



## ENVIRONMENTAL EFFECTS OF PUBLIC FORESTRY INCENTIVES IN FINLAND, NORWAY AND SWEDEN

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### ABSTRACT

*Legislation and economic measures constitute a more investment-friendly and less harvesting-friendly forest policy in Norway than in Finland. The Swedish situation is intermediate. Consequently, Norway has had the largest increase in standing volume and has the largest percentage mature forest. The greatest number of measures to enhance biodiversity and amenity directly have been undertaken in Sweden, with detailed regulations and direct subsidies. It is, however, too early to measure any effects on the indicators of environmental effects used in this survey.*

*Keywords: Forest policy, incentives, multiple-use, non-market goods, nonindustrial private forestry.*



### INTRODUCTION

Forests are more than timber. But their beauty, wildlife and ability to fix CO<sub>2</sub> can normally not be bought or sold for money. Markets fail to value and allocate such goods properly. Therefore, some intervention by the state is required.

State intervention has been common for centuries in Finnish, Norwegian and Swedish forestry. The first strong public reactions related to environmental effects in the 1960s criticised the intensive timber production in the Nordic countries. The reactions became more and more visible, and reached a peak at about 1970. In consequence, regulations were made in the Forestry Acts in Norway and Sweden during the decade, and since then there has been an almost continuous debate leading to changes in regulations and other incentives. Swedish authorities have recently implemented a new Forestry Act and drastically reduced subsidies for wood production. In Finland the whole forest policy, with forest taxation, legislation and subsidies, will be thoroughly modified in the near future. The main reason for this is environmental goods, particularly biodiversity, in both countries.

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To what extent have public incentives been effective in taking environmental goods into account?

This paper describes public incentives in Finland, Norway and Sweden during the last 25 years, and tries to connect them to data illustrating the development of forests in these tree countries. A definition of multiple-use values, where environmental goods from the forests are included, is given by Hytönen (1995). The issues of CO<sub>2</sub>-sequestering, biodiversity and recreation/ amenity will be stressed in this paper. Public incentives towards the forest industry, funding of research and all types of education, extension service and public administration will not be considered. I also concentrate on measures regarding "non-industrial" private forest owners.

#### NATURAL AND MAN-MADE CONDITIONS

There are natural differences between the three neighbouring countries. The climate in Norway, except for the south-eastern part, is far more humid and only the core regions in the south-eastern part have such flat forest landscapes as are found in Sweden and Finland. Therefore, the cost of Norwegian wood-production is higher, and one is tempted to believe that more areas are protected by the nature of the terrain. The area of forest land<sup>1</sup> compared with population is highest in Finland with 4.7 ha per inhabitant. The figures in Sweden and Norway are 2.9 and 1.6 ha, respectively. Primary wood production contributes 3.2 % to Gross Domestic Product in Finland, 1.5 % in Sweden and 0.6 % in Norway (SN, 1993; SN, 1993a; CBS, pers.comm.; National Board of Forestry, 1993 and FFRI, 1992).

Also man has created different frames for forestry and forest policy. There are few areas of forest land in Norway which are far from any settlement, compared to what is found in Sweden and Finland. This has historical and nature-related reasons, but is probably also an effect of strong rural development policy in Norway. Therefore, there is more forest land in Finland and Sweden with little infrastructure. On these areas there is less wood production activity, but probably also less consideration of

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<sup>1</sup> Forest land is forest with higher annual growth than 1 m<sup>3</sup>/ha on the average under normal circumstances.

environmental and recreational aspects when wood production is undertaken. In Norway 27% of the population lives in rural districts, while the figures for Sweden and Finland are 17% and 20%, respectively (Nordic Council of Ministers, 1994).

In all three countries farmers and other interest groups in rural districts have had enough impact to limit free trade in forest properties. This has contributed to maintaining small forest properties, and a large part of properties owned by farmers and other “non-industrial” private persons (NIP). Looking at forest properties larger than five ha, Sweden has on average larger forest properties than Finland and Norway, but the differences are quite small (SN, 1992; SN, 1993; National Board of Forestry, 1993 and FFRI, 1992). The shares of forest land owned by different categories are given in Figure 1.

Norway has the largest and Sweden the least proportion of forest area owned by “non-industrial” private forest owners (NIP), and Sweden and especially Finland have relatively more state-owned forests than Norway.

At the beginning of this century all three countries confronted a common challenge. The state of the forests was bad after extensive harvesting and very little silviculture (Barth, 1916; Hultkrantz, pers.comm. and Finnish Forestry Association, 1995), a fact which influenced forest policy for a long period.

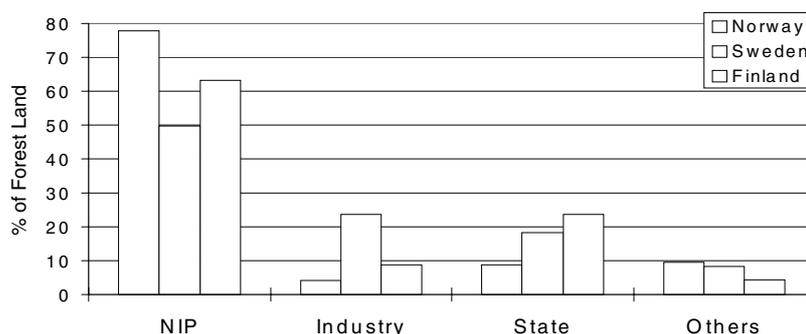


FIGURE 1. SHARE (%) OF FOREST LAND AREA BY FOREST OWNER CATEGORIES

Source: SN, 1992; SN 1993; National Board of Forestry, 1993 and FFRI, 1992.

