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LONG-TERM HISTORICAL CHANGES IN THE FOREST RESOURCE

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NOTE

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ABSTRACT

The publication presents eight case studies (Finland, France, Great Britain, Greece, Hungary, the Netherlands, Sweden and the United States of America) on long-term historical changes in the forest resource, quantifying trends to the extent possible and indentifying factors underlying decreases and increases in forest area, as well as other changes to the forest resource.

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PREFACE

The global discussion on the causes of deforestation in the tropics has led to renewed interest in the history of the forests of the countries which are now considered "developed": what factors underlay the process of deforestation in those countries, and the subsequent expansion of the forest area? What measures, if any, were taken to reverse the direction of change? Can lessons be learnt from the experience? The discussion acquired a political dimension as developed countries were accused of hypocrisy in first destroying their own forests for profit and then attempting to prevent other, poorer countries from following the same course.

Unfortunately, even foresters often do not have the necessary information to put the present situation with regard to forestry in developed countries in a long-term historical context, and in general the discussion, although heated, has been based on a very limited basis of fact and analysis. The ECE Timber Committee and the FAO European Forestry Commission asked a small number of countries to prepare case studies of the long-term historical changes in the forest resource of their country, quantifying trends wherever possible and examining the major underlying factors. The Committee and the Commission intended in this way to widen the factual basis for the ongoing political discussion.

The case studies were prepared by national experts during 1993 and presented to the joint session of the Committee and Commission in Rome, which then asked the secretariat to bring them together and publish them. Unfortunately, this process has taken two years because of acute staff shortages in the secretariat. Nevertheless, in view of the continuing interest in the topic and the high quality of the case studies, the decision was taken to persevere in the efforts to bring the case studies together for publication.

The case studies in this publication have been prepared by the following experts, whose services were contributed by their respective governments:

Kullervo Kuusela ..... Finland
George André Morin..... France
D.B. Henderson-Howat..... Great Britain[1]
Nicholas S. Efstathiadis ..... Greece
Sandor Oroszi ..... Hungary
Hannes Sipkens..... The Netherlands
Erland v. Hofsten ..... Sweden
Douglas W. MacCleery..... USA

Mr. Morin also prepared the elements of an overview which opens the publication, identifying some common features of the national case studies.

The secretariat expresses its profound gratitude to these experts, as well as to their governments and institutions for their major contribution to understanding the historical context of the present day forests of developed countries.

[1] Northern Ireland, the other country of the United Kingdom, could not be covered due to lack of comparable data.

Chapter 1

COMMON POINTS

G.-A. Morin

1.1 Overview

Geographical diversity and the differences in political developments aside, the six national reports studied (those from France, Hungary, the Netherlands, Sweden, the United Kingdom and the United States) highlight, sometimes in virtually identical wording, a number of interesting points that are common to all the countries in question. Basically, the cycle seems to have always been the same, even if the course of events was never as simple and linear as described below.

1.2 The forestry cycle

(i) Phase I

Phase I involves the settlement and destruction of forestland for farming purposes, and a period of over-exploitation, mainly attributable to demand for fuelwood. At this stage, the link between agriculture and forests is perfectly illustrated in the case of western Europe by the episode of the Black Death in the mid-fourteenth century (see France and the United Kingdom). In a short space of time, this major plague reduced the population of western Europe by over a third, and in some places by over 50 per cent.

This population slump was general. Even if it is somewhat unjustly linked in France with the Hundred Years War, France was no worse effected than Britain. Entire regions were depopulated and numerous villages disappeared; the spontaneous return of the forest followed. Not until the beginning of the sixteenth century in France and the end of the eighteenth century in England was there again population pressure on forests comparable to that at the end of the thirteenth century.

Overall, the technological environment changed very little and very slowly - in some places there was even a long-term declining trend in farm yields. The reverse correlation in this context between population density and forest area is clear, as is the capacity for the spontaneous reconstitution of forest cover as soon as population pressure eases.

(ii) Phase II

Phase II is characterized by a growing realization of the limited nature of forest resources, and culminates in the first sets of regulations and the emergence of the concepts of management and sustained yield (at the end of the Middle Ages in France, the United Kingdom and the Netherlands, in the late nineteenth century in Sweden, and at the beginning of the twentieth century in the United States).

Management techniques and efforts to achieve sustained yield were often applied empirically at the local level before being codified by national authorities. Various specific situations accelerated or intensified this realization, such as: the problems of erosion, avalanches and the stabilization of sand dunes; the problems of supplying towns with fuelwood; and the concern of newly emergent states to have access to a strategic raw material, particularly for the development of their navies.

(iii) Phase III

Phase III may be identified by a stabilization made possible by some or all of the three following factors, as a result of which the forestry legislation finally became effective: the development of foreign trade as a means of meeting a country's demand for wood (the Netherlands, the United Kingdom and, to a lesser extent, France from the sixteenth to the eighteenth centuries); the use of fossil energies in all countries; and lastly and above all, industrialization and, as a consequence the end of rural isolation, rural migration, and the improvement of agricultural productivity. This was very much the case in France in the nineteenth century and in the United States from 1920.

It must be said that industrialization initially had negative effects on forests. Before coal and oil were used as fuel, forest industrial facilities (foundries and glass or salt works) substantially increased the demand for fuelwood, thereby placing an intense pressure on forests. Conversely, the potential for economic gain promoted progress in silviculture.

The building of railways also required substantial quantities of wood for railroad ties, but at the same time opened up access to new forest resources, as was the case of the United States in the second half of the nineteenth century.

(iv) Phase IV

Phase IV is one of expansion, including increases in area, and increases in standing volumes per hectare and annual increments. The latter has progressed to the point where today each country's harvest is considerably smaller than its annual increment.

The phenomenon of expansion was general and was intensified by the official reforestation policies of the United Kingdom, with the establishment of the Forestry Commission in 1920; the United States from 1920 onwards; and France, with the reforestation of the Landes area of Gascony (Second Empire), the development of protection forests under the Mountain Land Restoration Programme and the establishment in 1946 of the National Forest Fund.

(v) Phase V

This current phase is common to all the countries studied. As environmental concerns assume growing importance in an urbanized society, concern for forests is becoming one of the main ways in which they are expressed.

A feature of this latest phase is the lag in public discussion, with criticisms being based on situations and risks that are now past, while on the whole the actual condition of forests warrants optimism. Generally speaking, public expectations from forests have become increasingly demanding. Management targets must now include environmental concerns that go far beyond the mere production of wood.

There is a key difference between the situations in Europe, where primary forests are virtually non-existent (even in northern Sweden), and in the United States, where there are still "quasi-primary" forests. With the latter, however, the role of Native Americans and their shifting slash-and-burn agriculture should not be underestimated.

The reports, particularly those of the Netherlands and the United States, mention several times that the resilience of forests is almost always greater than initially predicted. That is clear evidence of the importance, particularly marked where forests are concerned, of cumulative phenomena.

The importance of the cumulative nature of action must be stressed with respect to forest policy, for which long-term continuity and regularity of action are more important than the level of financial inputs. For these reasons, the application of land-use policy has often been undertaken within specific legal and fiscal frameworks.

The above-mentioned resilience is proof that, in the temperate zone, agricultural use has neither destroyed nor even lastingly diminished the productive potential of forestland (limited exceptions do exist, however, mainly in the United States). This is certainly one of the basic differences when compared with tropical countries, where deforestation, when combined with the effect of natural climatic conditions, is often the start of a process of irreversible land destruction.

It is noteworthy, even if does not always appear directly from the statistics, that the use of agricultural and forest land for human settlement and infrastructure is not recorded by the authorities even when it is irreversible. Such artificialization of a growing proportion of land is more perceptible in the most densely populated west European countries.

Another important feature, and one common to all the countries, is something of a long-term trend towards lower per capita consumption of wood. That trend is very clear in the United States, although per capita consumption there is still relatively high.

Consumption of fuelwood, which has historically been high in all the reporting countries, remains significant from the point of view of the use of forest by-products, even though fuelwood production is no longer an end in itself.

The structure of wood consumption has changed considerably, involving the diminution of fuel wood; an increase in demand for sawnwood, but increasing efficiency of conversion; and the emergence of new uses (pulp and panels), which are mostly by-product based.

Also noteworthy is the fact that, other than in Sweden (a difference attributable to the extent of that country's forests relative to the size of its population), per capita consumption of wood is very close to 1 m^3 per year in all the European countries, including Hungary.

1.3 Conclusion

That the situations in all the countries are so similar shows that forests are, as it were, making a comeback. It is essential to note that, notwithstanding the numerous and sometimes large variations in climate in the study area in the wide sense of the term, the deforestations of the past have not, on the whole, had any irreversible effect on the productive potential of the land. Irreversibility comes from the artificialization of ever greater areas of land to build towns and infrastructure.

The concepts of management and sustained (or sustainable) management can, therefore, provide a basis for effective policies. Future versions of these concepts will have to take into account the entire range of the expected uses of forests.

Chapter 2

FINLAND

Kullervo Kuusela

2.1 The forest before human influence

With regard to bio-geographical spans of time, the Boreal coniferous forest of Finland is young. Its history began about 10,000 B.P. (years before present) when trees, other plants and animals returned following the retreating continental glacier (figure 2.1.1).

Tree species are colonizers of bare land. They adapt to great fluctuations of climatic and natural disturbances such as wildfires and insect and storm damage which destroy old stands and lead to the regeneration of new ones; this, in turn, maintains the productivity and biodiversity of forested areas.

Birch was the first pioneer which forested the land rising from post glacial waters. After the cold and dry Arctic period the climate became warmer around 9,000 B.P. This favoured wildfires, which increased the presence of pine. During the Atlantic period (8,500-5,000 B.P.), the climate was the most favourable it had been since the continental glaciation. It was a warm, humid and maritime epoch: broad-leaved trees became prevalent with birch being the most common species, followed by pine and grey alder. Trees of the temperate summer-green forest zone such as black alder, elm, hazel, ash, oak, lime and maple increased and had a greater northerly range than they do now. The climate again became colder and has since fluctuated between cold, humid and sub-maritime with continental Eurasian influences around.

FIGURE 2.1.1
Geographical location of Finland

Pine has increased since the Atlantic epoch. Spruce spread from the east and reached western Finland around 3,000 B.P. and the Åland islands and its northern boundary around 2,000 B.P. The vegetation of the northern and middle taiga became established at that time.

The mean annual temperature was about 2° Celsius higher than now in the Atlantic period and 1-2° Celsius lower in the sixteenth to nineteenth centuries. The annual mean temperature continues to fluctuate; the warmest year of the 1930s was 5.5° Celsius higher than the temperature of the coldest year in the 1960s (table 2.1.1).

The cold, moist climate and relatively flat terrain, especially in the regions neighbouring the Gulf of Bothnia, favoured peat-forming mires. Wetlands cover one-third of the land area. The coverage is greatest in the east and north-east from the northern part of the Gulf of Bothnia (60 to 70 per cent), 30 per cent in northern Finland and less than 10 per cent in those parts of the southern Finland where evaporation is greater than precipitation in the summer months.

Biological production and biodiversity in the natural forests were based on the dynamics of fire ecology. Wildfires, and on a smaller scale, storm and insect damage, maintained the cycle of pioneer and climax plant associations and soil fertility.

Wildfires occurred on dry, sandy and gravely soils about once every 50 years. The interval between fires was 100 to 150 years in fertile heath forests and more than 200 years in the most fertile herb- and grass-rich moist forests.

In the cold, moist climate, only small areas were burnt at a time. Dead and damaged trees, and healthy trees capable of producing seeds remained and a variable forest mosaic was formed. In warm, dry and windy summers, surface fires developed into crown fires which burned all the trees in continuous areas of thousands and even tens-of-thousands of hectares. Charred tree remains and ash found in the peat layers of mires demonstrate the extent of such fires.

Pioneer trees such as birch, aspen and grey alder, which regenerate by light seeds dispersed by wind and by vegetative sprouts, reforested the fresh mineral soils. Pine, whose thick butt bark protected it from fire, seeded the barren sandy and gravely soils. Shade-adapted spruce seedlings sprung up underneath the pioneer trees, thus beginning the succession process toward spruce-dominant climax stands (table 2.1.2).

TABLE 2.1.1
Facts about Finland

Geographic location:	60°-70° N, 19°-31° E	*Climate*	*South*	*North*
Total area:	337,000 km²	Mean annual temperature (°C)	+ 5.0	-1.0
land	305,000 km²	Mean temperature in July (°C)	+ 16.0	+12.0
waters	32,000 km²	Mean temperature in February (°C)	- 5.0	-13.0
Forestland	201,000 km²	Effective temperature sum during		
Scrubland	32,000 km²	growing season (°C)	1 300	600
Wasteland	30,000 km²	Length of growing season: number of		
Roads, etc.	1,000 km²	days with temperature >5°C	170	120
Total forestry land	264,000 km²			
Population	5.0 million	Annual precipitation (mm)	700	500
Labour force:	2.5 million	Precipitation in May & September (mm)	300	250
agriculture/forestry	10 per cent	Snowfall (mm)	150-250	250-300
industry	30 per cent	Length of snow coverage (months)	4	7
services	60 per cent			

TABLE 2.1.2
Forest-forming trees and their properties

Properties	*Birch* [a]	*Aspen* [b]	*Alder* [c]	*Pine* [d]	*Spruce* [e]
Regenerates by seeds	x	x	x	x	x
Regenerates by sprouts	x	x	x		
Seedlings require light	x	x	x	x	
Seedlings with stand shade					x
Tree height in old stands:					
South Finland	24-30	24-30	10-15	22-30	24-32
North Finland	20	20	5	15-24	15-24
Age at which stands start to degenerate (years):					
South Finland	80-90	60-70	30-40	120-140	100-120
North Finland	90	70	40	150-200	120-150
Pioneer	x	x	x		
Intermediate				x	
Climax					x

[a] White birch (*Betula pendula*) and Downy Birch (*Betula pubescens*).
[b] Aspen (*Populus tremula*).
[c] Grey alder (*Alnus incana*).
[d] Scots pine (*Pinus sitvestris*).
[e] Norway spruce (*Picea abies*).

A surface fire killed almost all the spruces, and repeated fires prevented them from colonizing barren sandy and gravely sites on which pine remained the dominant tree. Lush herb-rich forests and the edges of waterways were the strongholds of broad-leaved trees, particularly the southern species such as oak, ash, elm and lime.

When the spruce forest remained fire free for long enough, the old trees began to decay due to fungal diseases and insect damage and finally died singly and in groups. Wind throw also opened gaps in the stand which were colonized by broad-leaved trees and, beneath them, spruce seedlings.

In the progressing succession, nutrients, particularly nitrogen, were bound into forms unavailable to plants, namely humus, composed of incompletely decomposed litter. Thus, the acidity of the site increased and the cycling of nutrients between trees and soil, the biological production of the ecosystem and the biodiversity decreased. The latter three were at their minima in the old climax stands.

Fire released nutrients that were previously bound in the humus and lowered the soil acidity by 1-2 pH units, while the warmth of the sun accelerated the decomposition of humus on treeless sites. Flourishing ground vegetation also assisted the breakdown of nutrients into their constituent parts, making them available to adjacent trees. The erosion of soils is of minor significance in the Boreal zone for both climatic and vegetation reasons.

Tree species are adapted to reforest treeless sites and to resist relatively large temperature changes. The Boreal coniferous forest is one of the most durable of the terrestrial ecosystems. It can be destroyed only by land use change or by excessive emissions from mining, industry and energy production. The tree stand of the Boreal forests have a natural, even-aged structure. Succession stands, composed by trees of different ages and sizes, develop by self-thinning towards an even-aged structure.

2.2 The use of forests in the pre-industrial period

The first people colonizing the area made their living by hunting, fishing and raising the semi-domesticated reindeer. Furs of wild animals were the first market commodity. Forests also enabled the establishment of permanent settlements (table 2.2.1).

Trees, as a huge store of solar energy, provided fuel for enduring the cold climate. Wood was also used for buildings, furniture, tools and other implements. Wooden boats and ships permitted the colonization of the archipelagos and inland waterways, and permitted overseas trading (figure 2.2.1, table 2.2.2).

Shifting cultivation, in which trees are cut and burnt for fertilizing ash, complemented by game hunting and fishing, produced the necessaries of life. The forest was also an extensive pasture for cattle. Shifting cultivation at its greatest extent covered about 4 million hectares of forestland.

Living off natural resources required hard physical work. The limit which determined how much a self-sufficient population with a natural economy could expand was dictated by the hunger, cold and diseases of famine years. The limits set by the natural economy were broken by the introduction of trade between peoples.

