (employees and self-employed), wood and wood products 16 700 people and pulp, paper and paper products 10 000 people (Statistisk sentralbyrå (SSB) 2002). According to Levende skog-project (2002), the forestry and forest industry sector directly employed 30 000 people.

3.1.6 Current EFISCEN data structure

Norway is divided into 17 regions, which correspond to those shown in Table 3.1: Østfold (1), Oslo-Akershus (2), Hedmark (3), Oppland (4), Buskerud (5), Vestfold (6), Telemark (7), Aust-Agder (8), Vest-Agder (9), Rogaland (10), Hordaland (11), Fjordane (12), Romsdal (13), Sør-Trøndelag (14), Nord-Trøndelag (15), Nordland (16) and Troms (17) (Figure 3.1). Ownership is not divided into different categories. Site is qualified by the H_{40}-system. H_{40}-site classes correspond to the production capacities as shown in Table 3.8. Trees species include the following: deciduous (1), pine (2) and spruce (3) (Schelhaas et al. 1999).

Table 3.8. Site classes and their correspondence with productivity.

m^3/ha/yr

	Productivity		
H_{40} site class	**Spruce**	**Pine**	**Deciduous**
23	12	-	8.5
20	9.5	9	6.5
17	7.5	7	5
14	5.5	5	3.5
11	3.5	3.5	2.5
8	2	2	1.5
6	1.2	1.2	-

Source: Schelhaas et al. 1999.

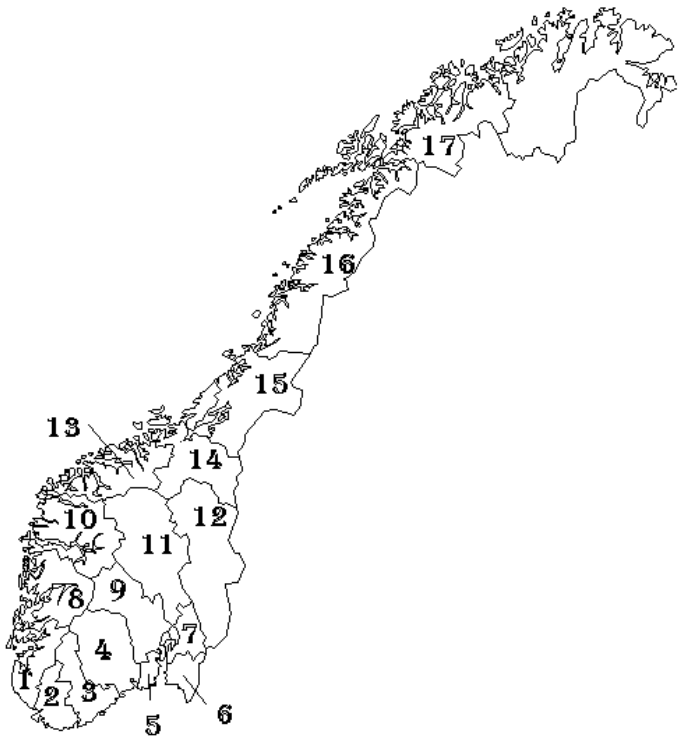

Figure 3.1. Regions by EFISCEN data structure. Region numbers are explained in text.

3.2 MAIN GOALS OF FOREST MANAGEMENT

3.2.1 Protection of biodiversity

The amount of dead trees in forests is important for maintaining biodiversity. There is an average 10.3% of windthrown and dead trees of the total growing stock (Tomter 1999). Less than 5% is old-growth forests (Skogforsk 2002). About 200 000 ha of forested area are strictly protected through national parks and nature reserves (Levende skog… 2002). That is 1.7% of the forested area, and is less than in other Scandinavian countries (Finland 10.7%, Sweden 3.4%) (Skogforsk 2002). About half of that is productive forest land. In 1996 it was decided to expand strictly protected areas with 12 000 ha (Levende skog… 2002). In addition there are 3 million ha of forests with management restrictions. Forest landscape protection areas are about 200 000 ha (Levende skog… 2002). Protection areas on all land use area are shown in Table 3.9.

Some 9.4 million ha of forests have been Pan European Forest Certification certified by May 2002. Most of the area is certified by group certifications (PEFC 2002).

Table 3.9. Protection areas on all land use classes in 2000. Includes fresh water lakes and sometimes sea areas.

ha

	National parks	Nature reserves	Landscape protection areas	Biotope protection areas
Region 1	32 000	53 065	9 683	128
Region 2	230 100	28 828	57 154	464
Region 3	76 700	22 000	307 860	3 807
Region 4	336 080	34 056	258 079	1 583
Region 5	94 490	47 730	52 389	4 793
Region 6	461 120	59 008	81 724	250
Finnmark	156 350	35 098	12 937	-
Total	1 386 840	279 590	779 825	9 325

Source: Directorate for nature management (Statistisk sentralbyrå (SSB) 2002).