## FOREST POLICY INCENTIVES

*Extension Service*

At the beginning of this century, Sweden built up an own organisation, "Skogsvårdsorganisationen", to undertake the restoration of Swedish forests. This organisation consists of a central part, the National Board of Forestry, and a part at the county level. The organisation became responsible for implementing a wide range of forest policy issues. At the public administrative level, all knowledge of timber production was concentrated in this organisation. In consequence, "Skogsvårdsorganisationen" was given the responsibility e.g. to issue directions. Also in policy making, "Skogsvårdsorganisationen" has had a great impact (Eckerberg, 1995; Hultkrantz, pers.comm. and Svensson, pers.comm.)

In Finland, a parallel to "Skogsvårdsorganisationen" was built up at the beginning of the century. Its function may be compared to the Swedish system, but it has not got similar impact in policy making. The issuing of directions is undertaken at the ministerial level. Finnish administration is unique in its strong element of corporatism. Forest industry, forest owners and forest workers are represented together with the state in the regional forestry boards (Finnish Forestry Association, 1994 and Palo, pers.comm.).

Also in Norway, a particular organisation to restore forests was built up. However, its administrative tasks were undertaken by the public administration and extension service under the supervision of elected committees from 1932. Until 1976, this committees had a strong element of corporatism. The state level is the Ministry of Agriculture, and there is a county level and also a municipality level.

*Legislation**Forestry Acts*

In Norway the Forest Act has been a framework law. The aim of the Act has been protection of forests, or more precisely; protection of timber production. The Forest Act that parliament passed in 1932 prohibited cutting which did not improve future development of the stand or endangered regeneration. The so-called "Forest Trust Fund" (skog-avgifta), which was introduced in 1930, is in fact a

compulsory investment fund (Eid & Øistad, 1992). The forest owners were obliged to deposit a certain percentage (c.10%) of incomes from harvests with this fund, and could not use them for anything but investments in timber production specified by the authorities. Combined with the new act it became a powerful forest policy measure.

The Forest Act was renewed in 1976 to take proper account of environmental and recreational aspects. However, the main aim is still timber production, and regulations to enhance environmental goods are vague. For example, the content of § 16 in the law is as follows: "Forest owners shall take the environment and recreation reasonably into account under the harvesting operation. If measures against this are planned or done, the Ministry of Agriculture can forbid or limit cuttings on this particular property for a period." (Translated by the author.) This has hardly ever been enforced (Trømborg, 1993 and Tilley, 1994). In addition, § 17b provides detailed regulations in particular areas. It has not been applied to areas other than the forests surrounding Oslo, Oslomarka, and recently also in a small area of 100 ha in Østfold county.

The Swedish Forest Act has been more detailed than the Norwegian, with a far higher frequency of fines and judgements (Trømborg, 1993 and National Board of Forestry, 1995). According to the Forest Act, regeneration, felling of old or scattered forests, and forest plans have been obligatory, and there has been restrictions, for example on selection fellings. The number of fines and judgements indicate that these regulations and obligations have been implemented. In addition, the regulations have been very important as references for the extension service (National Board of Forestry, 1995).

Environmental and recreational aspects became a part of the aim of the law in 1974, and from 1975 forest owners had to submit a notice to the authorities before final fellings. Since then, regulations to take account of environmental issues have grown in number and intensity. In the present Forest Act of 1993 the aim of timber production became less important. Only obligatory regeneration is left. The aims of timber production and environmental/ recreational aspects are now equally important. However, so far there have been few fines and no judgements

concerning environmental aspects (National Board of Forestry, 1995 and Merzell, pers.comm.). Eckerberg (1987) and National Board of Forestry (1995) found that some of the regulations, especially those concerning biodiversity, have not been followed to an acceptable degree. The reason might be vague regulations concerning these aspects until the last act, and "Skogvårdsstyrelsen"'s timber production friendly attitudes (Eckerberg, 1995).

In Finland there are several acts concerning forestry. For our purpose the most interesting is the Private Forestry Act. The principle of this act is that forests shall not be destroyed. "Destroyed" forest is not clearly defined in the act, but it is limited to forests made difficult to regenerate for timber production, e.g. an old diverse forest is not "destroyed" when it is replaced with a uniform plantation. The law obliges forest owners to regenerate after clearfelling and to follow prudent management principles. Implementation has taken place through forest planning, obligations to give notice of final fellings and in the worst cases punishment through fines. There has also been a kind of a compulsory investment fund in Finland. Until 1993, an amount of income from final felling had to be used for regeneration. The amount was estimated in a plan approved by the district forestry board (Palo, pers.comm.). Another important act is the Forest Improvement Act, whose aim is to reserve public grants and loans for investments in forests, like drainage, forest road construction and regeneration of non productive forest land. Since 1987, it is stated that subsidised measures should not "considerably" affect the environment negatively. Drainage operations were then also made subject to special permission from the environment protection authority (Eckerberg, 1995). In 1993 a new State Forest Act introduced measures to take account of environmental and recreational issues (Palo, pers.comm.).