TABLE 2.2.1
Population and proportional importance of livelyhoods and forest products, from pre-1000 to the 1900s
(Proportions indicated on scale of 0 to 100)

	1000	*1100*	*1200*	*1300*	*1400*	*1500*	*1600*	*1700*	*1800*	*1900*
Population (millions)						0.30	0.45	0.50	1.62	5.00
Hunting & fishing; reindeer husbandry in Lapland	100	72	72	72	72	72	50	28	28	
Building & heating	100	100	100	100	100	100	100	100	83	50
Shifting cultivation	-	100	100	100	100	100	100	100	77	5.5
Pasturing in forest	-	100	100	100	100	100	100	88	77	33
Agriculture on fields	-	-	-	-	-	-	28	50	77	77
Shipbuilding	94	94	94	94	94	94	94	94	77	22
Extraction of tar & charcoal buring							50	50	50	17
Roundwood exports								28	50	28
Sawnwood								28	61	100
Pulp & paper									17	100

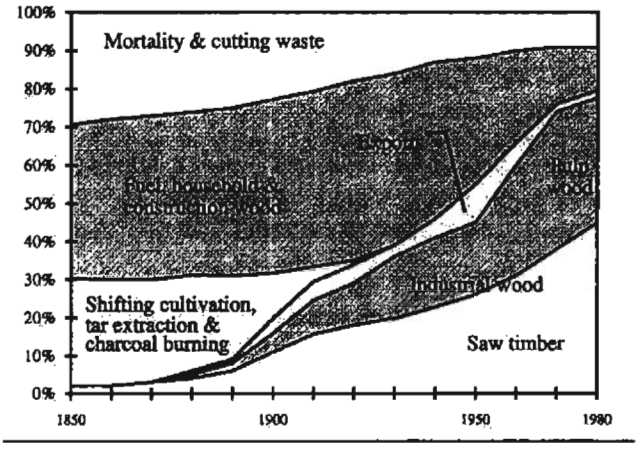
Note: "-" indicates unknown value.

TABLE 2.2.2
Indicators related to stem timber drain in Finland

	1850	*1875*	*1900*	*1925*	*1950*	*1970*	*1980*
Drain [a]			50		53		59
Population (million)	1.6	1.9	2.7	3.3	4.0	4.6	4.8
Agrarian labor force (per cent)	90	84	77	72	46	15	12

[a] Measured as stemwood over bark, million m^3 per annum.

FIGURE 2.2.1
Drain of stem timber in Finland by use



The exchange of commodities multiplied after firewood, timber, tar and wooden ships started to vie with game and furs as trading goods. Surviving famine years was no longer dependent on game and fish and the meagre harvest produced by shifting cultivation. Tar extracted from resinous pine wood was the most important trading commodity during the three centuries prior to the twentieth century. The annual consumption of wood for tar extraction was, at its largest, 10 million m^3.

Ores provided the raw materials for the first factories. Metals were extracted from the ore using heat produced by wood and charcoal combustion. Water-powered sawmills gave the first hints of how production could be increased by replacing manual power with more efficient alternatives.

2.3 Forests as a base for industrialization

The first machine shop in Finland was established in 1837 and its first product was a steam engine, built in 1838. However, a steam engine imported from abroad was already providing power to regular ship traffic on Lake Saimaa in 1833. The establishment of sawmills was permitted in 1857 and the first stretch of railway was completed in 1862.

Steam power was produced by burning wood and led to an increase in industrial production. Waterways and steam power were used to transport raw materials from far inland, especially timber, to the factories. Steam power was also used to transport raw materials and finished goods to the cities and over the sea to faraway countries. The importance of distance in the sparsely populated country was effectively reduced. The world markets provided the raw materials, machines and foodstuffs which enabled the population to grow and production to increase and diversify.

Full-scale industrialization did not begin until wood ceased to be used as a fuel and domestic commodity and became a raw material for industrial production. The sawmill industry expanded rapidly in the 1880s following an increase in the demand for sawn goods in Europe and the liberalization of production. The "green gold" of Finland was discovered at that time (table 2.3.1).

An increase in literacy, the development of printing techniques and the spread of the newspaper all strongly increased the demand for paper. There was a shortage of raw materials such as cotton and hemp fibre for the manufacture of paper in the 1840s and 1850s, and paper had to be imported from abroad.

The value of the forest in a country with few other natural resources further increased following innovations for using wood fibre as a raw material for paper. The first pulp grinding machine was commissioned in 1860. The production of wood pulp and paper became big business following the establishment of the first kraft pulp mill in 1880 and the first sulphite mill in 1885.

Industrialization, together with developments in agriculture and cattle raising on cultivated fields and

TABLE 2.3.1
Value of total and forest industry exports, 1915-92
(Million FMK in 1992 money values)

Year	*Total exports*	*Forest industry*	*Per cent of total*	*Historic event*
1915	3,598	1,492	42	
1918	347	211	61	World War I
1927	8,487	6,358	75	
1931	6,957	5,281	76	Recession
1937	14,510	1,075	74	Boom
1939	11,383	8,390	74	
1940	3,565	2,335	66	World War II
1945	2,766	2,205	80	World War II
1950	13,363	10,249	77	
1951	26,351	21,642	82	Korean boom
1953	16,971	11,819	70	
1960	30,698	21,108	69	
1965	34,199	23,021	67	
1970	57,928	31,629	55	
1974	82,746	42,935	52	Oil crisis
1976	72,781	30,696	42	Recession
1981	110,374	41,625	38	Boom
1985	114,271	41,338	36	
1990	108,439	40,812	38	
1991	95,649	36,419	38	Overvalued FMK
1992	107,472	38,883	36	Devaluated FMK

pastures, and the replacement of firewood by coal and oil, resulted in a major structural change in wood consumption. In the middle of the nineteenth century, about 40 per cent of the stemwood drain was used for energy, buildings and other household commodities, 27 per cent for shifting cultivation, tar and charcoal extraction and only 3 per cent was used as industrial wood. The rest of the drain, 30 per cent, decayed in the forest as natural losses and logging residues. Today, industrial wood accounts for 82 per cent of the drain.

If forest industries had not been able to increase their wood consumption, the forest resources would have remained largely unused. This would have resulted great losses in the growth potential of the national economy. The national importance of forestry and the forest-based industries is demonstrated by the share of forest products in the value of exports. During the early decades of industrialization it accounted for 80 per cent of the total value of exports. Its share was greatest during the years when the economy had to be rebuilt from the ruins of the First and Second World Wars.

The more the forest industries' production and exports increased, the more raw materials, machines and commodities could be imported from abroad. These were essential for the diversification of production and for the growth of the economy: the forest sector created capital for the development of other sectors. Without the income from forestry work and wood sales, agriculture would not have been viable over large parts of the country. Most of today's metallurgical and chemical industries, and even the electronics industry, have been established and developed close to forest industries.

2.4 From exploitative to sustainable forestry

(i) Forests in the mid-nineteenth century

At the end of the period of shifting cultivation and tar extraction, the forest resources within the reach of horse and water transport were seriously depleted. Around 1850, there was a shortage of all timber assortments and fuel wood in the south-eastern part of the country and in the regions of the western seaboard; construction lumber and sawlogs were in short supply throughout southern Finland. The richest resources were located on the main watersheds and in the north-eastern and northern parts of Finland.

According to the forest balance calculations made in 1873, the estimated drain was a little smaller than the gross increment, but this did not compensate for the removals of sawlogs. The estimated drain was greater than the increment in both 1913 and 1919, when removals of industrial roundwood were 12.5 million m³ per annum, having increased from only 2 million m³ per annum at the end of the nineteenth century. The critical forest balance initiated efforts to develop forest education and research, forest laws, and to introduce and establish organisations for forest administration.

(ii) Forestry legislation

Up to the middle of the nineteenth century, forests were more or less in the common use of the agricultural population. The first legal restrictions were enacted to protect forests from destructive cutting and preserve them for use in mining and the metal and shipbuilding industries. The Forest Law of 1886 was enacted to ensure natural regeneration after the cutting of mature stands. The Law, renewed in 1917, also mandated the rational thinning of growing stands. The Law Concerning Private Forests of 1927 covered all but state forests. Its principal obligations were that the forest should not be destroyed and the ground had to be left in such a condition after cutting that the natural regeneration of the forest would not be endangered. Further, if a young growing forest were cut in a manner contrary to rational thinning, it too would be regarded as destruction of the forest.

If the law were violated, authorities could stop the cutting and try to persuade the forest owner that the mandated improvement cuttings and regeneration measures should be carried out. If agreement was not reached, the forest could be protected for a number of years by court order and the necessary works would be carried out by authorities at the forest owner's expense. This law remains valid to this day.

A legal tool to improve and increase forest resources has been the Forest Improvement Act of 1928 and its later renewals. Under the Act, the state budget has financed forest improvement projects in all private forests except those owned by companies. In 1953, the scope of the Act was limited to concern only forests owned by private persons. Forest improvement started with forest drainage activities and the regeneration of poorly producing stands. The activities were extended to include the building of forest roads, fertilization, tending young stands and pruning. Regional employment and social aspects have also been involved in the forest improvement policy.

TABLE 2.4.1
Institutes of forestry education and research

Ministry of Education
University of Helsinki
Faculty of Agriculture & Forestry:
Institute of Forest Economy (3 professors)
Institute of the Use of Forest Resources (5 professors)
Institute of Forest Ecology (6 professors)
Institutions for Basic Sciences (four) (10 professors)
Field Station Hyytiälä
Forest Library
International Training Services
University of Joensuu
Faculty of Forestry: (8 professors)
Research Station Mekrijärvi
Academy of Finland
Commission of Agriculture & Forestry
Forest & wood colleges & schools (25)
Foundation for Forest Tree Breeding
Ministry of Agriculture & Forestry
Forest Research Institute
Research Departments (3):
Forest Ecology (6 professors, 8 research specialists)
Forests Growth (4 professors, 2 research specialists)
Forests Resources (3 professors, 9 special researchers)
Regional Research Stations (8)
Research Forests
Total area: 140,000 hectares
Production forests: 80,000 hectares
Research plots: 20,000
European Forest Institute (EFI)
Independent, non-governmental institute established in 1992
Private organizations
Metsäteho (research & development unit for forestry works & forest industry)
Association for Work Efficiency

TABLE 2.4.2
Forest administration: Office for International Affairs, Department of Forestry, Ministry of Agriculture and Forestry

State Forests
Forestry (Income responsible)
Regional District Groups (3)
Nature Protection
Park Districts (6)
Recreation Services
Seed & Plant Production
Districts (2)
Seed Procurement & Tree Breeding
Nurseries (4)
Private Forestry
Forest Centres (2)
Tapio for the Finnish-speaking regions
Skogskultur for the Swedish-speaking regions
Forest Boards (10)
Province of Åland
Seed Centre of Tapio
Central Association of Agricultural & Forest Producers
Unions of Forest Management Associations (19)
Forest Management Associations (341)

(iii) Forest education and research

Researchers at the University of Turku concerned with the national economy have been interested in forestry since the eighteenth century. Experiments to develop cutting methods that ensure natural seeding were established in the first half of the nineteenth century, and the first textbook on silviculture was published in 1885. The academic training of foresters first occurred in Evo in the 1860s. As a part of the teaching, silvicultural methods were investigated and yield tables were prepared for pine, spruce and birch stands.

Forestry education was moved to the University of Helsinki in 1907 and the Finnish Forest Research Institute was established in 1917. State forests were placed under the administration of the Research Institute to "practice model forestry" and experiment with exotic tree species. Research forests became the basis for long-term yield studies and biological experiments, studies in forest improvement and silvicultural methods, and thinning and regeneration regimes. The first research branches also included forest technology and economics.

The Forest Research Institute carried out the world's first National Forest Inventory in 1921-24. The field work, based on statistical sampling, covered all forests and land uses. The inventory has been repeated eight times, with the field work of the most recent one occurring between 1986-94. Forest budgets, prepared using the results of inventories and timber utilisation and removals studies, have been the basis for developing both forestry and the forest-based industries.

The number of teaching and research branches has greatly increased since the 1950s. The Faculty of Forestry was established in the University of Joensuu in 1982 and eight regional research stations with staffs and laboratories have been established for the Forest Research Institute. The rapid growth of the capacity of the Forest Research Institute is illustrated by the current number of academic researchers (about 220) as well as the number of additional researchers involved in research projects, the total of which is about ten times the number of researchers at the end of the 1940s.

The diversity of teaching and research is illustrated by the branches, each directed by a professor: silviculture, wetland forestry, forest soils, tree breeding, forest pathology, forest zoology, limnology, environmental protection, forest mensuration and management, logging technology, wood technology, forest and peat production, forest economics, forest business economics, wood marketing, land use economics and private forestry. Forest industry technologies also have their own teaching, research and development institutes and laboratories (table 2.4.1).

The Government of Finland established the European Forest Institute in 1992. It is an independent, non-governmental research body conducting problem-oriented and multi-disciplinary forest research serving the needs of policy-making in Europe.

(iv) Forest administration and promotion

The first forest administration with employees was established in 1632 when Finland was a part of Sweden. For a long time it was responsible for regulating hunting, safeguarding trees valuable for shipbuilding and those producing edible seeds, and preventing the destructive exploitation of forests. The administration was enlarged into state domains and privately owned land when the division of forests began in the eighteenth century.

TABLE 2.4.3
Structural development of labour force from 1880-2000

	1880	*1920*	*1940*	*1960*	*1986*	*2000* [a]
Agriculture/forestry	86	75	60	35	10	5
Industry	9	16	22	33	31	25
Services	5	9	18	32	59	70
Total	100	100	100	100	100	100

[a] Forecast.

The State Board of Land Survey and Silviculture was established in 1851 when Finland was an autonomic part of Imperial Russia. The national institutions and laws, however, were developed on the basis of the principles of the earlier Swedish period. The State Board of Forestry was separated from land surveying and began independent activities in 1864. It was mainly responsible for continued divisions of forests between the state and private ownership and protecting the crown forests against illegal exploitation. State forests were divided into regional and local areas. When the industrial demand for wood increased, silviculture and the cutting and selling of timber became its major activities. The State Board of Forestry also, for a period, operated a sawmilling and pulping business in northern Finland.

From 1917 onwards, the administration of state forests was developed to supply timber for industry, serve as an employer in rural areas and manage nature protection areas. The State Board of Forestry also supervised private forestry until the 1990s. The Board was then reorganized as a timber-producing enterprise under state control and charged with managing recreation services and nature protection areas on state land.

The need to organize the promotion of private forestry was suggested in the 1860s and the first two forest advisers were employed in the 1870s; the Finnish Forestry Association was established in 1877. Since then it has united all other forestry organisations in the work of promoting forestry and distributing information. Funds were granted to the Forestry Association and local agricultural and economic associations for advising forest owners. A number of forest management associations were established on the initiative of local forest owners (table 2.4.2).

The promotion of forestry was given a legal basis in 1917 with the creation of 18 district forestry boards and two central forestry boards: one for the Finnish-speaking and another for the Swedish-speaking regions. These organisations uphold the law concerning Private Forestry, promote forestry by distributing information, direct and assist forest operations and encourage cooperation between forest owners. District forestry boards were financed by the state and earned incomes by selling services.

The majority of the forestry board members are elected by the forest owners. This self-government of the forest owners, including the enforcement of forest legislation, has proved to be a successful arrangement. Separate forest improvement districts were established for planning and carrying out forest improvement projects financed by the state.

There have been minor organisational changes, such as uniting district forestry boards and forest improvement districts, placing them directly under the Ministry of Agriculture and Forestry and renaming them Forest Boards and Forest Centres. In 1937, the number of the local Forest Management Associations was 303. They received a legal and financial basis in 1950 and they now number 341. Associations are governed by the representatives of forest owners. The membership is voluntary, but every forest owner whose assessed annual yield exceeds 20 m³ is obliged to pay a forest fee to the associations. Associations guide and assist forest owners in all forest works. Organizing the logging and selling of timber has increased in recent years. These activities are supervised by regional unions which are a part of the Central Association of Agricultural and Forest Producers.

TABLE 2.4.4
Forest ownership conditions in Finland, 1922 and 1980
(Per cent)

	1922			*1980*		
	Forestland	*Growing stock*	*Increment*	*Forestland*	*Growing stock*	*Increment*
Private	54.9	50.4	63.3	63.9	70.5	76.3
State	35.3	37.5	21.3	23.9	18.3	11.7
Company	8.0	9.7	10.8	8.0	6.9	7.8
Other	1.8	2.4	2.6	4.2	4.3	4.2

Source: National forest inventories.