3.2.2 Timber production

The Norwegian topography sets restrictions to timber production. Some 25% of the productive forest area is so steep that some form of cable transportation is needed (Hytönen and Blöndal 1995). Some 49% of the forestland has inclination more than 20%, 24% of the forestland has an inclination of 20–32%, 15% of the forestland has an inclination of 33–49%, and 10% of the forestland has an inclination of more than 50% (Tomter 1999).

3.2.3 Carbon sequestration

Norway ratified the Kyoto Protocol in May 2002. In the period of 2008–2012 Norway has committed itself to limit its greenhouse gas emission to a maximum of 1% above 1990 emission levels (Ministry of the Environment, Norway 2002a). In 1990 Norway's greenhouse gas emissions were 52.0 Mtonnes CO_2 equivalents and in 1999 56.2 Mtonnes CO_2 equivalents (Ministry of the Environment, Norway 2002b).

Annual (1999) CO_2 net uptake of forests is 17.7 Mtonnes CO_2 equivalents, which is about 32% of the Norway's total greenhouse gas emissions (the net carbon sequestration in forest). Some 16.4 Mtonnes CO_2 equivalents is annually removed from forests (harvesting and natural loses). Sequestration in forests soil or wood products is not included in the previous figures. Carbon reservoir in buildings, furniture, landfills and other wood products is estimated to be about 60 Mtonnes CO_2 equivalents, and to increase 0.7 Mtonnes CO_2 equivalents per year (Ministry of the Environment, Norway 2002b).

Norway's policy is to maintain and increase CO_2 binding biomass in forests. In recent years the net uptake has been 14–18 Mtonnes CO_2 equivalents, and in the next 10–15 years it is estimated to rise to 18–20 Mtonnes CO_2 equivalents due to the past forest management practices (Ministry of the Environment, Norway 2002b).

3.2.4 Non-wood forest products and recreation

Norway has some limitations to public rights of access when compared with Finland and Sweden. Movement on foot is allowed on *innmark* (fields, grazing areas, yard and garden areas) only when the soil is frozen or under snow cover and not between 30 April and 15 October. *Utmark* (other public outdoor areas) has no limitations for movement or staying overnight. The public rights of access include the right to collect berries, mushrooms and

common herbs (Saastamoinen 1999). The most important berries are bilberry (*Vaccinium myrtillus*) cloudberry (*Rubus chamaemorus*) and lingonberry (*Vaccimium vitis-idaea*) (Salo 1995). There are, however, limitations to cloudberry picking. In the three northernmost counties, where the cloudberry yield is more abundant, cloudberry picking is forbidden on private land and allowed only to local people on public land. Collecting unripe berries is forbidden in the whole country and quantity restrictions may also be applied (Saastamoinen 1999). Norwegians have traditionally used less mushrooms in their diet than Finns or Swedes.

Outdoor activities are an important part of the national identity (Saastamoinen 1999). Some 80% of Norwegians take an interest in outdoor recreation. In earlier times collection of berries and mushrooms were popular forms of recreation, but nowadays the top four activities are short walks, sunbathing, longer country walks and bathing (State of the Environment Norway 2002). About 10% of the men over 16 years hunt. There are total 187 800 hunters in Norway, of which 95% are men (season 2001–2002) (Statistisk sentralbyrå (SSB) 2002). The total number of red deer and moose killed annually are given in Table 3.10.

Table 3.10. Total number of red deer and moose killed in 2001.

Number of animals killed

	Red deer	**Moose**
Region 1	43	9 861
Region 2	332	8 002
Region 3	211	8 324
Region 4	20 947	443
Region 5	2 041	7 220
Region 6	-	2 916
Finnmark	-	534
Total	23 574	37 300

Source: Statistisk sentralbyrå (SSB) 2002.

3.2.5 Reindeer husbandry

The ownership of reindeer is restricted almost exclusively to Sami people but there are a few reindeer companies in southern Norway. In 1990 there were about 220 000 reindeers in Norway (Helle 1995).

3.3 FELLING DATA

3.3.1 Tree species and timber assortments

According to the Statistisk sentralbyrå (SSB) (2002) total commercial roundwood removals in 2000 were 8 million m^3. The proportion of spruce was 71%, the proportion of pine 28% and the proportion of broadleaved 1%. The proportion of fuelwood was 8%. Two-thirds of the removals are cut from regions 1 and 2. FAOSTAT data from 2001 is in Table 3.11.

Table 3.11. Roundwood production in 2001.

1 000 m^3 u.b.

	Logs	Pulpwood	Other industrial roundwood	Wood fuel	Total
Coniferous	4 213	3 397	.	203	7 813
Deciduous	7	46	.	488	541
Total	4 220	3 443	26	691	8 379

Source: FAOSTAT forestry database 2002.

3.3.2 Felling method

Almost 90% of the produced volume comes from final cuttings (Statistisk sentralbyrå (SSB) 2002) (Table 3.12).

Table 3.12. Percentage of timber volume for sale by type of felling in 1999.