#### *Nature Conservation Legislation*

Nature conservation legislation is quite similar in all three countries regarding criteria and types of conservation areas. In all countries the protection of state-owned land is rather easy. The main difference lies in the ability to expropriate. Property rights are traditionally very strong in Finland and expropriation for nature conservation can only be decided by the Government, which has never done

so to this day (Weissenberg, pers.comm.). Earlier court judgements have shown that expropriation for nature conservation is more difficult in Norway than in Sweden (Lorange Backer, pers.comm.).

### *Economic Incentives*

#### *Forest Taxation*

The Nordic countries are well known for their income distribution policies. The high income tax rate with progressive marginal tax is the basic instrument. Even if there is an expressed aim to have equal strength and type of taxation in all branches of the economy, tax exemptions as an alternative to direct subsidies occur.

Norway has had a so-called "direct taxation" principle in timber production since 1954. Net value of harvest became the basis for taxation. At the same time forest owners were given the right to subtract the value of silvicultural investments from revenues from timber sales. Later, investments in roads also were made deductible. Value increment in forests will not be taxed directly, in contrast to what is the case for other industries. It has been demonstrated in various studies (e.g. Eid, 1964 and 1981) that internal rate of return before tax is equal to internal rate of return after tax for investments in timber production when the marginal tax rate is constant. This applies both to the prolongation of rotation period, afforestation, and forest road construction, and can be viewed as a strong subsidy for wood production.

For forest owners with small properties it is not rational to carry out final fellings every year, which constitutes a particular problem for forest taxation with progressive marginal tax rate. This is avoided by the "average-taxation", where the average of the last five years' income is the basis for taxation. Additional interest resulting from this is not taxed, and when starting up and ending this process, there are rules that with good planning may be exploited and result in less taxation (Høsteland, 1984). Furthermore, before 1983 the value of forest roads could be upgraded in connection to the selling of forest properties. The next owner could depreciate them once more. From 1983 to 1993 the Forest Trust Fund could be used to depreciate the value of a forest property when it was sold

to a close relative. This meant that the part of the Forest Trust Fund which was used for this purpose was not taxed. The way these rules were formed, one would have to do considerable fellings to have maximum advantage (Høsteland, 1984).

In Sweden too forest taxation is direct taxation, which stimulates investment in timber production. But there are also elements of an increment taxation system in Sweden. Income from fellings is the basis, but an important tax exemption exists, the so called "skogsavdrag". The sum of these exemptions can, during the period a forest owner has got a certain property, be as large as half the forest property's value. However, the sales revenue when selling the property is taxed, and the aforementioned exemptions are added when the property is to be sold. But forest owners gain from considerable amounts of tax debts in this way. And if a property is transferred as inheritance or a gift, as happens often, there will be no revenues and no taxation except from ordinary gift taxation. The problems of periodic revenues and expenses are solved by different adjustment techniques. The most important is the "forest account" (skogskontot). Revenues may be deposited here and used for any purpose within ten years. They are taxed when they are used. The interest on the "forest account" has not been taxed until now, and the taxation percentage still is low (15%). A result is considerable tax debts (Karlsson, 1990 and Jacobsson, pers.comm.). This whole system seems to stimulate harvesting compared to the Norwegian system.

In Finland, the forest area has been the basis for forest taxation. From 1993 onwards, forest owners may choose between this system and direct taxation rather similar to the Swedish system. From 2006 only this direct taxation system will be applied. According to the area taxation system, *estimated* net income from the forest area, and the value of own labour for logging and transport, are taxed. Until 1991, estimated net income was totally independent of realised income. The basis was the forest area distributed by site classes, locality (altitude), its expected distribution among tree species and quality, and current timber prices. What was actually growing on the land was not considered. An estimated cost of silviculture, administration and depreciations was deducted to find net in-

come. The average of the last three years' net income was the basis for taxation. Forest owners with a higher net income through intense harvesting and appropriate investments and costs, got tax advantages (Heino, 1990 and Ovaskainen, pers. comm.). If the harvesting rate (after 1991) is lower than the estimated base for taxation (the "tax cubic metre"), the difference can be deducted to a certain degree. At present current rather than estimated costs are the basis for cost deductions (Ylitalo, pers.comm.).

Special tax exemptions with subsidising effects are (Heino, 1990 and Ovaskainen, pers.comm.):

- 1) If the forest owner's family carry out cutting and transport, the value of their labour will normally be taxed. After 1980 labour for the first 150m<sup>3</sup> has not been taxed. This meant subsidising of own labour. The measure was implemented to stimulate thinnings.
- 2) Regeneration areas larger than 0.5 ha within accepted regeneration and felling plans have not been included in the area for taxation after 1980. Regeneration, and probably also fellings, are thus stimulated.
- 3) 30% of costs for construction of forest roads can be written off immediately.