(v) Land-use policy

Finland was a agricultural country up to the 1940s when agriculture and forestry still accounted for 60 per cent of the labour force (table 2.4.3). The guiding principle of land use policy has been to promote farming settlements and to increase the land ownership of the agricultural population.

Historically the forests were in unregulated, common use, and were used for cutting timber, pasturing, shifting cultivation and tar extraction. Policy concerning ownership conditions was first introduced in 1775 and has continued since then. Initially the aim was to define the land area where farming was permanently established and to consolidate the boundaries between the farmland including forests and the surplus land, which was designated as state land.

A growing social problem was the great number of leased farm holdings both on private and public land. It was solved by laws enacted from 1918 to 1922. About 120,000 farms and small holdings were made independent, with 16,000 of them on about 860,000 hectares of the former state land.

The expanding forest industry companies also started to buy forestland. The area of land purchased was 2.6 million hectares of Finland's territory before 1945. Municipalities and parishes also bought land. The transfer of private land into company ownership resulted in other social problems. Laws were enacted to stop the development in the 1910s and 1920s. Company land ownership was restricted and companies had to surrender 64,000 hectares of the land they had already purchased.

After the Second World War, the agricultural population of the area ceded to the USSR, about 12 per cent of the Finland's territory, had to be resettled. New

TABLE 2.4.5
Stumpage price incomes, the costs of silviculture and forest improvements by ownership groups and the stumpage price of removals m³
(Million FMK in 1992 money value, per annum)

	1954-55	*1963-64*	*1967-68*	*1970-71*	*1974-75*	*1977-78*	*1979-81*	*1989-90*	*1991-92*
Total stumpage income:	6,453	6,762	4,750	7,877	10,483	7,070	9,753	8,897	5,409
private and others [a]	5,073	5,668	3,669	6,982	8,982	5,609	8,412	7,599	4,199
forest industry companies	851	709	627	393	722	743	656	548	641
state forests	529	385	454	502	779	718	685	750	569
Total costs:		632	1,057	1,207	1,630	1,601	1,363	1,320	1,32
private and others [a]		368	644	800	1,130	1,129	985	1,013	1,098
forest industry companies		118	129	153	226	181	169	102	85
state forests		146	284	254	274	291	209	205	143
Total costs (per cent of income):	9.35	22.25	15.32	15.55	22.64	13.98	14.84	24.51	
private and others [a]	0.00	6.49	17.55	11.46	12.58	20.13	11.71	13.33	26.15
forest industry companies		16.64	20.57	38.93	31.30	24.36	25.76	18.61	13.26
state forests		37.92	62.56	50.60	35.17	40.53	30.51	27.33	25.13
Stumpage value of removals m³ (FMK/m³)	135	133	101	157	254	176	189	175	121

[a] The ownership group "Private and others" includes the forests owned by private persons (93 per cent of the groups' forestland), municipalities, and jointly owned forests.

TABLE 2.4.7
Structural development of the annual raw-material supplies of forest industries and removals
(Unit solid m³ over bark)

	1947-49		*1979-81*		*1989-91*	
	Million m³	*Per cent*	*Million m³*	*Per cent*	*Million m³*	*Per cent*
Industrial:	17.6	100.0	57.7	100.0	57.3	100.0
domestic round wood	16.9	96.0	45.0	78.0	44.0	76.8
imports	-	-	4.0	6.9	6.1	10.7
wood residues	0.6	3.4	8.1	14.0	6.1	10.6
recycled fibre [a]	0.1	0.1	0.6	1.1	1.1	1.9
Removals:	41.0	100.0	51.8	100.0	46.8	100.0
industrial round wood	16.9	41.2	45.0	86.9	42.2	90.2
exports	2.6	6.4	2.0	3.8	0.7	1.5
fuelwood	16.0	39.0	4.1	7.9	3.3	7.0
other uses	5.5	13.4	0.7	1.4	0.6	1.3

[a] One metric ton equals about 2.5 m³ of wood.

TABLE 2.4.6
Cost structure of silviculture and forest improvements, 1963-75

In private forests	*Per cent*	*Type of activity*	*Per cent*
Directly paid by owners	49	Preparation of regeneration area	7
Low-interest state loans	22	Seeding and planting	26
State grants	29	Seedling-stand implement	19
		Fertilization	12
		Drainage of wetlands	20
		Forest road construction	16
Total	100	Total	100

"cold" farms were also established for the war veterans of the agricultural population who were not already farm owners. About one million hectares of forestland owned by the state and private companies were transferred into individual, private ownership.

The Land Use Act of 1958 was enacted to improve the economic and social structure of the existing farms by providing them with additional land. About 500,000 hectares of state forests and 20,000 hectares of company forests were used for these purposes. During the period of independence (since 1917), 2.7 million hectares of state land, 340,000 hectares of company land and 150,000 hectares of parish land have been transferred into private ownership. The concept of family farming was also created.

The mechanization and rationalization of agriculture resulted in a rapid decrease of the farming population. Through the division of land via inheritance and sales between relatives, farm forests are increasingly owned by private persons working in sectors other than farming. Non-farmers now own about 50 per cent of private forest holdings and somewhat less than 50 per cent of private forestland.

The Agricultural and Forestry Land Procurement Right Act was enacted in 1978 to protect the land ownership of farms. According to the Act, companies and non-farming persons must have official authorization to purchase land; and the authorities have the right to buy land and sell it on advantageous terms as supplementary land for small farms.

The average size of private forest holdings was 45 hectares in 1929 and is now about 30 hectares. The number of holdings is increasing while the size of each is decreasing. Developments in forest ownership conditions since 1922 are shown in table 2.4.4.

(vi) Financing the intensification of forestry

Standing trees were long considered to be a free gift, grown by nature, and exploitable in the manner of coal. To traditional farmers, the forest is still regarded more as nature's bank than a productive asset to be maintained by inputs. It is not generally recognized that under the existing growing stock conditions the net forest income can be increased by silvicultural inputs financed by the incomes from timber sales. However, forest improvement on treeless and scrub land is an investment of sufficiently

TABLE 2.4.8
Structural development of energy sources for the forest industries, 1973-92
(Per cent)

	1973	*1992*
Wood based	37	37
Peat	-	3
Hydropower	8	16
Nuclear	-	27
Other purchased electricity	12	-
Natural gas	-	10
Coal	6	4
Oil	37	3
Total	100	100

long term that they are not economically attractive for private persons, as the time necessary for seedlings to become mature stands varies from 80-180 years.

The basic principle has been that private forest owners pay the running silvicultural costs and that the state support long-term investments. State forestry is financed by the state budget and companies pay their own costs. State support is divided into grants and low-interest loans. In the 1920s and 1930s employment funds were used for forest drainage activities; later their primary use was tending young stands (table 2.4.5).

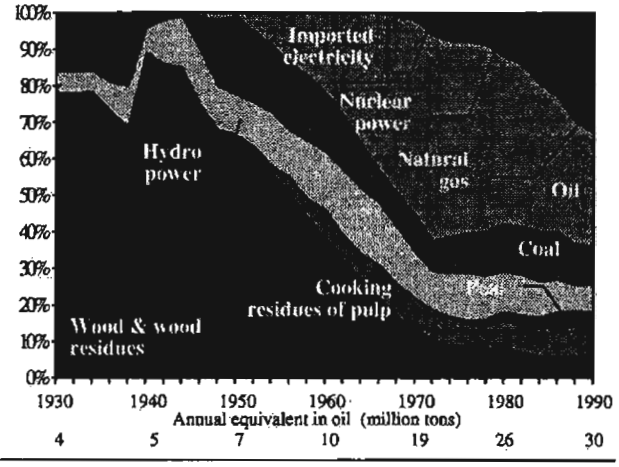
The district forestry boards and forest improvement districts promote forestry and planning. They also carry out forest improvement projects which are financed by the state budget. Incomes from selling services have amounted to 10-30 per cent of the expenditures of the district forestry boards. The basis of the financing of the forest management associations is the forest fee paid by forest owners. It has been 2-6 per cent of the taxable forest income assessed for holdings where the annual yield exceeds 20 m³. The fee has covered 60-70 per cent of the expenses of the forest management associations.

The Forest Improvement Act of 1928 and its later amendments are the basis for financing forest improvement projects. Grants cover the planning and supervision costs of the projects and parts of the labour costs in central and northern Finland. The costs of seeds and plants in forest improvement projects, the afforestation of fields, chemical applications, regeneration of low-producing stands in northern Finland, fertilizer taxes and 60-80 per cent of the costs of tending and pruning young stands have been paid by additional grants and employment funds (table 2.4.6).

Loans for long-term investments, such as forest drainage, are repaid after one to ten interest-free years. Repayment is by annual instalments of 6 per cent, of which 3 per cent is interest and the rest amortization. The annual instalment of loans for forest road construction has been 10 per cent and for the fertilization of growable stands, 18 per cent.

In the 1960s, the Forest Financing-, or Mera-programmes increased the forest improvement inputs. The Bank of Finland issued granted a bond loan of FMK 20 million complementing the state's financing. The World Bank provided a loan of USD 20 million as an addition to the state budget for financing the forest improvement project carried out between 1973 and 1975.

FIGURE 2.4.1
Energy use by primary source, 1930-90



The forest income taxation system applied since the 1920s has been considered a policy instrument intended to encourage both intensive silviculture and the willingness to sell timber. The gross yield of every forest holding was calculated on the basis of site quality, regional average increment and the timber-assortment structure of removals estimated by the National Forest Inventory and from statistics of timber-assortment stumpage prices.

Regional average costs of forestry and some holding costs were deducted from the gross yield and the net yield became the taxable income. The system was changed in favour of taxation of the net timber sales income with a tax of 25 per cent in 1993. For the time being, a forest owner can choose to pay taxes according to the old system for the next 13 years.

(vii) Forest industries as raisers of forest incomes

Industrial wood accounted for about 3 per cent of the total drain of stemwood in the mid-nineteenth century, and 20 per cent at the beginning of the 1920s. It is now 82 per cent. Sawmills created the main demand for timber up to the 1950s. The growing pulp and paper industry created the demand for and set the price of small-size and low-quality timber and so created the basis for thinnings and regeneration cuttings. This development is demonstrated by the structural change of removals by uses. From 1948-1990, the proportion of domestic industrial wood of removals increased from 41 to 90 per cent while the share of fuel and other household wood decreased from 52 to 8 per cent (table 2.4.5).

Consequently, the real stumpage value of removals per m³ rose from FMK 135 in 1954 to about FMK 180 in the 1980s (table 2.4.7). During the same time, gross stumpage-price incomes increased from FMK 6,400 million per year to FMK 9,000 million per year, and net incomes, after deducting the costs of silviculture and forest improvements, rose from FMK 6,100 million per year to FMK 7,500 million per year. The drop of stumpage-price incomes in 1991 and 1992 has been caused by the low prices caused by the deep economic depression prices and the reduced supply of timber from private forests.

TABLE 2.5.1
Forest tree breeding and seed and plant production, 1991-92

1992	Number of trees for breeding	Seed production stands		Seed orchards	
		Number	Area (ha)	Number	Area (ha)
Pine	7,960	602	3,942	176	2,718
Spruce	5,948	252	1,468	22	250
Birch:					
B. pendula	3,281	66	146		
B. pubescens	929	47	111	15	1
Larch	503	3	8	7	49
Other	4,554	23	26	7	8
Total	23,175	993	5,701	227	3,026

1991	Pine	Spruce	Bettula pendula	Bettula pubescens	Larch	Total
Production of seed orchards (kg)	4,136	-	73	-	253	4,462

Seeds and plants used

1991	Seeding	Supplementary seeding	Total	Planting	Supplementary planting	Total
	(kg)			(Thousands of seedlings)		
Pine	11,524			109,465	12,356	121,821
Spruce	65			67,388	10,888	78,276
Other	5			29,277	1,952	31,229
Total	11,594	498	12,092	206,130	25,196	231,326

(viii) Wood as a source of energy

As already noted, wood was long the primary source of energy. The significance of coal and oil grew markedly during the pre-war period. During the war years, wood energy again accounted 80 to 85 per cent of energy production, with hydropower providing 15 per cent and peat 2 per cent of all primary energy. Since then, total energy consumption has increased from 4 million tons of oil equivalent per annum to 30 million tons in 1990. Energy from wood and its residues account for 18 per cent of total production. The wood equivalent is about 20 million m³ per annum (figure 2.4.1).

The oil crisis in the 1970s stimulated efforts to increase the production of bio-energy. The direct burning of wood in households, however, continued to decrease and has stabilized at about 3.3 million m³ per year. Technology and equipment have improved and systems can now burn all biomasses, and also fossil materials, as a mixture thereby minimizing harmful emissions. There are a number of bioenergy units, often together with sawmills, serving the heating needs of small communities (table 2.4.8).

Sulphate pulping produces more bioenergy than it needs for its own operation. A modern pulp mill sells one third of its energy to paper producers and other consumers. In 1992, wood accounted for 37 per cent and peat 3 per cent of the total energy consumed by forest industries. Oil and coal accounted for 3 and 4 per cent, respectively. As a whole, the development the energy mixture in forest industries has considerably reduced the net emission of carbon dioxide per product unit.

2.5 The development of current forestry and forest industries

(i) Forest management planning

Forest planning began during the second half of nineteenth century and in the beginning of the twentieth in state and company forests and in the larger private estates. Plans included the inventory of resources, descriptions and estimates of sites and stands, stand treatment proposals, site and stand maps, estimates of growing stock and its increment and sustainable cut by timber assortments and the production of ten-year forestry programmes.

The district forestry boards and forest management associations increased management planning in private forestry; such plans increased slowly during the 1950s and 1960s, but increased rapidly as a part of regional forestry planning carried out by the district forestry boards and financed by the state budget in the 1970s and 1980s. All private forests have been covered by stand and ownership inventories. The annual field work of the regional inventories covered almost 1 million hectares in the 1980s. Plan coverage now includes about 73 per cent of the area of private forests. Forest owners can buy plans for their forests at about half of the cost of the work required to produce one.

All state, company and municipal forests have management plans based on repeated inventories. The jointly owned forests given to farmers as a part of the settlement policy, and also parish forests, are required by law to have management plans.

National forestry plans are based on the results of the forest inventories covering all the country and carried out by the Forest Research Institute. The field-work years of these inventories are 1921-24, 1937-38, 1951-53, 1960-64, 1964-1970, 1977-84 and 1985-94. The national forestry plans to increase the production of wood, extend silvicultural and forest improvement works and develop forest industries have been as follows: Programme of the Forest Planning Committee (HKLN Programme), 1961; Programme of the Agricultural Committee (Teho-programme), 1962, and a supplementary programme, 1964; Forestry financing programmes: Mera I in 1965, Mera II in 1966 and Mera III in 1969; Variable forestry intensity programme of the Economic Council, 1969; Forest 2000 Programme of the Economic Council, 1985; and Revised Forest 2000 Programme, 1992.

The forecasts for the development of removals, forest resources, inputs to silviculture and forest improvements were usually prepared for the first 10 or 20 years, while growing stock, increment and drain forecasts covered 50 to 100 years.

(ii) Silviculture, cutting methods and forest improvement

The earlier destructive practice of selection cuttings, i.e. removing only the largest trees, has been replaced by silvicultural thinnings and regeneration cuttings. The aim of thinnings is to harvest that part of the crop which would

TABLE 2.5.2
Forestry works, 1950-92
(Thousands of hectares per annum)

	1950-51	*1960-61*	*1965-66*	*1970-71*	*1975-76*	*1980-81*	*1985-86*	*1990-91*
Thinnings			454	190	99	150	195	145
Regeneration cutting:			220	184	123	170	134	122
clear cutting			122	99	93	136	100	88
seedtree & shelterwood			98	85	30	34	34	34
Removal of seedtrees			[a]	146	89	88	43	31
Other cuttings			[a]	6	8	16	31	4
Grand total			674	526	319	424	403	302
Clearing of regeneration areas	72	161	195	161	161	158	139	118
Prescribed burning: [c]	4	16	12	0.7	0.5	1	6	2
Scarification of sites	4	14	73	68	92	123	120	122
Seeding	25	38	69	31	31	25	22	26
Planting	5	32	67	111	94	111	109	100
Total	30	70	136	142	125	136	131	126
Tending seedling stands	38	107	185	212	521	302	269	243
Pruning							7	10
Fertilization	0.0 [b]	0.5 [b]	30	194	204	90	85	8
Drainage of wetlands	9	118	221	268	191	107	69	35
Cleaning of ditches & additional ditching (Thousands of km/year)	1	4	5	4	3	5	9	19
Forest road construction (km/year)	300	854	1,582	2,633	3,741	4,087	3,942	3,700

[a] Included in thinnings
[b] In company and state forests
[c] Average annual area in 1955-59 was 31,000 hectares.

be lost by self-thinning (natural mortality) and to improve the quality of the final crop. Planting and artificial seeding accelerate the establishment of valuable new stands by 10 to 15 years compared with natural seeding on the sites where there are not enough seedlings under the mature trees. Natural seeding is used on barren sandy and gravely sites and on most of the peat lands.