% of the volume

	Final cut	Thinning	Other felling
Region 1	81	17	2
Region 2	93	6	1
Region 3	97	2	1
Region 4	93	4	3
Region 5	98	1	1
Region 6 + Finnmark	86	11	3
Total	89	9	2

Source: Statistisk sentralbyrå (SSB) 2002.

3.3.3 Industrial timber use

Industrial timber consumption is shown in Table 3.13.

Table 3.13. Industrial timber consumption in 2000.

m^3

	Spruce	Pine	Deciduous
Sawmills and wood industries			
Special timber and logs	2 868 744	911 240	6 517
Unsorted logs and pulpwood	280 926	51 419	1 871
Other roundwood	136	7 004	-
Mechanical and chemical pulp industries			
Special timber and logs	20 903	1 790	30
Unsorted logs and pulpwood	2 322 229	363 044	20 143
Other roundwood	-	-	-
Fibre and particle board industries			
Special timber and logs	123	-	-
Unsorted logs and pulpwood	4 781	20 933	18 914
Other roundwood	-	-	-
Other Norwegian buyers			
Special timber and logs	17 078	23 855	2 228
Unsorted logs and pulpwood	84 632	33 228	6 019
Other roundwood	3 944	12968	-
Foreign buyers			
Special timber and logs	107 877	50 471	-
Unsorted logs and pulpwood	99 547	129 684	5 509
Other roundwood	-	-	-

Source: Statistisk sentralbyrå (SSB) 2002.

3.3.4 Bioenergy

Total energy production in Norway is 230 TWh, and 12.8 TWh of this (about 6%) comes from bioenergy (1998 and 1999). About 7 TWh are used in households and 6 TWh in industry. Production of bioenergy has increased 400–500 GWh per year in recent years. Use of wood in households has also increased and about 80% of the households have the possibility to use wood for heating (Norsk bioenergiforening 2002). According to Norsk bioenergiforening there is potential for annual use of 34.1 TWh of bioenergy (Table 3.14).

Table 3.14. Use of bioenergy in 1997 and potential in 2020.

TWh

	Use in 1997	Potential in 2020
Forest fuel	12.4	21.0
Garbage and gas from it	1.2	5.0
Straw	0.1	3.6
Energy grass and energy wood	0	3.2
Manure	0.001	1.3
Total	13.7	34.1

Source: Norsk bioenergiforening 2002.

3.4 MANAGEMENT

3.4.1 Ownership

There are about 125 000 forest owners in Norway and the average size of the property is 50 ha. Some 80% of the forestland is owned by private forest owners. State and municipalities own 12%, industry 4% and other private owners 4% (Norges skogeierforbund… 2002). Forestry is, therefore, small-scale management.

3.4.2 Management practices

Clear cutting is the dominant final felling type (Table 3.15). The average size of clear felling area is only 1.5 ha and the sizes of seed tree cuttings and shelterwood cuttings are only slightly larger, 2.1 ha (Statistisk sentralbyrå (SSB) 2002).

Table 3.15. Area of forest management practices in Norway. Data includes properties with at least 2.5 ha productive forestland area. Drainage and fertilisation data is from year 2000 and only comprise work financed with forest trust fund or government subsidies. Other data is from 1999.

ha

	Area
Planting and seeding	26 510
Tending young forest	55 712
Cleared for regeneration	
Completely cleared	33 268
Seed tree method	7 592
Shelter wood method	3 404
Plots smaller than 0.5 ha	5 890
Drainage, new ditches	390
Fertilisation	1700

Source: Statistisk sentralbyrå (SSB) 2002.

3.4.3 Management guidelines

Norway has set up standards for forest management, which are also required for forest certification (Levende Skog 1998). According to the standards spruce forests should be harvested with a “closed stand method” if biological conditions allow. Also very small clear cuts can be used if natural regeneration is possible. Clear cutting and planting/seeding should be used only if natural regeneration is impossible. Also pine stands should be regenerated with clear cuts only if natural regeneration (seed tree method) is impossible or when shifting tree species. Deciduous forests should generally not be replaced with another species and “closed felling system” should be used.

For the mountain spruce forests there is a “mountain forest harvesting system” and pine is regenerated with small clear cuts or small seed tree areas. An average of 5–10 trees per ha should be left standing on felling areas.

3.5 HARVESTING

3.5.1 Felling

According to Schwaiger and Zimmer (2001) almost 70% of the harvesting is mechanised.

3.5.2 Haulage

About 70% of the hauling is done with forwarders, 25% with tractors, and the rest with other means (Schwaiger and Zimmer 2001).

Extraction distances do not differ greatly in different parts of the country although they tend to be a little bit longer in regions 5 and 6. In 24% of the forestland, the extraction distance is 1–199 m, in 27% 200–499 m, in 25% 500–999 m, in 17% 1000–1999 m, and in 7% over 2 km (Tomter 1999).

3.5.3 Long distance transportation

Some 85% of the long distance transportation is done by trucks, 10% by rail and 5% is either floated or shipped (Schwaiger and Zimmer 2001).

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