Points 1) and 3) are also included in the new direct taxation system. The implementation of this system followed a wide-ranging tax reform in 1993. The main arguments to introduce this system are that the area taxation system is expensive and difficult to implement fairly. Despite the fact that the new system will have profound effects on environmental and recreational issues through a likely prolongation of rotation periods, this aspect was not discussed properly (Ovaskainen, pers.comm.).

#### *Grants for Forestry*

As shown in Table 1 grants have been important in Norwegian forest policy, particularly the last 10–15 years. The motivation for these has been timber production, even if most grants now are conditional upon the satisfaction of certain multiple-use criteria. Regarding investments in silviculture and forest road construction, the same aspects have been strongly supported both by the forest taxation system and the Forest Trust Fund. Harvesting has been reduced by taxation and stimulated through grants. It

should be noted that rural development policy has been a strong motivating factor for the grants.

In Sweden the amount of grants has been far more modest than in Norway, compared with the size of the forest sector. An exception was the beginning of the 1980s. The so-called 5-3§ programme, where considerable amounts were spent on felling of sparsely stocked stands and replacing them with dense plantations, contributed especially to this. Grants here have also had a regional profile, with a larger portion to the North-western part of Sweden.

TABLE 1. GRANTS TO NORWEGIAN, SWEDISH AND FINNISH FORESTRY.  
Amount of grants to Norwegian forestry 1972–94 (Sources: Skogdirektøren, 1970–87; Stortingsproposisjon nr. 1, 1970–95; Eid, 1992; Inderberg, pers.comm. and Næss pers.comm.), to Swedish forestry 1972–94 (Source: National Board of Forestry, 1970–95), to Finnish forestry 1972–94 (Source: FFRI, 1970–94) and state loans to Finnish forestry 1972–94 (Source: FFRI, 1970–94). In mill. 1993 -NOK.

	COUNTRY	ANNUAL AVERAGE YEAR (19–)						
		72–75	76–79	80–83	84–87	88–91	92–93	94
<i>Total</i>	Norway	156	214	281	357	382	400	281
	Sweden	253	272	686	435	329	185	87
	Finland	374	438	343	368	485	494	424
<i>Loan</i>	Finland	311	383	339	324	266	173	54
<i>Cutting / transport</i>	Norway	0	17	49	63	57	94	45
	Sweden	0	11	267	187	91	0	0
<i>Roadbuilding</i>	Norway	59	82	107	123	159	167	126
	Sweden	84	91	151	80	65	41	11
	Finland	38	71	89	86	97	74	40
<i>Loan</i>	Finland	65	122	148	145	125	90	36
<i>Drainage</i>	Norway	6.0	5.5	7.2	11	10	3.9	2.0
	Sweden	0	0.8	18	15	4.9	0	0
	Finland	104	82	69	58	100	76	36
<i>Loan</i>	Finland	103	82	63	59	62	51	17
<i>Silviculture</i>	Norway	92	111	118	160	156	136	126
	Sweden	169	169	250	146	147	88	0
	Finland	232	285	185	225	288	345	348
<i>Loan</i>	Finland	143	180	129	120	78	33	0
<i>Environmental</i>	Sweden				7.5	22	56	76

## COMMENTS TO TABLE 1.

## Explanations of Norwegian subsidy-categories in Table 1:

*Cutting / transport:* Mainly grants for harvesting in difficult terrain, transport, felling of broadleaved trees (to regenerate with spruce), technical equipment, planning of timber trade in Northern and Western Norway, extraordinary grants (related to devaluation of Swedish and Finnish currencies or low timber prices. Remarkable grants in 1993), and employment measures. All these grants except for the two last ones exist only or almost only in the Western and Northern part of the country.

*Road-building:* Grants for forest road construction (where difficult terrain and remote timber supply regions have had priority), the subsidising effect of loans and tax exemptions through the use of the Forest Trust Fund<sup>\*</sup> for road construction, and a part of the extraordinary grants in 1993.

*Drainage:* Grants for drainage and the subsidising effect of tax exemptions through the use of the Forest Trust Fund.

*Silviculture:* Mainly grants for silviculture (remarkably higher in the West and North), thinning of young stands, afforestation of agricultural land, net costs of state-owned forest nurseries and the "Forest seed service" (Skogfrøverket), a part of the extraordinary grants in 1993 and employment measures.

## Explanations of Swedish subsidy-categories in Table 1:

*Cutting / transport:* Mainly the 5-3§ programme.

*Road-building:* Grants for construction of forest roads and employment measures in 1993.

*Silviculture:* Grants for afforestation of agricultural land, forest improvements, silvicultural investments in the North and investments in forest seed plantations.

*Environmental:* Grants for measures to enhance biodiversity or conserve cultural heritage (this also include no action, when the alternative is timber production), forestry in broadleaved forests of high value, and inventory of key habitats and swampy forests.