The scarification of regeneration areas accelerates the establishment of new stands by natural seeding. It also advances the release of nutrients, especially on raw-humus sites. Pruning became popular in the 1980s and is carried out in young pine and birch stands in order to secure high-quality, knotless saw wood. Drainage improves the productivity of wetlands and mineral sites where stagnant water obstructs the growth of trees. Forest drainage has been a major input, increasing the increment of the growing stock in conditions where wetlands cover one third of forestry land. Clear cutting and the seed-tree method of regeneration increases the amount of solar radiation reaching the surface soil. Together with scarification and prescribed burning, they maintain the succession of plant communities, soil fertility and biodiversity. The construction of forest roads is another essential forest improvement input. It makes economic logging and silviculture feasible. Roads also open large forest areas for recreation and other uses (tables 2.5.1-2).

(iii) Results of progressive forestry

Improved cutting methods, intensified silviculture, regeneration of low-producing stands, forest drainage and fertilization have each improved the productive quality of the forests and created the basis for a long-term increase in wood resources. The major achievements since 1950 are shown in table 2.5.3.

According to the results of the National Forest Inventories, the growing stock decreased slightly at the beginning of the 1960s, after which it started to increase. It has increased by 22 per cent during the period 1952-90 in spite of considerable felling (table 2.5.4). The drain of stem volume from the growing stock has been 1.33 times as great as the initial growing stock in 1952. However, the increment of the growing stock has increased by 44 per cent, thereby more than compensating for the considerable fellings. The share of sawlogs in the growing stock increased from 34 per cent in 1952 to 40 per cent in 1980 due to improved thinning methods.

TABLE 2.5.3
Major achievements of progressive forestry in Finland since 1950

Clearing regeneration areas	6,671,000 ha
Scarification	2,990 ha
Prescribed burning of regeneration areas	372 ha
Seeding and planting	4,564 ha
Tending of seedling stands	10,000 ha
Pruning (since 1983)	95 ha
Forest drainage (650,000 hectares before 1950)	5,317 ha
Fertilization	3,100 ha
Cleaning of ditches and additional ditching	248,000 km
Construction of forest roads	107 km

The development of the growing stock's age-class structure demonstrates the effectiveness of post-war forest policy. The area of young stands (1-40 years old) was 1.2 million hectares greater and the area of old stands (older than 101 years) and 1.2 million hectares smaller in 1980 than in 1952. The stock density of the growing stands has increased markedly (table 2.5.5).

Concerning tree species composition, the proportional area of stands dominated by broad-leaved trees decreased from 15 to 8 per cent by 1973. Since then it has slowly increased. Birch, originally established in areas of shifting cultivation, has become intermixed amongst coniferous trees. The general appearance of forests is becoming a mixture of tree species except on barren sites where pine has been the dominant tree even under natural conditions.

TABLE 2.5.4
Development of growing stock volume, its increment and tree-species composition, 1937-90
(Per cent)

	1937 [a]	*1952*	*1967*	*1973*	*1980*	*1990* [b]
Growing stock: [c]	1,411	1,538	1,491	1,520	1,660	1,880
pine	46	44	44	45	45	45
spruce	32	35	37	37	37	37
broad leafed [d]	22	21	19	18	18	18
Total	100	100	100	100	100	100
Share of sawlogs	30	34	39	41	40	
Increment: [e]	50	55	57	57	68	79
pine	42	39	39	39	41	43
spruce	35	37	40	40	37	35
broad leafed [d]	23	24	21	21	22	22
Total	100	100	100	100	100	100

[a] On the current area of Finland. Resources were about equal in 1923.
[b] Updating 1.1.1990.
[c] Growing stock is indicated in million m³.
[d] Birch dominates. The proportion of grey alder has varied in the estimates from 1.1 per cent to 1.8 per cent and that of aspen from 1.1 per cent to 1.4 per cent. Both proportions have increased since 1952.
[e] Increment is indicated in million m³/a.

TABLE 2.5.5
Development of stand areas in different age classes, 1952-80

	South Finland	*North Finland*	*Entire country*
Class (years)	*Change in age class areas (Thousands of ha)*		
Regeneration area:	+228	+290	+518
1-40	+2,077	+1,161	+3,238
41-100	-1,218	+900	-318
101-140+	+443	-1,174	-731
Total	+1,530	+1,177	+2,707
	Per cent of area in 1980		
Regeneration area:	3	4	3
1-40	35	23	30
41-100	52	37	46
101-140+	10	36	21
Total	100	100	100

[a] During this period the earlier category of productive forestland increased by 2.7 million ha to the present forestland area.

The increased production potential is illustrated by the alternative treatment of forest resources estimated in the Forest 2000 Programme (table 2.5.6). If removals remain at the current level, the growing stock will double its volume in 2030 compared with 1990. Sustainable removals can be increased from the current 51 million m³ per year to 85 million m³ per year in the period 2020-29.

The concern about forest damages in Europe in the 1980s, characterized by defoliation and discoloration of needles and leaves and attributed to industrial emissions, traffic and consumption, have instigated research projects to study the phenomenon. In Finland, about 3,000 systematically located permanent sample plots were established and studies have been carried out to identify the causal relationships of forest damage.

Currently, the general health of forests can be regarded as satisfactory. There have been changes in species composition, for example, in the proportional amounts of lichens. Nonetheless, the stem wood increment of growing stock continues to increase. All tree species in the production forests are the original local ones. Their ability to renew and maintain the forest ecosystem is, so far, as strong now as it was in the natural forests before man. Wood resources do not restrict the increase and diversification of forest industries or the use of wood for

TABLE 2.5.6
Development forecasts for removals, growing stock and gross increment according to revised Forest 2000 Programme, 1992

Forecast 1: Removals continue along the annual averages of 1985-89

	1990-99	*2000-09*	*2010-19*	*2020-29*	*2030*
	Removals (million m³) over bark, per annum				
Pine	22.2	19.9	20.2	21.3	
Spruce	19.5	19.3	18.8	18.2	
Birch	7.0	8.0	9.6	8.7	
Other broad leafed	1.6	2.0	2.3	2.1	
Total	50.5	49.2	50.9	50.3	
	Growing stock (million m³)				
Pine	794	916	1,134	1,468	1,919
Spruce	672	751	835	946	1,117
Birch	265	313	350	367	390
Other broad leafed	59	69	72	69	67
Total	1,790	2,049	2,390	2,851	3,494
	Gross increment (million m³/a)				
Total	76.4	83.3	97.0	114.5	

Forecast 2: Greatest possible removals in 1990-2029 if all mature stands and silvicultural thinnings are harvested

Removals	105.1	68.6	54.3	61.3	
Growing stock	1,790	1,392	1,334	1,547	1,890
Gross increment	65.3	62.7	75.6	95.6	

Forecast 3: Greatest possible sustainable removals

Removals	67.1	80.7	83.9	88.8	
Growing stock	1,790	1,859	1,798	1,750	1,712
Gross increment	74.0	74.6	79.1	85.0	

energy. The increased wood production capacity also gives more opportunities to establish nature protection areas.

(iv) Diversified forest industry

Sawn wood, pulp and relatively low-grade papers and paperboards, matches, wood wool and bobbins were the main products of the forest industries up to the end of the 1940s. Since then, production has been greatly diversified and the processing value of products has been increased. There are now several grades of wood-based panels, printing, writing and other papers, paper boards and converted paper and paper board products (see tables 2.4.7-8, 2.5.7-9).

(v) The forest sector as an employer

Before the mechanization of forest work, forest labour was supplied by the farming population and people living in rural areas. Until the 1940s, the labour input for gathering fuel and household wood was greater than that of logging and transportation of industrial roundwood (table 2.4.3).

Agriculture's demand for labour and horses was greatest in summer months while forestry dominated in the winter when frozen wetlands and waters and snow made it possible to transport timber by horses and sledges, (complemented by trucks by the end of this period). Floating in rivers and lakes was the major means to transport timber. The first mills were built adjacent to rivers, which provided water power, and at river mouths. Floating was most intense in the spring and early summer

TABLE 2.5.7
Structural development of forest industries' production illustrated by the multipliers of the main product groups, 1947-92

	Multiplier	
	1947-49 to 1979-81	*1971-81 to 1990-92*
Basic industry:	3.0	
Mechanical wood industry:	2.5	0.90
sawnwood	2.2	0.72
veneer and plywood	2.9	0.84
wood-based panels	19.8	0.54
Pulp:	4.7	1.20
sulphite	1.3	0.27
sulphate	9.0	1.27
semi-chemical	new	1.16
mechanical	4.4	1.36
Paper and paper board:	8.9	1.59
newsprint	4.9	0.83
kraftpaper	8.8	0.81
writing and printing	c. 67.0	2.39
other paper	c. 1.9	1.46
paper board	12.1	1.33

when water courses were full of melt water. There was very little or no demand for labour for silvicultural works in this time. Wetland draining did not begin until the 1930s.

The felling and bucking of trees was done by axe and handsaw and barking by hand tools. Long-distance floating was complemented by railways and trucks. If the seasonally fluctuating labour input in commercial logging is calculated in working years, the number is much smaller than the number of people involved, indicating that most of the agricultural population worked in one way or other for various durations in procuring timber for industry (table 2.5.10).

This period ended at the beginning of 1950s, but the number of working years in forestry still varied from 110,000-140,000 per annum depending on the business cycle. The number of monthly workers ranged form 60,000 to 186,000 in 1964. In 1951, barking and floating accounted respectively for between 5 and 6 per cent of the total 94,000 working years in commercial forestry, while 60,000 horses accounted for 15,000 working years .

The motorization and mechanization of agriculture began in the 1950s. The supply of workers and horses for forestry decreased and the cost of labour increased. Forestry met the challenge by motorization, mechanization and rationalization (table 2.5.11). The rapid structural development is demonstrated by the statistics as follows.

The use of axe and handsaw ended in the 1970s. Workers with chainsaws became dominant in the 1960s and continued until around 1980. Multi-process harvesters were introduced at the beginning of the 1970s, and by 1990 they accounted for 50 per cent of all prepared timber assortments and 15 per cent of thinnings. Their share will be around 90 per cent by 2000. Debarking is now done at the mills.

The number of horses used decreased from the 1960s and their use was terminated in the 1980s. Farming tractors became popular in the 1950s, but turned out to be uneconomical in forest terrain. Their main use is now in the delivery procurement of timber from farm forests.

TABLE 2.5.8
Production and exports of forest products in 1992

	Production/export unit	*Production*	*Export*	*Production (per cent)*	*Mills (number)*
Wood industry:	1000 m³	7,789	5,164	66	4,358
sawnwood	1000 m³	6,900	4,649	67	c. 4330
plywood		462	375	81	20
particle board		354	95	27	6
fibre board		73	45	62	2
Pulp:	1000 tn-m.t.	8,525	1,289	15	44
sulphite	1000 tn-m.t.	54	9	17	1
sulphate		4,859	1,187	24	17
semi-chemical		456	10	2	4
mechanical		3,156	83	3	22
Paper:	1000 tn-m.t.	7,069	6,293	89	29
newsprint	1000 tn-m.t.	1,257	1,146	91	..
kraftpaper		407	298	73	..
writing/printing paper		4,972	4,525	91	..
other paper		432	326	75	..
Paper board	1000 tn-m.t.	2,078	1,753	84	16
Total paper/paperboard	1000 tn-m.t.	9,147	8,046	88	45
Converted paper/ paperboard products	1000 tn-m.t.		273		
Recycling fibre:	1000 tn-m.t.				
recovery		456	38		
percentage of consumption		45			
Sawlogs	1000 m³		125		
Pulpwood	1000 m³		185		
Other roundwood	1000 m³		31		
Fuelwood	1000 m³		1		
Chips	1000 m³		213		
Wood residues	1000 m³		5		
Poles (40 per cent of them impregnated)	1000 m³		140		
Roughly square-edged wood	1000 m³		21		
Total	1000 m³		721		

TABLE 2.5.9
Export value of forest industry products, roundwood and poles, and the import value of roundwood in 1992

	Million FMK	*Per cent*
Total forest industry:	7,214	18.4
sawnwood	4,687	12.0
plywood and veneers	1,638	4.2
wood-based panels	204	0.5
other wood products	685	1.7
Pulp	2,865	7.3
Total paper:	20,028	51.1
newsprint	2,658	6.8
kraftpaper	1,105	2.8
writing and printing paper	14,752	37.6
other paper	1,513	3.9
Paperboard	6,674	17.0
Converted paper and paper board products	2,061	5.3
Recycling fibre	42	0.1
Forest industry total	38,884	99.2
Other wood exports:	303	0.8
roundwood and wood residues	144	0.4
poles and roughly square-edged wood	159	0.4
Grand total	39,187	100.0
Value of imported wood	1,334	

Forwarders started to increase in the 1960s, accounting for more than 90 per cent of forest transport in 1990.

Floating accounted for 65 per cent, railways for 20 per cent and trucks for 15 per cent of long-distance transport in 1950. In 1990, the corresponding shares were 15, 10 and 75 per cent. Floating is now carried out by bundles in lake courses. The last loose floating (on the Kemi River) occurred in 1991.

TABLE 2.5.10
Working years in forestry, logging and floating at the end of the manual power epoch (1951)
(Total working years per annum at the beginning of the 1950s: 100,000-140,000)

Thousand working hours							Number of horses
Felling	Hauling	Barking	Floating	Other works	Total	Horses	
53.5	19.6	4.5	5.8	10.4	93.8	15.5	60,000

TABLE 2.5.11
Machines operating in harvest and transport, 1982-92

Year	Harvesters	Forwarders	Farm tractors	Trucks
1982	160	2,100	1,000	2,000
1987	330	1,600	1,000	1,600
1992	650	1,200	100	1,300

TABLE 2.5.12
Number of persons employed in the forest sector at the beginning of the 1990s

Sector	Persons employed
Forestry	40,500
Sawmilling	13,500
Other wood industry	22,100
Furniture industry	13,600
Pulp industry	6,200
Paper industry	28,100
Conversion of paper products	8,500
Total	132,500
Branches of energy, transport, trade metal industry and services associated directly with forest sector	43,000

Note: Including effect on investments and consumption the employment multiplier effect is 1.5-2.0.

Timber is sold either standing on the stump or as timber assortments logged by farmers (delivery sales). Standing timber is logged by buyers or increasingly by contractors who also perform the silvicultural and forest improvement work. During the 1960s, and at the beginning of the 1970s, delivery sales accounted for more than one-third of the total harvest. The share decreased in the 1980s and is now about 25 per cent.

The productivity of labour rose 4 per cent per annum in felling and bucking and almost 9 per cent per annum in forest transport in the 1980s. Mechanization and rationalization effectively restricted the rise of logging costs when labour prices rose; this made it possible to maintain high stumpage prices compared with other countries in the Boreal zone.

The labour force employed in the forest industries was 120,000 in 1980 when the rapid growth of production levelled. Rationalization and automatization had decreased employment to 92,000 by 1990. At the beginning of the 1990s, 132,000 people, or 5.3 per cent of the labour force, were employed in the forest sector (table 2.5.12). Of these, 40,500 were employed in forestry, 49,200 by the mechanical woodworking industries, 34,300 were in pulp and paper and 8,500 were in converted paper and paper board industries. The industrial branches directly servicing the forest sector employed 43,000 persons. Including the effects of investments and consumption, the employment multiplier effect is about 1.5-2.0. The structural development of forest industries has diversified the labour force and raised its professional competence. Further, exporting forest sector know-how is a flourishing branch of consultancy (table 2.5.13).