## Conditions for the Finnish state loans:

The interest rate of the loans is 3–5%, while the re-payment period varies from 7 to 24 years. The loans are interest-free for 2–8 years. The conditions are set by purpose and district. Loans for regeneration thinning, new drainage and forest roads have been somewhat cheaper than others. However, the main difference is according to district (Aarnio pers.comm.).

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\* From 1983 on there have been tax exemptions (up to 35%) through the use of the Forest Trust Fund to finance silviculture and construction of forest roads. The subsidizing effect is estimated (see Eid, 1992) and treated as grants.

In Finland state funding has been given through state grants and cheap loans. The amount and aim of these are given by the "Forest Improvement Act" and long-term governmental programmes for forestry (Palo, pers.comm.). Therefore the amount is quite stable from year to year.

## All TABLE 2. RELATIVE AMOUNT OF GRANTS.

Grants in 1993-NOK per employee and per m<sup>3</sup> timber cut (Sources: SN, 1970–93; National Board of Forestry, 1978, 1984 and 1993, and FFRI, 1978, 1984 and 1993).

	COUNTRY	YEAR		
		1976	1982	1991
Per employee:	Norway	14,500	25,800	58,500
	Sweden	5,300	16,100	7,800
	Finland, grants	6,900	5,900	7,200
	Finland, loans	7,600	6,200	7,400
Per m <sup>3</sup> timber cut:	Norway	23	26	35
	Sweden	4.5	13	4.3
	Finland, grants	9.3	7.0	12
	Finland, loans	10	7.2	5.3

An *employee* is defined as a person who has been working at least one hour with timber production during certain examination weeks. *Timber cut* includes subsistence harvest.

types of grants and loans have a strong regional profile. The pronounced increase in grants for silviculture since 1983 is due to special grants for Lapland. In the period 1987 to 1993 subsidies for drainage normally were used to regenerate areas after clearcutting, and from 1993 all subsidies were for this purpose (Aarnio, pers.comm.). There are no rules to prioritize the subsidies towards environmental concerns, but of course, the District Forestry Boards may do so (Palo, pers.comm.).

## ENVIRONMENTAL EFFECTS OF THE INCENTIVES

*Forest Roads*

Occasionally, the construction and existence of forest roads have been hotly debated. Most representatives of recreational interest groups appreciate the access that forest roads give (e.g. Aasetre, 1992 and Veisten & Hoen, 1994). On the other hand cut slopes, embankments and road lines in steep terrain give a bad visual impression, and representatives of wilderness oriented recreation do not appreciate the existence of forest roads (e.g. Aasetre, 1992). To some extent forest roads in steep terrain can cause erosion and even landslides. Probably, most game

TABLE 3. CONSTRUCTION OF FOREST ROADS.  
*Km constructed forest roads annually 1968–92*

COUNTRY	ANNUAL AVERAGE YEAR (19–)				
	68–72	73–77	78–82	83–87	88–92
Norway	2283	2128	2203	2266	2802
Sweden	3218	3100	3611	4034	3183
Finland	2744	3418	4255	4148	3713

Sources: SN, 1993; National Board of Forestry, 1970–95 and FFRI, 1994.

is advantaged from forest roads. Birds can pick gravel and moose and roe-deer can walk in snowless promenades if forest roads are used during winter. When forested areas are easily accessible, environmental and recreational aspects probably will be more carefully maintained when timber production measures are undertaken in the first place.

From 1967 to 1992, 61,000 km of forest roads were constructed in Norway, 90,000 km in Sweden and 93,000 km in Finland. This represents 850 m per km<sup>2</sup> forest land in Norway, 390 m in Sweden and 470 m in Finland. The high road density in Norway may partly be explained by large tax exemptions and grants. The fact that a considerable amount of Norway's forests are situated in steep terrain, might be an additional explanation. On the other hand, forest roads in Norway also are more expensive to construct.

#### *Standing Volume of Timber*

Forests are effective in sequestering CO<sub>2</sub>. The higher the timber yield, the larger amount of CO<sub>2</sub> is sequestered. In the case of Norway, the net fixation is approximately 22% of emission from burning fossil fuels. Flexibility compared to other measures is an argument for storing CO<sub>2</sub> in trees. When more is known about global warming in the future, trees may either be used for energy and traditional purposes, or they might be stored through conservation measures (Lunnan *et al.*, 1991).

Biodiversity also could have been an argument for increasing standing volume. In the beginning of this century, Scandinavian forests were in a bad shape both from

a timber production and an environmental point of view. The forests were poorly stocked. An increase of standing volume would contribute to a state of the forests closer to the natural state, and less light and wind exposure. A considerable share of threatened forest species are sensitive to temperature changes and drought due to light exposure and wind (Ingelög *et al.*, 1984 and Sjöberg & Lennartson, 1995). The shift from uneven-aged to even-aged silviculture, which took place between 1930 and 1960, contributed significantly to increased primary timber production per hectare in all countries (Braathe, 1980; Östlund, 1993 and Finnish Forestry Association, 1995). It is not clear whether today's even-aged forestry is better regarding threatened species than the selection cutting practice in the beginning of this century (see e.g. Olsen, 1988 and Östlund, 1993), but an increase of standing volume and density, within even-aged forestry, would definitely be an advantage. However, there is clearly a limit here. For example, the bush layer habitats will be less diverse under a dense spruce-forest cover, and very dense forests are normally not attractive from a recreational point of view (Aasetre, 1992). Many threatened species also have developed on sparsely stocked areas used for pasture (e.g. Sjöberg & Lennartson, 1995). This limit will