TABLE 2.5.13
Value added of forestry in the national economy in 1990

	Million FMK	Per cent
Operating surplus, of which:	8,016	1.79
net stumpage earnings	6,612	1.48
income from delivery sales & value of own work	589	0.13
logging entrepreneurs' incomes	538	0.12
other operating surplus from logging	57	0.01
operating surplus from silviculture & promoting forestry	220	0.05
Cost of wear & tear on capital	2,164	0.49
Other indirect taxes	11	0.00
Subsidies	-31	-0.01
Wages & salaries, of which:	2,339	0.52
logging	1,592	0.35
silviculture & promoting forestry	747	0.17
Employer contributions to social security schemes, of which:	559	0.13
logging	378	
Silviculture & promoting forestry	181	
Other		0.66
Total	13,058	2.92
Value added in basic values:		
wood industry	6,561	1.46
paper industry	13,459	3.01
Forest industry:		
share of industrial production		19
share of total exports (approx.)		40
share of net export earnings (approx.)		50
Total	20,020	4.47
Total forest sector	33,078	7.39
Total national economy	447,526	100.00

(vi) The multiple use of forests

Forests have always had multiple uses. Wood, foliage, edible plants and game were the products for the first people who lived as a part of the forest ecosystem. Throughout time, shifting cultivation, pasturing, gathering foliage for cattle, tar extraction and charcoal burnery, picking wild berries and mushrooms, reindeer husbandry and recreation have been self-evident uses of the forests.

The modern concept of multiple-use forestry is a product of the welfare society where the proportion of people working in primary production is very small. The majority of people have become estranged from their material dependence on forestry and consciously demand leisure-related benefits from the forests. Multi-functional forestry is fashionable. Most of the conflicts between wood production and other use are more artificial than real in a country like Finland where there is 4.0 hectares of forestland and 5.3 hectares of forestry land per capita; especially when given the right of free access (every man's rights).

Other forest products such as wild berries, mushrooms, decorative lichen, game, reindeer meat and skins and peat have a notable income value, especially in rural areas, in addition to their recreational and landscape values. Forest roads have opened vast areas for multiple-use activities (table 2.5.14). Forest landscapes are a resource for both domestic and international tourism. Maintaining pleasant landscapes, nature protection areas and natural monuments is an essential part of multiple function forestry.

(vii) The protection of forest nature

TABLE 2.5.14
Additional forest products

Product	Million FMK per year (1991-92)
Blueberries	13.3
Lingonberries	34.1
Cloudberries	11.4
Mushrooms	8.2
Decorative lichen exports [a]	11.0
Total	78.0

[a] 1992 only.

Game animal	Number per hunting year (1990-91/1991-92)
Gallinaceus	395,000
Farmland game-birds	136,000
Waterfowl	882,000
Hares	362,000
Fur animals	298,000
Elk and deer	52,000

Reindeer stock and meat production, husbandry year 1990-91

	Number slaughtered		Meat production
Number in round-ups	> one year old	calves	(Million kg)
429,000	57,000	123,000	4.0

Peat resources and production in 1992

Total resources		Exploitable resources		Production	
Area [a]	Peat store [b]	Area [a]	Fuel peat store [b]	Fuel peat [c]	Agric. peat [b]
1,171	34,240	872	19,250	6,645	1,784

[a] Area indicated in thousands of hectares.
[b] Measured in million m³
[c] Thousand tonnes.

The idea of establishing areas for scientific research and enjoyment where forests and other ecosystems remain outside all production activities was first expressed in 1880. The first nature protection areas were established in state forests in the 1910s and given legal status by the Nature Protection Act amended in 1923 an since renewed many times.

A network of nature parks for research and national parks as natural recreation areas was established in the 1930s. Land owners have also proposed the establishment of smaller areas and natural monuments on their land, propositions which are sanctioned by county councils. The National Board of Forestry, the Forest Research Institute and private industries have also established stands and smaller areas to be maintained outside of wood production (table 2.5.15).

After the Second World War, the great need for timber, efficient logging methods and motorized transportation allowed production to begin in the forests of eastern and northern Finland; prior to this time, these forests were in a virgin state. This initiated activities in the 1960s, which continue to increase nature protection activities today.

TABLE 2.5.15
Nature protection areas by forestry land class in Finland by region, 1992

	Forestland	Scrubland	Wasteland	Total
South Finland [a]	34	10	34	78
corresponding land class [b]	0.3	1.6	8.8	0.6
North Finland [a]	411	665	1,343	2,419
corresponding land class [b]	4.8	26.3	50.4	17.5
Whole country [a]	445	675	1,377	2,497
total forestry land [b]	2.2	21.4	44.0	9.2

[a] Area indicated in thousands of hectares.
[b] Per cent.

Number and proportion of types of nature protection areas, 1989

	Number	Per cent
Strict nature reserves	15	10.0
National parks	20	43.2
Areas under the Nature Protection Act	764	1.3
Virgin forests	160	1.8
Nature management forests	300	13.4
Wetland reserves	182	28.9
Protected wetlands	46	1.4
Total	1,487	100.0

On the basis of the proposals made by the National Parks Committee, in 1978 the Government decided to establish seven new nature parks and 17 national parks. The programme has been complemented by establishing nature protection areas on wetlands and nature management and wilderness areas, the latter two mostly in northern Finland. The area of nature protection areas was about 710,000 hectares in 1977, and now stands at 2,499,000 hectares.

Nature management areas are treated by cutting regimes which maintain the natural qualities of the landscape and encourage recreation. Parts of the wilderness areas are under regulated forestry. All other nature protection forests, as well as national parks, are strict nature reserves. Reindeer husbandry is allowed in the northern nature and national parks.

The establishment of nature protection forests continues in southern Finland. Current activities are aimed at maintaining the biodiversity of forests by designating areas where commercial activity is prohibited.

2.6 Towards sustainable development and the management of biodiversity

Mankind's increasing pressure on natural resources to provide for its vital needs, global deforestation and the threats to forest biodiversity have led to much research and activity; the aim of this work has been to determine its principles and to initiate measures to achieve sustainable development as defined by the Brundtland Committee and the United Nations Conference on the Environment and Development in Rio de Janeiro.

Sustainable development aims to preserve the basis of life and welfare of mankind now and in the future, and to use natural resources in such a way that the functioning of ecosystems and their biodiversity are maintained. A primary target is to stop the net emission of carbon dioxide into the atmosphere and to prevent potentially disastrous climatic changes.

Forestry has a key role in the strategy of sustainable development. Forests form the largest terrestrial ecosystems with their rich diversity of plant and animal species. Natural forests assimilate atmospheric carbon and solar energy into the biomass and release them during decomposition. Carbon recycles to the growing trees and energy flows through the ecosystem of an entirely natural

TABLE 2.6.1
Carbon in the forest ecosystem in 1990

	Million tons	*Per cent*	*Per cent*
Total trees:	740	100	26
stemwood	410	56	15
branches	120	16	4
foliage	40	5	1
roots	170	23	6
Ground vegetation	30		1
Ground vegetation, 0-30 cm	2,040		73
Grand total	2,810		100

forest without satisfying the needs of mankind (figure 2.6.1, table 2.6.1).

Growing and using wood is a part of the natural circulation of carbon and the flow of energy (table 2.6.2). Therefore, replacing fossil fuels and the commodities prepared by fossil energy reduces the net emission of carbon. Increasing forest biomass as a carbon sink also reduces the net balance of carbon in the atmosphere. As an example, the current increase of the Finnish growing stock, accomplished by intensified silviculture and forest improvement measures, has assimilated an amount of carbon which equals about 70 per cent of Finland's total annual emissions from fossil fuels in 1992.

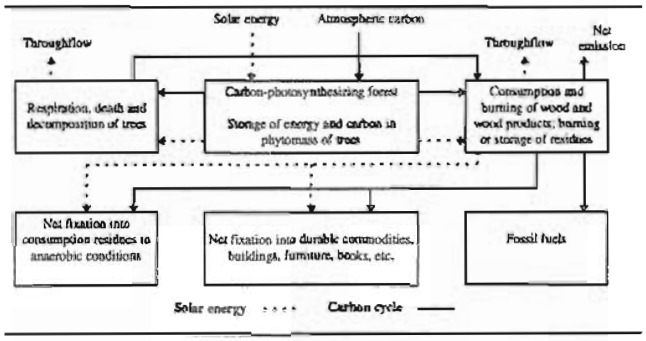
The qualities of Boreal tree species guarantee the ecological sustainability of forests. The hierarchical system of interacting plants, animals and micro-organisms is adapted to maintaining its functions under a wide range of natural and anthropogenic environments. Its biodiversity is also dynamic with constantly changing species compositions.

The elements of biodiversity include natural and cultural habitats which can be maintained by planned production measures and strict natural reserves. The basis of a rich biodiversity is to maintain the cycling of pioneer and climax forest plant associations in due accordance with the laws of fire ecology. Wildfires have been eliminated. Shifting cultivation and forest pasturing cannot be reintroduced. The only way to maintain biodiversity based on the cycling of plant and animal successions is wood-producing forestry combined with ecological management.

TABLE 2.6.2
Stemwood and the carbon balance in 1990 and carbon emissions from fossil fuels in 1988

	Volume (million m³)	*Dry weight (million t.)*	*Carbon*
Growing stock (1.1.1990)	1,880.0	781.1	403.1
Gross increment	79.0	32.8	16.9
Drain:	55.0	22.8	11.8
natural losses	1.3	0.5	0.3
fellings:	53.7	22.3	11.5
logging residues	4.8	2.0	1.0
removals:	48.9	20.3	10.5
sawlogs	21.2	8.8	4.6
pulpwood	24.3	10.1	5.2
fuelwood	3.4	1.4	0.7
Growing stock (31.12.1990)	1,904.0	791.1	408.2
Net annual increase	24.0	10.0	5.1
Carbon emissions from the use of fossil energy, including peat, in 1988			14.7

FIGURE 2.6.1
Flow of solar energy and carbon in the atmosphere, and forests and forest products as sources of net carbon emissions



Finnish forestry is geared to manage biodiversity by planning and implementing methods of silviculture and logging which maintain the cycling of plant communities (and resemble the fire ecology process) and by preserving and increasing natural and cultural habitats inside production forests to compliment the strict natural reserves. The target of commercial wood production and biodiversity management is to satisfy the material, immaterial and cultural needs of society and support global sustainable development.

Chapter 3

FRANCE

G.-A. Morin

3.1 Background

This brief paper is not designed to re-write the history of forestry institutions, a subject which has been covered many times, but rather to try to reconstitute what may have been the evolution of the forest fabric as an element of the rural environment. This chapter will examine the evolution of the forest area *vis-à-vis* other uses of the rural environment, that of the nature of forest stands, and that of other elements external to the forest, such as the population (especially farmers) and the level of technology applied in farming.

On the basis of the available information, two distinct periods may be identified. The first runs untill the end of the eighteenth century, for which no consolidated national statistics are available. The second began in 1800, when a statistical office was established within the Ministry of the Interior, which at the time also covered agriculture. The agricultural statistics contain a forestry component, but until the Second Empire, the Forestry Department (Eaux et Forêts), which dealt essentially with the management of State-owned land, fell under the administrators of State property, and thence the Ministry of Finance.

The first major statistical survey of forests dates from 1912. It bears the name of State Councilor Daubrée, Director-General of the Forestry Department, whose initiative it was. Only in 1958 was it decided to draw up a National Forest Inventory, and the complete results of the first cycle were not published until 1980.

3.2 Principal problems encountered since the beginning of the nineteenth century

(i) Changes in the national territory

Since the beginning of the nineteenth century, the principal changes in the French national territory were the incorporation of Savoy and Nice in 1860 (around 300,000 hectares), the German annexation of Alsace-Moselle spanning from 1871 to 1918, and from 1940-44 (450,000 hectares), and the Italian annexation of Corsica in 1943 (175,000 hectares).

The annual farming statistics take these changes into account. Therefore, corrections must be made if we are to abide by the principle of measuring changes within the internationally recognized borders at the time of the 1992 survey.

(ii) Changes in the elements measured

(a) Definition of forestland

The definition of forestland varies according to the source of the statistics. Until the National Forest Inventory was established and the Ter-Uti survey implemented, cadastral sources systematically under-estimated the area of forest in favor of waste and cleared land, obviously for reasons of taxation.

(b) Nature of tree species as "forest" species

Poplar has only been recorded separately in the statistics since 1936. Chestnut stands and osier beds (the latter category being residual at the time it was eliminated) were recorded separately until 1967, but formerly cultivated chestnut stands were progressively included under forest areas as they were abandoned.

(c) Other land uses

In 1990, built-up land and infrastructure covered 4 million hectares, or 7.4 per cent of the national territory (table 3.2.1). At the beginning of the nineteenth century, it is estimated that it covered 0.5 million hectares, or 1 per cent of the territory. In 1990, heathland, maquis, water bodies and wetlands, and land with outcropping parent rock covered 4.8 million hectares, or 9 per cent of the national territory. The area covered by water bodies and wetlands, and outcropping rock totaled 1.8 million, an amount which has remained stable for two centuries.

The category of *heathland, fallow, etc.*, on the other

TABLE 3.2.1
Population and land use in France by period
(Million hectares)

Period	Population (million)	Agri. land	Forest land	Heathland, fallow, etc.	Built-up areas, infra-structure	Unproductive land, water & rocks
1000	8-10	14-15	26	12-14	E	2
1300	20-22	27	13	12-14	E	2
1450	10-12	16-17	22	12-14	E	2
1700	22.5	30	8-9	12-14	0.5	2
1827	30	31.5	7-8	12	0.5	2
1840	32	31.5	8.4	12	1	2
1862	35	34	9	8	1	2
1914	40	34	10.2	6.5	1.3	2
1990	56	31	15	2.8	4	2

Note: The area figures are adjusted to a total area for France of 55 million hectares. Heathland, fallow, etc., and built-up areas have not, until recently, been the object of precise statistical measurement.

hand, has fallen sharply since the nineteenth century, dropping from 9.2 million hectares in 1840 to 5.7 million hectares in 1938, and to 2.5 million in 1990. The changes in this category are important in tracing the relationship between forested areas and cultivated agricultural areas. At the beginning of the nineteenth century, areas such as the Landes in Gascony or Champagne Crayeuse fell into this category. Since then, the Landes of Gascony have been almost completely reforested, whereas following the afforestation at the end of the nineteenth century, the Champagne Crayeuse was almost entirely cleared after the Second World War. On the other hand, in the case of Corsica, there has been a reduction of almost 80 per cent in cultivated areas in favor of maquis and garrigues, without any expansion of forested areas proper. This same phenomenon may be observed, though on a smaller scale, in the entire Mediterranean zone.

Progress in technology and farming practices have considerably reduced the extent of these areas, the use of which is often not clearly defined. This problem of marginal lands, which in the past was important in a country like France, remains so today in the northern part of the mainland and in the Mediterranean zone.

3.3 Outline chronology

(i) From the Middle Ages to the end of the eighteenth century

The first statistical assessments did not appear untill the end of this period, with that of Vauban in 1707, Young in 1788 and the Comité des Domaines in 1792. A number of historians have since conducted assessments by cross-checking the methods used to survey the forest area, which may be worth comparing with population assessments.

During this period, the relationship between population and forests was based primarily on competition for space. Changes in the area of agricultural land under cultivation may therefore be compared with changes in population, especially in view of the fact that technical progress in agriculture was extremely slow. One may even discern a long-term trend for the farming potential of certain newly cleared land to be exhausted in the absence of fertilizer and other improvements.

Throughout this period, heathland, fallow land and forests played a supplementary role for rural populations. Unlike farming plots, which were subject to individual appropriation, such areas were managed in an essentially collective way.

Under these circumstances, the demographic difficulties of the fourteenth century constitute a major event that went hand in hand with a renewed spread of the forests. Indeed, it was not until the eighteenth century that the French population returned to the level at which it stood at the end of the thirteenth century.

On the basis of assessments made by Huffel in his Histoire des forets françaises, forested areas in the tenth century are estimated at around 25 million hectares with a population of the order of 10 million. The twelfth century was the time of the moines-défricheurs, monks who cleared forests for cultivation; the word défricher, or "clearing", acquired a positive connotation that it retains today in its figurative uses. At the end of the thirteenth century, the area under forest had fallen to 13 million hectares, while the population stood at around 22 million.

The population slump in the fourteenth century reduced the population to some 12 million, and so it may be hazarded that the forested area rose back above 20 million hectares. While the plague of 1358 and the impact of the Hundred Years War are often mentioned, it seems that a state of crisis prevailed from the beginning of the fourteenth century that could be attributed to an imbalance between the population and the natural environment.

The appearance of new needs from the first industrial activities resulted in the problem of wood supply becoming a preoccupation of the political authorities from the beginning of the sixteenth century. In the seventeenth century, at the time of Colbert's ordinance (1669), few forest assessments were available; the evaluation made by Vauban in 1707 suggests a total area of 6.8 million hectares: markedly less than the figure recorded in the thirteenth century with an equivalent population.