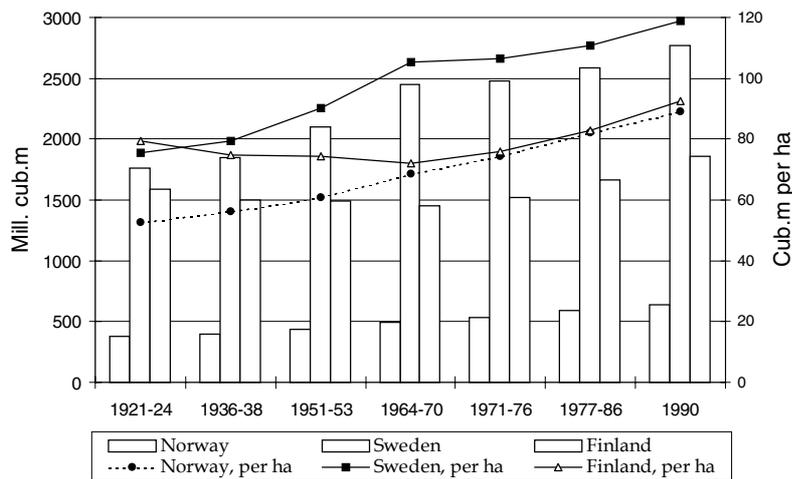


FIGURE 2. STANDING VOLUME 1921-90

Standing volume in Finnish, Norwegian and Swedish forest land 1921-90.  
Sources: Tomter, 1994; SN, 1970-93; National Board of Forestry, 1970-93;  
FFRI, 1970-93. The columns refer to left y-axis and the curves to right y-axis.

of course vary from area to area, dependent on use and type of habitat. It is difficult to estimate to what extent this limit is reached or passed in areas in the different Nordic countries.

Standing volume in Finland has increased by 17% since 1921–25 and 29% since 1964–70. In Norway the increase has been 68% since 1921–25 and 30% since 1964–70. The figures for Sweden are 57% and 13%, respectively.

The highest increase in standing volume has taken place in Norway, despite the higher road density in Norway and subsidized long distance transport and harvesting in difficult terrain. A reason could be that the state of the forests at the beginning of this century was worst in Norway, since Norway had the least share of forest areas far from any settlement. However, Norway has a forest taxation system that stimulates investments and saving in the forests, and limits cuttings. The forest taxation system in Sweden is more "cutting-friendly", and with the Finnish area taxation system it has been most profitable to cut. Norway also has the Forest Trust Fund and the largest amount of grants for silviculture.

As shown later, the Finns have drained by far the greatest area of bogs and swampy forests. This should result in an increment of standing volume and is probably a reason for the high increment in recent years.

### *Old Growth Forests*

Old growth forests are important habitats for scarce and vulnerable species, e.g. specialists species of fungi, lichen and beetles. Large old trees are necessary for larger birds of prey's nesting and for hole-nesting birds (e.g. Sjöberg & Lennartson, 1995). Several studies also indicate that old forests are valuable for recreational uses (e.g. Aasetre, 1992; Axelsson Lindgren, 1995).

Relative age class V is defined as mature forest. As seen from Figure 3, there was significantly more relative age class V in Norway than in Sweden and Finland during the last period. At the beginning of the 1970s Sweden had the highest relative share of class V. Finland had the least share of mature forests during the whole period. One explanation for the differences might be that the relative age

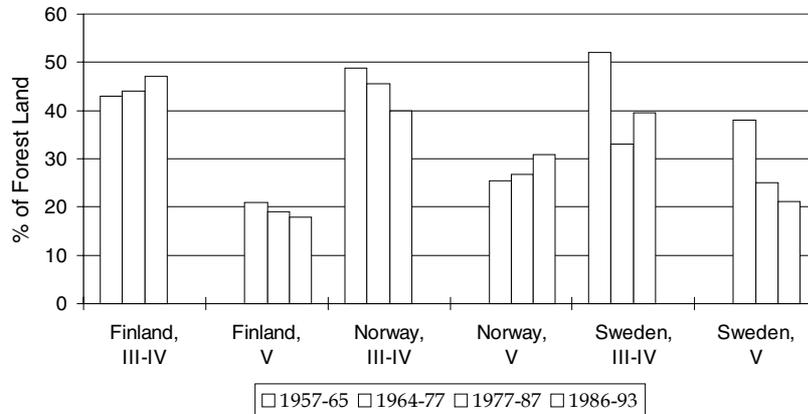


FIGURE 3. PERCENTAGE OF FOREST LAND IN RELATIVE AGE CLASSES  
 Percentage of forest land in relative age class III-IV 1957-87 and percentage of forest land in relative age class V 1964-93.  
 Sources: Norwegian Institute of Land Inventory, 1938-93; National Board of Forestry, 1970-95; FFRI, 1970-94 and Ihalainen, pers.comm..

class distribution in earlier periods was different in the three countries. In consequence, unequal amounts of young forests could grow into mature forests.

The main portion of relative age classes III-IV grows into mature forests within 30 years. From earlier stand distributions the following should be expected:

- 1964-77: Some of class III-IV in 1957-65 has grown into mature forests, which should lead to the highest share of class V in Sweden and the lowest in Finland.
- 1977-87: Class III-IV in 1957-65 is still growing into mature forests, but the share from 1964-77 is equally important. Norway should now have the highest part of age class V while the differences between Sweden and Finland should be small.
- 1986-93: The share of class III-IV in 1964-77 and 1977-87 are equally important, while the distribution in 1957-65 is getting less important. The portion of class V should be approximately equal in all countries, but maybe somewhat lower in Sweden.

When comparing this expectations in Figure 3, we note that the share of class V in Finland in all three periods is lower than expected. The differences between Norway and Sweden correspond fairly well to what should be expected, but the increase in Norway and the decrease in Sweden both are slightly higher.

The forest policy measures mentioned above may be an explanation also here. The greater the pro-investment incentives (except investments in forest roads) and the less the pro-cutting incentives, the greater the proportion of old forests. In the case of Norway, its difficult topography and thereby high logging costs also may be an explanation for the high proportion of mature forests.

#### *Drainage of Bogs and Swampy Forests*

Bogs and swampy forests are also important for many bird species, plants and scarce and vulnerable species of the groups mentioned previously. They give variation in the landscape and increased quality of recreation (Aasetre, 1992). Drainage for the purpose of timber production has mainly been done on the richer types, which are also richest regarding biodiversity. Drainage also causes leaching of nutrients and particulate material at the time of drainage and immediately after it. In consequence, drainage has been strongly criticized from the environmental point of view. However, generalists like moose, roe-deer, hare and red fox probably have benefited from drainage, especially of larger bogs. Low productivity bogs then became

TABLE 4. BOGS AND FORESTRY DRAINAGE.

*Area of bogs and swampy forests under the treeline before drainage started, annual drainage 1950–92, and percentage of area 1900 drained. In km<sup>2</sup>.*

COUNTRY	AREA OF BOGS AND SWAMPY FORESTS, 1900	AVERAGE ANNUAL DRAINAGE				% OF AREA DRAINED
		1950–69	1970–79	1980–89	1990–92	
Norway	19.000	88	26	30	30	12
Sweden	100.000	133	242	220	54	10
Finland	125.000*	1227	1974	779	373	40*

\* Only the bog area, swampy forests are not included.

Sources: SN, 1970–93; National Board of Forestry, 1995 and FFRI, 1994.

replaced by forests with a productive bush-layer, a valuable pasture (Helle, 1995). Studies also indicate that mires emit less methane, a strong greenhouse-gas, after drainage. Drained mires may thereby contribute to fixation of greenhouse-gases to a larger extent than what is sequestered by their future growing trees. This statement is uncertain (Lunnan *et al.*, 1991) however.

Before forest drainage started, Finnish forests included relatively more bogs and swampy forests than the Swedish, which in turn had more than the Norwegian. The Finns have drained by far the most and have also spent the largest amount of grants for this purpose.

### *Broadleaved Trees*

Broadleaved trees in general are important as fodder for game and represent variety and amenity (see Aasetre, 1992 and Axelsson Lindgren, 1995). Regarding biodiversity and amenity, large broadleaved trees are especially important. The amount of broad-leaves has grown in all countries. This is also a fact if we go as far back in time as 1920 (SN, 1970–93; National Board of Forestry, 1995 and FFRI, 1994). However, as shown in Table 5, the volume share of

TABLE 5. BROADLEAVED TREES RELATED TO TOTAL VOLUME.  
Percentage broadleaved trees of total volume, 1964–90, and ‰ broadleaved trees over 30 cm diameter of total volume 1971–90. Under the treeline.

	1964–70	1971–76	1977–86	1990
<i>% broad-leaves</i>				
Norway*	12	13	13	17
Sweden	14	15	16	15
Finland	19	18	18	18
<i>‰ broad-leaves &gt; 30 cm</i>				
Norway*		10	11	15
Sweden		21	23	27
Finland		14	15	15

\* In Norway only the so called "forest districts" are included (Western and Northern Norway are excluded due to lack of data series).

Sources: Norwegian Institute of Land Inventory, 1938–93; National Board of Forestry, 1970–95 and FFRI, 1970–94)

broadleaved trees has increased significantly only in Norway. The share of taller broadleaved trees has grown in all countries, but more in Norway and Sweden than in Finland. The higher share of larger trees in Sweden is probably due to Sweden's geographical location and a higher proportion of temperate, broadleaved forests. The Swedes have also had regulations to preserve beech forests since 1974. In 1984 this was extended to all types of temperate, broadleaved forests (Svensson, pers.comm.). Relating these tendencies to other forest policy measures is difficult. One could be tempted to believe that Norway, with its strong incentives for silviculture based on conifers, should have a lower growth in share of broadleaved trees than the other countries. Since rather the contrary is the fact, other explanations like less summer farming and less fuelwood consumption probably are more valid. Finland's higher share of broadleaved trees is probably a consequence of higher prices on birch timber.