A number of explanations are proposed, such as: the cumulative effect of a slow decline in agricultural yields, necessitating cultivation of larger areas to maintain the level of production; the cumulative impact of encroachment and grazing on the state of forests, which could have lead indirectly to clearing; the initiation of a definite process of urbanization, which gave rise to new demand for building timber and fuelwood; requirements for shipbuilding and the appearance of the first factories; and the definition of forests which was adopted.

At the end of the eighteenth century substantial areas were beginning to be taken up for urbanization and infrastructure, the overall situation regarding forests had not improved, and the total area under forest remained stable. However, growing industrial needs were leading to a deterioration of the areas remaining under forest and to increasingly short coppice rotations.

(ii) Since the beginning of the nineteenth century

Contrary to what is widely thought, the first statistics do not show any substantial deterioration in forested areas by the end of the Revolution and Empire periods, but rather the accentuation of an earlier process.

The principal changes relate to: the disappearance of forest privileges and collective management methods; the Civil Code (1802), which propagated the strict "Roman" concept of the right of ownership, and the Forest Code (1827), which drew out its implications for forest management; the emergence of new energy sources, which lessened the importance of fuelwood; and the near disappearance of demand for marine timber, which had hitherto been of strategic importance.

Industrialization and improved communications brought about the increases in agricultural productivity and the beginning of migration to the cities. For example, during the period 1856 to 1956 one may observe a steady increase in the area under forest, which may be related to an equally steady decline in the proportion of the French population dependent on agriculture.

The increase in forested area was not always accompanied by a corresponding fall in area under crops: a substantial part of heathland and fallow land may have been developed for forestry purposes just as much as for farming purposes, in which case it offset the spontaneous or planned afforestation of certain areas progressively abandoned by farmers.

In the nineteenth century, forests were assigned new functions, and especially a protective role: a 90,000 hectare dune forest was established on the coast of the Landes in Gascogny at the beginning of the nineteenth century, and protection forests were established over more than 400,000 hectares, principally in the southern Alps and the Pyrenees.

The afforestation of the Landes in Gascony, begun under the Second Empire, eventually produced a man-made forest of 1 million hectares. As we have seen, the reforestation of more than 100,000 hectares in Champagne Crayeuse produced mixed results and was not permanent. Sologne (200,000 hectares) was also a major reforestation operation of that period.

During the first half of the twentieth century, the area under forests remained stable, rising gradually from 10 to 11 million hectares. The observed substantial increase since then would seem to be due to an actual decline in farming, a decline in areas of heathland, maquis and fallow land, and the active afforestation policy resulting from the establishment of the National Forest Fund in 1946. The Fund has financed two million hectares of reforestation, with only 50 per cent involving extensions of existing forests.

The first findings of the National Forest Inventory show that areas under forest had been underestimated. The series of agricultural statistics (which became Ter-Uti) included a redefinition at the end of the 1060s that led to an increase of almost 1 million hectares in the estimate of total forested area.

3.4 Forest uses

(i) State forests

For the State, forests are a part of the national heritage. The importance of the State as a major land owner is one of the typical features of forests, in contrast to agricultural activities (chart 3.4.1). It is estimated that State land holdings stood at 675,000 hectares at the beginning of the seventeenth century, 933,000 hectares in 1790, 2,300,000 hectares under the Revolution (and after the nationalization of property belonging to the clergy and emigrés), 1,280,000 hectares in 1827, and 1,760,000 hectares in 1992. It is likely that the substantial fluctuations recorded during the Revolution and Empire periods account for the mistaken impression of a shrinkage in forested area during that period.

The role of State-owned land in the budget may be estimated as follows (chart 3.4.2): land-related revenue in 1787 represented 1.2 per cent of the State budget, 1.7 per cent in 1877, and 0.15 per cent in 1992 (though not actually included in the budget).

(ii) Wood production

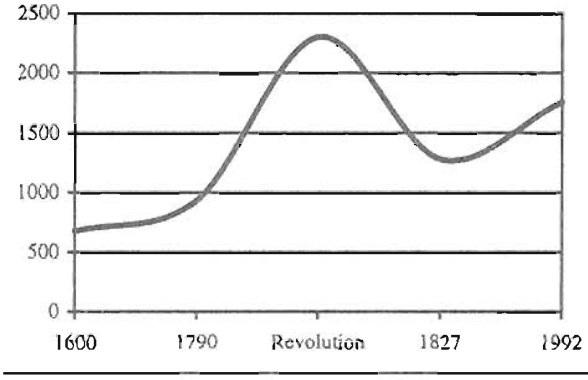
On the basis of the statistics provided by Daubrée and including a production estimate for the Alsace-Moselle region, forestry production at the beginning of the twentieth century may be estimated at 25 million m^3, including 17.6 million m^3 of fuelwood and 7.4 million m^3 of industrial wood. In 1992, marketed production totaled 32 million m^3, composed essentially of sawlogs and industrial wood. This quadrupling of industrial wood output demonstrates how much has been done in French forests over a period of almost two centuries. Estimates of auto-consumption show that fuelwood consumption has not changed markedly since the beginning of the twentieth century.

(iii) Income

The distribution of income per hectare in each department in 1818 and 1984 shows that income from forestry per hectare declined substantially in relation to farming income during this period (by 75 per cent). However, the fruit of the work of foresters may be clearly seen in the emergence of heathland forests, forests in the Allier (high-quality oaks at Tronçais) and softwood forests in north-eastern France. In the sparsely forested areas north of the Paris basin, the latter region's record price of 1918, attributable to demand for wood in the Paris agglomeration, has been maintained as a result of the development of pulp industries.

(iv) Foreign trade

CHART 3.4.1
State-owned forestland in France by period



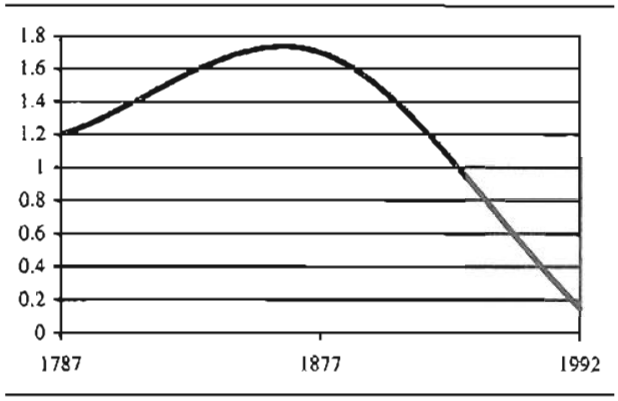
Historically, France's needs for building timber have been met through imports. France imported 2 million m^3 of sawn softwood in both 1913 and 1981, while the share of such imports in final consumption dropped from 70 to 25 per cent during the same period. By 1992, although no more than 60 per cent of the production potential of French forests was exploited, France had become a major exporter of wood raw material.

(v) Forest tree species

The demand for wood for heating led, throughout the Middle Ages in the hilly regions, to a decline in softwoods in favor of hardwoods, notably beech. The reforestation of the Landes of Gascony was achieved almost exclusively in maritime pine, which led to a considerable spreading of this species that was checked north of the Loire by the winter of 1879. Scots pine also experienced a period of "fashion" in the nineteenth century, in particular in the Champagne Crayeuse. The setbacks to some of these plantations, such as problems of seed type and the acidification of soils, considerably reduced the role of this species in reforestation. Lastly, since the nineteenth century numerous exotic species have progressively played an important role in reforestation, especially Douglas fir.

The long-term historical evolution of French forests has clearly shown that there have been major fluctuations

CHART 3.4.2
Revenue generated from State-owned land as a percentage of the State budget



both in the expansion of the forests and in their nature. These fluctuations reflect a complex relationship between farming (*ager*), heathland, pasture and fallow land (*saltus*) and the forest (*silva*). These fluctuations were possible because, as a result of climatic and pedological conditions in France, deforestation in the past did not lead to an irreversible decline in potential soil fertility, apart from a few marginal cases. The present-day situation shows that the saltus has almost disappeared, while there has been a substantial increase in areas neutralized for the long term as a result of urban growth or infrastructure.

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Chapter 4

GREAT BRITAIN

D.B. Henderson-Howat

4.1 Background

This paper is intended to provide a qualitative account, supported where possible by quantitative information, of the historical changes that have taken place in British forests. It is one of a number of country case studies prepared for the UN/ECE Timber Committee as part of its study of long-term changes in temperate-zone forest resources.

4.2 Definitions and availability of data

(i) Definition of national area

Great Britain consists of the three countries of England, Scotland and Wales. Northern Ireland is not part of Great Britain, although it is part of the United Kingdom. England and Wales have shared a common administration since the thirteenth century; the union with Scotland took place in 1707.

Contemporary land use and population in each of the three countries are shown below in table 4.2.1.

TABLE 4.2.1
Land use and population in Great Britain, 1992
(Millions of hectares)

	England	*Scotland*	*Wales*	*Great Britain*
Total land area	12.97	7.71	2.06	22.74
Forests and woodlands	0.96	1.14	0.25	2.35
Agriculture:				
Crops and grass	8.24	1.70	1.13	11.07
Rough grazing	1.17	3.99	0.52	5.68
Urban and other [a]	2.60	0.88	0.16	3.64
Population *(million)*	48.0	5.1	2.9	56.0

[a] Other includes, for example, mountain tops.

Thus, the percentage of woodland cover in Great Britain is 10.3 per cent, with 7.4 per cent in England, 14.8 per cent in Scotland and 12.1 per cent in Wales.

(ii) Definition of "forests" and "woodland"

There is no formal distinction between the words "forest" and "woodland" and they are often used interchangeably. Generally, however, the word forest carries connotations of larger areas of tree cover. In addition, in medieval times, "forests" were areas subject to Forest Law; they were primarily hunting reserves, containing a good deal of open country as well as woodland.

(iii) Availability of data

The first full census of British woodlands was carried out in 1924 and repeated in 1938, 1947, 1965 and 1981. In these censuses, the lower size threshold for woodlands included in the survey varied from 0.4 hectares to 2.0 hectares; some of the censuses were supplemented by other work to identify the extent of non-woodland trees.

Earlier information about British woodlands and forests comes from a variety of historical sources (including agricultural returns), but cannot provide a complete picture.

4.3 Outline chronology

(i) Until the end of the eighteenth century

Following the end of the last glaciation, some 10,000 years ago, trees began to reinvade Britain. By about 4000 BC most of Britain was covered in forest, except for mountain tops, marshes and small areas of natural grassland and moorland. Birch and pine dominated the Scottish Highlands; hazel-oak woodlands covered much of the rest of Scotland, Wales and upland England; and the commonest trees in lowlands England were lime, hazel, oak and elm. With the arrival of Neolithic man, at about this time, came the clearance of land for agriculture, which, along with grazing of regeneration by domestic stock, was to remain a primary cause of deforestation into modern times. It is estimated that by 500 BC only about half of England remained wooded.

The conversion of land to agriculture continued during the first four centuries AD under the Romans and for the next 600 years in Anglo-Saxon England. The wooded area of England probably fell below 20 per cent during Anglo-Saxon times. Despite this progressive deforestation there is evidence that wood requirements (for

energy, building and other general purposes) came from actively managed woodlands, and - in particular - coppice.

Several thousand references to woodland appeared in the Domesday Survey of England, performed in 1086. Over the whole country, about 60 per cent of parishes are recorded as having some woodland. It is estimated that the total woodland area was about 15 per cent of England and there are similar estimates for north east Wales.

Between the Domesday Survey and the arrival of the Black Death, in about 1350, the population probably doubled (from about 2 to 4 million people). Pressure to increase the area of agricultural land led to further clearance of woodland so that, by the mid-fourteenth century, only about 10 per cent of England was wooded. It is thought that, for similar reasons, this was also a period when a good deal of Scotland's natural woodlands were cleared. As elsewhere in Europe, monastic houses played a considerable role in clearing forest for agriculture, with, for example, the creation of large areas of sheep grazing in Scotland and the English uplands by the Cistercians.

Evidence of concern about the management of woodlands comes from early legislation. In the fifteenth century, an English Act of Parliament provided for the protective enclosure of felled areas and a Scottish Act encouraged the planting of trees. During this period, population pressure is likely to have eased, only reaching its pre-Black Death level again in the mid-sixteenth century. A contemporary estimate, in the late seventeenth century, suggested that the woodland area of England was about 1.2 million hectares (or 8 per cent), implying that clearance during the previous 350 years had been slow.

There was, however, a perception of woodland loss: legislation in 1553 referred to the great scarcity of woods that had arisen during the previous century, and a petition to the King sixty years later made a similar complaint. In the sixteenth century, restrictions were placed on the cutting of wood for iron-smelting in England: this may in fact have been counter-productive and have led to the neglect of woodlands that had hitherto been managed to produce a sustained yield of coppice material.

From the seventeenth century onwards, there was increasing interest in the establishment of plantations. This was reflected in publications such as Evelyn's "Sylva, or a Discourse on Forest Trees" (1664). One motive was the prospect of producing oak for ship building; by the end of the eighteenth century, demand for ship-building timber had reached 100,000 m^3 per year. In addition, conifers such as Norway spruce, European larch and Scots pine began to be planted with a view to future timber production. The land reforms of the enclosure movement made land available to land owners; other motives for establishing plantations included amenity, shelter and the improvement of estates for sporting purposes. Between 1750 and 1850 some 200,000 hectares of plantations were established in Scotland, where - with the exception of less accessible parts of the Highlands - natural woodlands had also been extensively cleared; by 1845, only about 1 per cent of Scotland was covered with natural woodland.

(ii) Since the beginning of the nineteenth century

In the early part of the nineteenth century, plantations continued to be established and productive conifers such as Douglas fir and Sitka spruce were introduced from North America. After the middle of the century, however, enthusiasm for domestic forestry began to wane; many landowners became increasingly interested in the sporting potential of their estates and the development, in manufacturing industry and overseas, of opportunities that offered more attractive financial prospects than forestry.

During the nineteenth century, Great Britain also relied increasingly on imported timber. The value of timber imports trebled during the first half of the century and doubled again by the end of the century. In the years preceding the war of 1914-18, Great Britain imported about 93 per cent of her timber. During that war, domestic timber production had to rise five-fold and fears of future timber shortages led the Government to set up the Forestry Commission in 1919.

TABLE 4.3.1
Changes in rural land use in Great Britain, 1900-90
(Million of hectares)

	Agricultural Use			
Year	*Crops & grass*	*Rough grazing*	*Forests & woodlands*	*Total* [a]
1900	13.13	6.65	1.12	20.90
1925	12.30	6.33	1.19	19.82
1950	11.66	6.64	1.47	19.77
1975	11.23	6.33	1.94	19.50
1990	11.07	5.68	2.35	19.10

[a] The balance between this total and the total land area in Great Britain (22.74 million hectares) includes both urban land and ground that is neither farmed nor under trees.

The Forestry Commission is a Government Department and its first task was to build up a strategic reserve of timber. It did this by encouraging private landowners to grow timber and by buying land and establishing its own plantations. The impact on agricultural production was minimized by focusing the expansion of forestry on the poorer agricultural land of the uplands. Table 4.3.1 shows the changes in rural land use during the twentieth century.

The afforestation programme of the middle part of the twentieth century effectively created this strategic reserve of timber. The changing nature of warfare meant, however, that it was less likely to be required. Nevertheless, the Government continued to support forestry expansion; a policy statement in 1972 referred to forestry's contribution to maintaining the stability of rural populations and the potential role of forests for recreation. This widening in the objectives of forest policy continued and in 1985 a broad-leaves policy was introduced in order to maintain and improve the broad-leaved character of well-wooded parts of the country and to establish broad-leaved woodlands in areas where they were scarce.

In 1991, the Government stated that the two main aims of its forestry policy were the sustainable management of existing woods and forests, and a steady expansion of tree cover to increase the many, diverse benefits that forests provide. In both, it recognized the advantages of basing policy on the realization of multiple objectives. The forestry industry by this time was making a substantial and increasing contribution to meeting the national demand for timber, as well as providing support

and employment for people living in rural communities. The Government also recognized the importance of forests and woodlands for recreation, as a component of the landscape, as wildlife habitats and as a means of absorbing carbon dioxide from the atmosphere.

4.4 Forest ownership and uses

(i) Ownership

Apart from the medieval "Royal forests" (which were primarily hunting reserves and only partly wooded), state involvement in forest and woodland ownership has been fairly insignificant until the twentieth century. Before the Forestry Commission was established in 1919, the only State forests were 15 "Crown Woods", whose origins lay partly in the medieval hunting forests and whose total area was only about 50,000 hectares (or 5 per cent of the total woodland area).