#### *Strictly Protected Areas*

In Norway, 1.1% of the forest land now is strictly protected, mainly after parts of the so called "protection plan for coniferous forests" was implemented in the beginning of this decade. The figures for Sweden and Finland are 3.3% and 2.4% strictly protected forest land, respectively (FFRI, 1994 and National Board of Forestry, 1995). Mainly it is low productivity areas situated in the far North or at high altitudes that are protected in all three countries. This fact is even more notable in Sweden and Finland than in Norway.

#### *Mechanization*

According to Eckerberg (1990), the case of Sweden is that the higher the degree of mechanization in forest operations, the less the extent to which environmental features are protected. Mechanization, therefore, may indicate some environmental features like the degree of key-habitats, single trees and edge-areas left after clearcut, size of clearcuttings, and degree of vegetation and soil damages. In Norway, 44% of cutting operations were fully mechanized in 1989. Over 60% were fully mechanized in Finland and in Sweden more than 80% of clearcuttings and over 50% of thinnings (Eckerberg, 1995).

Any explanation of the differences is difficult to give. The difficult topography in Norway surely plays an important role and a larger proportion of forest owners are farmers with low alternative value of their labour during the winter season.

It should be noted that the correspondence between fully mechanized harvesting operations and fewer environmental features protected might have changed since 1990. Many campaigns and courses to train the harvesting crews have taken place since then, in all three countries. In addition, the size of harvesters has decreased.

### *Forestry Conflicts*

The intensity of forestry conflicts also may indicate how well environmental issues are taken into account through timber production practices. Reunala (Hellström & Reunala, 1995 and Hellström, 1995) have done comparative studies of forestry conflicts in the Nordic countries. Their observations indicate that the intensity of forestry conflicts has been significantly lower in Norway than in Sweden and Finland. Hoen & Winther (1993) and Veisten & Hoen (1994) also have found that Norwegians to a high degree are satisfied with forestry practices.

### CONCLUSIONS

Natural conditions and culture surely are of great importance to the way people manage and use forests. Forest policy is only one of many explanations why the state of forests are as they are. However, it is clear that the direct forest taxation system being practised in Norway and Sweden has stimulated investments in wood production in the form of silviculture and forest roads, and prolonged rotation periods resulting in more mature forests. In Norway and Sweden legislation, and particularly in Norway considerable public funds, also have stimulated silviculture and constructions of forest roads, in addition to harvesting. It seems that the incentives to stimulate harvesting, like subsidizing forest road construction, transport and harvesting directly, have not been strong enough to neutralize the effect of direct taxation. In Finland, there has been a more harvesting-friendly forest taxation system. Silviculture, drainage and forest road constructions have been stimulated through legislation, subsidies and lately

also specific tax exemptions.

Environmental and recreational aspects have lately been stimulated directly through the framework forest law in Norway, through detailed regulations in Sweden and through extension and protection of nature in all three countries. Lately, Sweden to some extent has subsidised measures to enhance the flow of environmental goods directly, while Finnish and particularly Norwegian subsidies for timber production are made dependent upon the satisfaction of certain multiple-use criteria. The direct forest taxation system is a blessing for the environmental goods of the forests. Subsidies, tax-exemptions and legislation to stimulate harvesting are definitively not.

It is clear that, relatively, Norway has got more forest roads constructed after 1967 than the other countries. Norway also has least protected forest land. On the other hand, there are the most mature forests in Norway. Sweden and Norway have had least drainage and Norway has had the largest increase in standing volume, and thereby relatively most CO<sub>2</sub>-sequestering. The increase of volume share of broadleaved trees has been highest in Norway, there has been least mechanization in Norway and Norwegians seem to be more satisfied with forestry practices than Swedes and Finns.

However, to the extent that this is a result of forest policy, the results depend on forest policy over a long period, rather than changes in policy measures the last few years. Subsidies, tax-exemptions and restrictions should only be given to stimulate non-market goods, like biodiversity, amenity and CO<sub>2</sub>-sequestering. Timber harvesting and forest road construction should be properly stimulated by the market itself, and should, due to these non-market goods, rather be restricted than enhanced. I feel confident that, in the case of Finland, it will be profitable to reduce the level of timber harvesting incentives, as stated in Finland's new forest policy. Similarly one might advise the Norwegian government to abandon subsidies for cutting in difficult terrain and to considerably reduce subsidies and tax exemptions for forest road construction. It would most likely be profitable to enhance the ambition to stimulate environmental goods directly in all countries, particularly in Finland and Norway.

## ACKNOWLEDGEMENTS

Special thanks to Prof. Ole Hofstad at Department of Forest Sciences, Agricultural University of Norway, and Prof. Colin Price at University College of North Wales, Bangor, United Kingdom. They have improved the language in this article considerably.

Thanks also to Associate Prof. Lars Helge Frivold at Department of Forest Sciences, Agricultural University of Norway for improving the treatment of historical and biological issues, and to all my informants by personal communication.

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