Acquisition of land and planting by the Forestry Commission meant that the area of State forests grew rapidly and, by 1982, the area of State forest had risen to 905,000 hectares (or 50 per cent of the total). Since 1982, the area of privately owned forest has continued to grow through new planting activity, but the Forestry Commission has been selling forests and, by 1992, the area of State forest was 890,000 hectares (or 38 per cent of the total).

Because of its policy of expanding the forest area since 1919, the State has received no net income from forestry. In 1991-92, net expenditure was GBP 62 million per year, or about 0.03 per cent of total public expenditure.

(ii) Wood production and foreign trade

Great Britain has traditionally relied heavily on imported timber. There are records of imports from Scandinavia to Scotland in the mid-fourteenth century and customs returns from certain Scottish ports in 1599 show that timber accounted for 17 per cent of the value of imports. Later, more comprehensive, records show that timber fairly consistently accounted for 4-5 per cent of the total value of all imports throughout the nineteenth century. Imports rose steadily from about 3.5 million tonnes per year in the late 1860s to 10 million tonnes per year in 1900. By 1914, annual imports amounted to some 15 million tonnes and domestic wood production was estimated to be only about one million tonnes per year. (One tonne is approximately equal to one m^3.)

Domestic wood production rose as the forests established during the twentieth century came into production. It was 3 million m^3 per year in 1965 and 6.6 million m^3 per year in 1991. It is expected to continue to rise, reaching 12 million m^3 per year by 2010. Consumption has also risen (to 50 million m^3 wood raw material equivalent in 1990) and about 87 per cent of requirements are still imported. Table 4.4.1 compares the sources of imports in 1899 with those in 1991.

(iii) Other forest and woodland products

Overall changes in industrial wood production mask the decline in traditional uses of, for example, hardwood coppice. Other uses of forests and woodlands have changed in relative importance over the years. There is increasing interest in their potential for conservation and in their role in storing carbon. Their contribution to the landscape is widely appreciated, and problems arise when forest management does not take full account of good design practice. Attempts to value the "non-market" benefit of informal public recreation in the Forestry Commission's forests have produced estimates of around GBP 50-100 million per year. The potential of forests for hunting and grazing has long been recognized. For many woodland owners, the sporting value of woodland is still an important output. Woodlands can also have value for shelter and grazing, although in the absence of proper management this can lead to deterioration of the woodland.

TABLE 4.4.1
Total imports by exporting country
(Per cent)

Country	*1899*	*1991*
Sweden	24	27
Russia	22	5
Canada	19	19
USA	10	10
Other	25	39

(iv) Forest tree species and woodland composition

There is an important distinction between semi-natural woodlands and plantations. Semi-natural woods are composed of trees and shrubs native to the particular site which have not been planted but have arisen either from natural regeneration or from vegetative regrowth (from trees themselves originating as natural regeneration). Of particular conservation importance are "ancient" semi-natural woodlands, found on sites continuously wooded since the seventeenth century. By 1992, 317,000 hectares (or 1.4 per cent of Great Britain) remained as ancient semi-natural woodland, compared with about 500,000 hectares in 1945; measures have now been introduced to stem this loss, which was due partly to clearance for agriculture and partly to conversion to plantation. Apart from about 18,000 hectares of native pinewood in the Scottish Highlands, these semi-natural woodlands are almost entirely composed of native broad-leaved species.

During the twentieth century, there have been important changes in woodland composition. The area of productive coppice has fallen from 230,000 hectares to 40,000 hectares; much of this was ancient semi-natural woodland. At the beginning of the century, there were 420,000 hectares of broad-leaved or mixed productive high forest; in 1992 there were 592,000 hectares of mainly broad-leaved productive high forest. Over the same period, the area of conifer productive high forest had risen from 460,000 hectares to 1,521,000 hectares, reflecting in

particular the extensive planting programmes in the uplands.

The 1981 census showed that predominant species were Sitka spruce (526,000 hectares), Scots pine (241,000 hectares), oak (172,000 hectares), lodgepole pine (127,000 hectares), Norway spruce (117,000 hectares) and Japanese/hybrid larch (111,000 hectares).

Future expansion of forestry in Great Britain is unlikely to reflect this pattern. A higher proportion of broad-leaved species are now being planted. In 1991-92 broad-leaves accounted for one-third of the area that was restocked or newly planted; by contrast, broad-leaves accounted for only 5 per cent of planting in 1981-82. In addition to creating a productive forest resource, there will also be new planting to establish more community woodlands for public recreation and to create new woodlands of native type. Reform of the European Community's Common Agricultural Policy will lead to more planting of agricultural land that was previously not available for forestry.

4.5 Conclusions

Available evidence suggests that Great Britain's woodland and forest area probably fell below 50 per cent some centuries before the birth of Christ; below 20 per cent by the year 1000 AD; and had reached a level of about 10 per cent by the middle of the fourteenth century. Although offset by some planting (particularly in the eighteenth and early nineteenth centuries) the total area of woodland cover continued to fall and, when the Forestry Commission was established in 1919, it was only 5 per cent. Since 1919, the area of forests and woodlands has doubled to about 10 per cent, largely through the establishment of coniferous forests which have formed the basis of a modern wood processing industry.

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Chapter 5

GREECE

Nicholas S. Efstathiadis

5.1 Introduction

The creation of the modern Greek State in 1833 marked the beginning of an historical process in which forests evolved in close correlation with the country's political changes and economic and social development. The gradual liberation of the national territory caused a subsequent increase of forestland; unfortunate events, however, like wars or natural phenomena, produced negative effects. Along with these, the development of land-intensive economic sectors and raw material-demanding industries contributed to the further diminution of the industrial forests, from the strict, economic point of view, to the multi-purpose forest, capable of providing an array of products and services.

In light of the last scientifically executed forest inventory (completed in October 1992) and the endorsement of the definition that both productive forests and currently non-productive forests must be considered, a rough idea of the forest area historical changes is represented in table 5.1.1.

TABLE 5.1.1
Historical changes in forested area in Greece
(Thousands of hectares)

Year	*Liberated Province*	*Additional*	*Total*
1833	Peloponnessus, Central Greece, Cycladic Islands	899	-
1864	Ionian Islands	28	927
1881	Thessaly, South Epirus	317	1,244
1913	Macedonia, Epirus, Crete, Aegean Islands	991	2,235
1918	Thrace	252	2,487
1948	Dodecanesse	39	2,526

Relating to the development of forestry, most historians agree that four periods should be clearly distinguished. They are the Transitional Period (1833-93), the Preparatory Period (1893-1931), the Constructive Period (1931-65), and the Multi-purpose Management Period (1965-present). Each of these will be considered in some detail below.

5.2 The transitional period (1833-93)

The newly formed Greek State lacked practically everything to help it exercise an efficient administration: its economic and social situation was chaotic and vital needs were pressing. Survival efforts succeeded at the expense of forests being subjected to heavy grazing, unwise exploitation and continuous clearing for arable space.

Despite the scarcity of specially trained personnel, a prevailing attitude calling for the highest possible revenue at any cost, clearing for more agricultural land and the absence of a forest service as an integral entity, the period is marked by a series of legal measures aiming to bring some order to the situation. Among the new legislation, the following laws and decrees should be mentioned: "On the illegal acts performed against the forests"; "On the grazing regulation"; "On the private forests"; "On cutting and taxation"; "On forest personnel"; "On forest administration". The latter laid the foundation for a Forest Service but was later abolished by the law on the "Modification of Forest Administration", which assigned the relevant duties to the gendarmerie.

The few positive steps did not overcome the difficulties and deficiencies. It was realized that only an effective administration supported by scientists, technicians, and guardians would suffice; land-use classification and harvest regulation would preserve and improve the forest situation. It must be mentioned that in 1836 the first "Guide" on general forestry matters was published by the Ministry of Finance, the agency responsible for managing the forests.

5.3 The preparatory period (1893-1931)

The experience gained during the transitional period led to the recognition that only specially trained personnel should bear the responsibility of managing and protecting the forests. Thus, among the first legislative measures were the following: On modification and completion of the forest laws establishing the positions of Forest District Chiefs and defining the educational requirements for such as a Degree of a silvicultural of forestry school; On the personnel of the provincial forest service; On the organization of the silvicultural section at the agricultural school of Vytina-Arcadia. Under these laws, a number of university graduates were sent abroad for forestry studies

while the Silvicultural School started training and producing the core of the technical personnel.

The real solution to the personnel problem was achieved in 1917, however, by the creation of the Higher Forestry School in Athens. In 1927, the School was later transferred to the newly established Aristotelian University of Thessaloniki (Macedonia) where it currently operates.

Despite these positive efforts, forestry was still declining. Illegal cuttings, forest fires and uncontrolled grazing caused extensive losses obvious even today. Nevertheless, for the first time the importance of reforestation, torrent control, fire protection, and appropriate forest management was realized. It is worth mentioning, however, that for the first time, all the previous forestry related legislation was codified forming a single body (Law 4173/1920).

5.4 The constructive period (1931-65)

After the long transitional and preparatory periods, the time was ripe for the newly educated Greek foresters to show their scientific, technical, and administrative abilities. Starting with torrent control designs and works, followed by reforestation efforts the importance of forestry as a multi-purpose, pluri-beneficial activity began to be widely recognized.

Despite almost a decade of war-like activities (1940-49) that had a dramatic impact on the economic and social life of the country, new actions such as forest road building, the introduction of exotic species, forest range management and improvement, the creation of national parks and protected areas, and forest research were gradually introduced and quickly developed.

On the educational and training side it is worth mentioning Law 6320/1934, On assigning the use of public forests to the University of Thessaloniki for educational and research purposes. In accordance with this law, a forest of 3,000 hectares (Pertuli-Thessaly) was assigned to the Forestry School. Since then, this forest, after proper organization and management, became the main training field for students of forestry.

Another important event was the creation of the Middle Forestry School in 1950 under the jurisdiction of the Ministry of Agriculture, for training the mid-level personnel. Later, in 1977, the School was incorporated to the national higher educational system, becoming the School of Forest Technologists.

Another very important event of this period was the establishment of the State exploitation system of the national forests starting with the laws On modifying certain legislation pertaining to forests and On the exploitation of state forests directly by the State or by long-term leasing contracts.

The immediate consequence of this was a new beginning of scientific forest management under the principals of integrated development, effective management, and proper resource allocation. On the other hand, the private sector demonstrated interest in commercially integrated (Forest-Forest Industries) development projects.

In terms of research, the starting point was the establishment of an office with minimal personnel within the Ministry in 1929. This led to the creation of the Forest Research Institute in Athens in 1952, and a few years later, to the establishment in 1963 of the Forest Research Institute of Thessaloniki (Macedonia).

Generally speaking, the constructive period was the most important in our forest history, laying the foundations for future development. It was also a period of considerable development, dramatically changing the economy of the most disadvantaged regions of the country.

5.5 The multi-purpose management period (1965-present)

The knowledge accumulated over 130 years has led to the multi-purpose, integrated management of our forests today. The existence of specialized personnel, the economic development, changing social patterns, and the accession of Greece to the European Economic Community were the major guiding events to these modern management practices. The new five-year development plans reflect the tendency to exploit and reinforce all of the services provided by the forest areas including recreation, game and fishing activities, grazing, and water management.

The period is also marked by a rather intensive cooperation with international development and financial organizations in order to complete various special projects, such as Strengthening the Forest Research Institute (FAO); Feasibility studies on Forestry and Forest Industries in Western Greece (FAO); Forest inventory (FAO); Integrated Forestry Development Project (World Bank); Forestry Development Projects in Eastern Macedonia-Thrace (European Investment Bank).

After 1981, when Greece became a member of the EEC, a number of relevant regulations included forestry measures, such as protection, reforestation, road building and training. The period is also noted for the introduction of updated means in several areas such as aircraft for fire fighting, aerial-photography, computers, harvesting equipment and extensive post-graduate training programs domestically and abroad. In terms of legislation we should mention the Forest Code, On Forest Protection and On Forest Range Management.

In very broad terms the general targets of this period, which according to professors Papastratou and Makris are expected to last until 2005, are (i) complete protection and development of natural resources, (ii) increased productivity of forest resources, (iii) improvement of wild-life, development of forest recreation and mountain

tourism, and (iv) augmentation of forest protective effects to the natural environment. These targets are considered by the same professors as the basic foundation for a significant contribution of forestry to the national prosperity, and as the guiding principles for leading forestry into a state of integrated, multi-purpose management and multi-resource land use.

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Chapter 6

HUNGARY

Sándor Oroszi

6.1 Background

The beginnings of modern silviculture in Hungary reach back to the eighteenth century, but numerical data on the extent and income of forests and on the turnover of wood products have been available only since the second half of the nineteenth century. In this respect, the history of Hungarian forestry can be divided into two main periods: the period lasting until the middle of the nineteenth century, from which only estimated data on the extent of forest areas are available; the period beginning with the 1850s, from which at first approximate but later exact statistics of forestry are available.

The first comprehensive work of forestry statistics in Hungary was published in 1885. In this work, besides data on the extent of forests within each parish limit, species distribution, soil conditions and profitability are also analysed in detail. The national forest inventory, regularly kept from the beginning of the 1880s, has enabled researchers to register and trace changes in the country's forests within the limits of statistical data available.

6.2 Principal problems encountered since the middle of the nineteenth century

(i) Changes in the national territory

Since the Hungarian conquest in 895, Hungary and the Hungarian Kingdom signified the whole Carpathian Basin, that is, about 320,000 square kilometres. However, this situation changed in the middle of the period under examination, in 1920. In consequence of the Trianon peace treaty, the territory of Hungary was reduced to 93,000 km². Altogether, with this loss of more than two-thirds of its former territory, 84 per cent of all forest areas were apportioned to other countries.

In 1938, a part of these lost territories was reattached to Hungary. Thus, the national territory stood at 172,000 km² until 1944-45, and once again, Hungary possessed considerable forest areas. After 1945, and apart from minor modifications, the country's forestlands returned to their 1920 level.

These enormous territorial changes make the comparison of forest statistics difficult, to say the least. Namely, it is impossible to compile the data concerning the territory of historical Hungary (before 1920), that of the Trianon Hungary (between the two World Wars) together with that of today's Hungary into one, meaningful table. Past data, reduced to match today's territory, were elaborated for only a few parameters.

(ii) Changes in the elements measured

The notion of forest was not defined for several decades either by forest laws or by registers of landed property. Thus, in mountainous regions pastures were often recorded as forestland, which was advantageous for the owner with a view to taxes. Since 1961, forestland has been defined as any area of 0.5 hectares or larger that is covered with trees.

In the nineteenth century, Hungarian forest statistics used only the categories conifera, oak and beech and other deciduous trees. Forest statistics differentiating between species were gradually introduced only in the twentieth century.

In the data connected with measures aimed at increasing forested area, characterizing Hungarian silviculture throughout the period since the First World War, afforestations often figured together with tree belt and roadside plantations; such data include seedling and cost expenditures and other parameters. Thus, afforestations and non-forest tree plantations were included in the same category.

6.3 Outline chronology

(i) From the Middle Ages to the middle of the nineteenth century

The capital question concerning this period is what the forest ratio of the Carpathian Basin might have been like in the ninth and tenth centuries. Although one can not give a definite answer, different approximations exist. Forests might have covered about two-thirds of Hungary's territory at that time, while in the central part of the Carpathian Basin, equal to the territory of today's Hungary,

the forest ratio is estimated to have been 37 per cent. It is characteristic of the circumstances of the eleventh and twelfth centuries that the populated area where settlements were established consisted of about 200,000 km², while an area of about 120,000 km² in the Carpathian highlands forming the boundary of the country, was either unpopulated or very sparsely populated. In the above-mentioned central region, there were about 1.5 million inhabitants in the eleventh and twelfth centuries. Hungarian kings in the Middle Ages continuously endeavoured to populate the unpopulated areas which resulted in deforestation. Inhabitants settling in the mountainous regions, most of them having come from abroad, cleared forests not only for agricultural cultivation but also to work the highland mines, rich in ores. Incidentally, Hungary's first decrees and laws on forest protection were aimed at preserving forests reserved for mining purposes.

Wars against the Turks and the Turkish occupation of the central part of the country were the greatest trial for Hungary in the Middle Ages. In a country becoming a permanent theatre of war in the sixteenth and seventeenth centuries, not only the inhabitants but also the forests were hard hit by this period. The flora of the Great Hungarian Plain, previously forest steppe in all probability, totally disappeared and the region became a treeless steppe. At the same time, foothill forests also fell victim of fortress building and war operations in many places.

Establishing a rational forest management programme constituted part of the economic stabilization if the eighteenth century. National statistics and ordinance survey maps were made, but forested areas were not included or drawn up even then. On the other hand, afforestation programmes, encouraged by the law of the period, were begun in the sandy regions of the Great Hungarian Plain. These man-made afforestations were intended to stop or reverse the process of deforestation started in the earlier centuries.

(ii) From the middle of the nineteenth century to the present

Cadastral surveys started in the 1850s in Hungary and forest areas were drawn up in their course. At that time, a total forest area of 9.36 million hectares was recorded, however, this area was continuously decreasing. This decrease was partly due to the redistribution of landed property to the recently emancipated serfs, who converted the obtained forestland into pastures or arable land. Another cause of the decrease was the large-scale economic development that followed the Austro-Hungarian compromise in 1867. Railway construction and the building of factories and towns required a huge amount of timber. The Forest Law Act, codified in 1879, could prevent this process only partially. Nevertheless, one must know that statistical data and forest registers were not always kept up-to-date. Thus, fellings were recorded with a delay of several years, and in some cases, several decades.

According to the statistics, the forested area covered 9.18 million hectares in 1885, 9.02 million hectares in 1898, and 8.92 million hectares in 1916 (with a population of 20.89 million in 1910). In view of their decreasing forest area, the Hungarian State made great efforts to afforest wastelands and quicksand areas. These efforts were particularly successful on the sandy waste at Deliblát (Deliblato) and in the Carst. After the First World War, total forested area amounted to about 1.1 million hectares. This means 11.8 per cent of the total territory was forestland, compared with the former 27 per cent (with a total population in 1920 of 8.7 million). With the re-annexations, beginning from 1938, the total forested area increased again to 3.48 million hectares (a forest ratio of 20.1 per cent) with a population of 14.7 million in 1941.

After the First World War the species distribution of forests changed significantly, since scarcely any conifera were left within the new boundaries. Between the two World Wars, the afforestation project of the Great Plain, and after 1947, the nation-wide afforestation movement, were intended to change the state of the poor forest ratio. The success of the latter is proven by the fact that by 1990, new forests were planted on an area of about 600,000 hectares. As a result, the total forest area amounts to 1.7 million hectares in Hungary today, which means an 18 per cent forest ratio (with a current population of 10.4 million).

The majority of the forests planted after 1945 are on river flood-plains and in the sandy regions of the Great Plain. The species distribution of forests was also altered by the increasing proportion of fast-growing species.

The proprietorship of forests also underwent significant changes. In the 1980s, two-thirds of all forests belonged to the state, one-third belonged to cooperative farms, while private forests, which characterized the pre-war period, almost completely disappeared. Since 1990, new alterations in proprietorship have begun, the results of which are outlining the silviculture of the future.

6.4 Forest uses

(i) Timber production

There are no reliable data on timber production available from the period before the First World War. According to an official estimation published in 1896, about 23.36 million m³ of timber might have been exploited yearly in the country. In the 1930s, when the timber production of almost all forest proprietors was recorded by the statistics, this figure totaled 4.2 million m³. The latter includes the gross timber mass exploited from all the forests and tree belts in the country. In 1946, during the country's reconstruction, gross timber production was 6.2 million m³, in the 1950s about 3-3.5 million, about 5 million after ten years, in 1980 as much as 7.5 million and more than 8 million m³ in 1985.

(ii) Foreign trade

The historical Hungary was counted as an important timber exporter, first with oak, and later with pine. This situation essentially changed after the First World War. Timber, mainly pine, became one of the main items of Hungarian import. At the time, Hungary provided for its timber needs through imports from neighbouring countries.

After 1945, the volume of timber imports grew to a greater extent than ever, coming pricipally from the Soviet Union. Imports amounted to 5 million m^3 yearly in the 1970s. At the same time, Hungary exported about 1-1.5 million m^3 of timber yearly.

6.5 Summary

The twentieth century history of Hungarian silviculture serves as an example of the fact that, in spite of repeated territorial changes and amidst continually changing political and economic circumstances, a silviculture that focuses on the plantation of new forests and the utilization of their producing and protecting role, is an important factor in the country's economic recovery.

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Chapter 7

THE NETHERLANDS

Hannes Sipkens

7.1 Introduction

In the context of a tentative country-wide description of the historical development of the forest resources in the ECE, this paper is meant as one in a series of five or six pilot studies. After completion of these pilots the Timber Committee and the FAO Forestry Commission will have to decide on the enlargement of the area to describe. In this paper, the forest resource is regarded as an element of the rural environment and of the Dutch society as a whole. It is not meant as a rewriting of the forest history. This paper is mainly based on agricultural and land use statistics, the sources shown in the bibliography and upon the author's 40 years of forestry experience.

The Dutch territory covers 4.1 million hectares, of which 3.7 million are registered with the local communities. The balance of 0.4 million hectares is registered with the State and covers mainly the big waters: The coastal territorial zone, the Waddenzee in the north, lake IJsselmeer in the centre and the Ooster- and Westerschelde in the south-west. Before the reclamation of the Zuiderzee (now lake IJsselmeer) this balance was 0.8 million hectares. In the former Zuiderzee, 0.2 million hectares of land was reclaimed.

Until the second half of the twentieth century, the forest resource was mainly allocated to the diluvial sandy soils in the eastern and southern provinces. The alluvial clay soils along the rivers Rijn, Maas en Schelde and along the North Sea never had a forest cover or were already brought under cultivation in Roman times. Up to the Middle Ages, peat layers of up to several meters in thickness developed on parts of the sandy soils and the clay soils. This was used for peat production between the fourteenth and the twentieth century.

In the last few decades, from about 1950, 16,000 hectares of the alluvial clay soils in the reclaimed former Zuiderzee were afforested. By the year 2000, 10,000 hectares will be afforested in the coastal region. Although the rate of afforestation in the Netherlands is a mere 23 hectares per 1,000 inhabitants in parcels larger than 0.5 hectares, the countryside in general does not appear to be treeless. This is caused by: the large number of small forest parcels of over 0.5 hectares; the large number of amenity plantations, yard plantations, groves and other wood lots less than 0.5 hectares (over 300,000 in 1984); and the many kilometres of line plantations (in 1984: 82,000 km counted as a single row, with about 10 million timber trees).

This paper will cover two distinct periods in more detail: Section 2 deals with the period of forest destruction in general before 1800; Section 3 deals with the nineteenth and twentieth century, when society became concerned about laying waste to one-third of the land. In this period the first statistical information became available; this led to the present, detailed forest inventories from permanent sample plots measured at regular intervals. For each of the two periods I will briefly discuss: (i) Developments in society, including (a) Demography; (b) Agriculture; (c) Land use; (d) Wood consumption, construction, shipbuilding and industry; (e) Timber trade; and (ii) Development of the forest resource and its use, including (a) Attitude and behaviour of man to the forest: knowledge; management, regulations and forest law; (b) Forest area and composition; (c) Growing stock, increments and removals; and (d) Non-product functions: hunting, grazing, shelter, recreation, nature conservation. The conclusion to this paper appears in Section 7.4.

7.2 The period up to 1800

(i) Developments in society

(a) Demography

The demographic development of the Netherlands reflects that of Europe as a whole. The population of about 0.5 million in the ninth century grew considerably up to the middle of the fourteenth century. Between 1350 and 1500 the population was reduced to a level under 1 million. Further population growth is shown in figure 7.2.1. After doubling between 1500-1650, the population remained stable for another 150 years.

(b) Agriculture

Farmers on the alluvial clay soils could maintain soil fertility by keeping livestock to produce manure for arable land.[1] This could certainly not be said for agriculture on the diluvial sandy soils which have poor natural fertility.

[1] The distinction between arable land and other cultivated land is not a sharp one: an arable plot may be grazing land next year or vice-versa; in this paper, arable land means cultivated land under crops, dairy farming and horticulture.

To grow cereals (rye, oats and barley) on permanent plots, farmers used ratios of 1 to 10 or more of arable land to grazing land for their livestock. Forests were partly used for grazing. Evidence exists that farmers also used short-rotation forest crops (coppice) between crops in order to restore lost soil fertility. Eventually they shifted arable land to grazing land and vice-versa in order to minimize the need for manure.

(c) Land-use

Few statistics on land use exist for this period. At the end of the period, about 1.7 million hectares of land were under cultivation whereas 1.1 million hectares were uncultivated. This consisted of 0.8 million hectares of heathland derived from degenerated forests, peatmoor, drifting sands in the interior and dunes along the seashore. By that time, still roughly 0.2 million hectares of forests existed. We may therefore assume that in the early Middle Ages at least 1 million hectares - probably more - of high forests existed, covering roughly one-third of the land area. Apart from those high forests on sandy soils, there was a considerable area of marshy forest cover on peat soils. We suppose that the name of "Holland" for our western provinces is derived from "Holtland", which means land covered with marshy forest.

(d) Wood consumption, construction, shipbuilding and industry

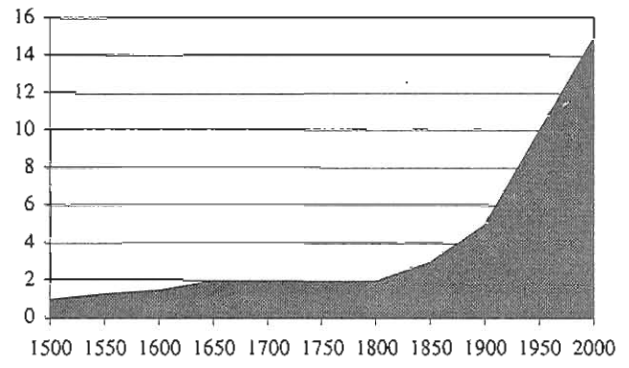
Timber was the main construction material for all types of construction: houses, mills, locks and bridges, stables and barns, carriages and furniture, etc. A special category in this respect is shipbuilding which was of strategic importance for a country heavily dependent on overseas trade. For example: at the height of the Golden Age, some 500 ships were built annually, primarily in Amsterdam and surrounding towns.

The Netherlands was a country of merchants and farmers. Industrialization started later than in other countries of western Europe and industries with a large energy input from wood hardly existed. There were no ironworks, few glassworks and ceramics, and salt was imported. Wind-energy was important. Of course wood was used for heating and cooking, but when it became expensive or no longer available, it was replaced by turf.

There is evidence that in the seventeenth century, the annual turf consumption was equivalent to the harvest of fuel wood from an acreage of 0.8 million hectares of coppice. By 1700, the peat in the western, urbanized, provinces was used up so turf digging was relocated to the eastern provinces. The need for infrastructure (waterways) and the longer transport distances to the consumption centres in the western urban regions drove the price of turf up by about 50 per cent in the course of the eighteenth century. Thereafter its price stabilized because of the availability of imported coal by the end of this period.

By 1650, at the peak of activity in shipbuilding and other construction, the forest growing stock of timber trees had almost disappeared. But the country did not suffer from wood shortage: timber was imported, fuel wood in the urban west was replaced by peat and in the rural areas timber trees still existed in line plantations, on farm yards, church yards and groves. Even today farm yards and church yards can be found where timber-oaks were planted some 150 to 200 years earlier, with the aim to have construction timber ready by the time the building would be due for renewal. In rural areas many hedges and wood rows existed that could meet the demand for fuel wood and small-sized timber for agricultural purposes.

FIGURE 7.2.1
Population growth in the Netherlands, 1500-2000
(Million)



Source: Buis, 1985.

(e) Timber trade

The relatively huge wood consumption in the sixteenth and seventeenth century required for building purposes (500 ships required 300,000 m³ of timber!) was secured by imports, after the exhaustion of domestic forest resources. In the seventeenth century the Netherlands imported 400,000 m³ of timber annually; its source was mainly Norway. This represented imports of 200 m³ per 1,000 inhabitants per year, a figure that is even higher than today's imports of sawn softwood. In the eighteenth century, timber imports fell slightly, but still measured over 300,000 m³ per year. The sources had also changed: half of all imports came from the Black Forest region in Germany and the other from the Baltics and Norway.

(ii) Development of the forest resource and its use

(a) Man's attitude toward and treatment of the forests

As discussed in paragraph 1.3, in the early Middle Ages there existed at least some 1 million hectares of high forest on the diluvial sandy soils. Although the farmers owned their farming plots, the forests and other uncultivated "wilderness" were controlled by the sovereign ruler. Parts of uncultivated land became the personal property of the sovereign or, after the abdication of the Habsburgs in 1581, were controlled by the central government. The right to use and sometimes own other parts of the uncultivated land was granted to local farmers' communities, while hunting and fishing rights were reserved for the sovereign.

In large areas of the forest this evolved into collective use and management. From the sources of forest history we have no indication that collective users lacked the knowledge required to manage the forest properly, that is, to take no more than the forest can regenerate. On the contrary, in the fifteenth century, people knew how to stop

forest degeneration: in the written rules for the management of collectively used forests we find bans on grazing, obligations to replant trees, temporary bans on forest use as a whole and other restrictions.

In spite of this existing knowledge, forests were, generally speaking, not properly managed. The prevailing reasons were private interests overruling common interests, and conflicts of interest between different user/owner categories. The measures taken to reduce the misuse of collectively used forests offered no alternatives for the users and thus failed. Sovereigns might decide to pay their war debts by cutting and selling large amounts of timber. The nobility preferred large hunting stock over forest regeneration. Central governments had other priorities than long-term investment in forest regeneration with low returns.

(b) Forest area and composition

The 1 million hectares of early Medieval forests on the diluvial sandy sites may have consisted almost completely of indigenous hardwoods. By 1800 their remnants, 0.2 million hectares, consisted to a high degree of degenerated forests which hardly resembled the description "high forest". Only limited areas, between 10,000-20,000 hectares, were actually high forests due to the reforestation of heathland with Scots pine.

(c) Growing stock, increments and removals

By 1650 the growing stock of timber trees was almost depleted. Apart from the use of the forest resource for the harvest of sawing logs and fuel wood, other products were harvested that mainly served a purpose in agriculture, such as small diameter timber, acorns and other fruits, fodder, forest floor litter, sods, and oak bark. Harvesting these products meant the removal of organic matter which also reduced site quality.

(d) Non-product functions

Hunting was of great interest to the sovereign and nobility. There is quite a lot of evidence that hunting practices conflicted with proper forest management. The same must be said about the grazing of livestock in collectively used forests. Especially in the twelfth and thirteenth century, population growth led to massive clearings of forests for arable land, thus increasing the pressure of grazing on the remaining forestland. The effect upon the forest became even worse when the proportion of cattle and horses in total livestock increased. Both hunting stock and grazing stock hindered forest regeneration and caused forest degeneration in the long run.

The function of the forest cover as a shelter to the soil was gradually lost in this period. The already described processes of forest degeneration by grazing, hunting stock, over cutting and other types of mismanagement resulted in heathland with localized shrubs and bushes. When over exploitation continued on the heathland (overgrazing, sod harvesting, etc.) it lost its vegetation cover completely and was transformed into drifting sand. This phenomenon had occurred since the ninth century. Records exist that relate how the hamlet of Kootwijk, an agricultural community of 20 farmhouses and fields, was buried under the sand. Drifting sands developed into a plague in the poorer Eastern provinces. They reached their widest expansion in the nineteenth century with more than 50,000 hectares.

Although examples of recreation forestry can be found from earlier ages, it was not until the eighteenth century that people recognized the recreational value of a forest. By that time wealthy merchants and governors from the western provinces created estates for themselves in the countryside. Nature conservation was not a recognized function in that period.

7.3 The nineteenth and twentieth centuries

(i) Developments in society

(a) Demography

Figure 1 shows how the Dutch population grew from a stable level of 2 million in the period 1650-1800. There is an increment of 1 million between 1800-50, 2 million between 1850-1900, 5 million between 1900-50 and another 5 million between 1950-92. The present population numbers 15 million.

(b) Agriculture

Public opinion at the beginning of nineteenth century held agriculture in great respect. This had been the case since the Dark Ages and would continue far into the twentieth century. The reclamation of uncultivated lands, mainly heathlands, for arable land was regarded as desirable. Massive reclamation in the first half of the nineteenth century led to overgrazing of the remaining heathlands and thus to the further extension of drifting sands. This repression took a heavy toll and had not yet finished in 1900. By 1880 chemical fertilizers became available. The importance of heathlands as the main source of manure in the agricultural system diminished rapidly. This led to further reclamation and by 1980 only 40,000 of the 800,000 hectares of heathlands from 1800 remained.

In the twentieth century, research, education, extension and organization caused an enormous growth in agricultural productivity. In spite of the rapidly growing population, the export of agricultural products became an essential element in the Dutch economy. Recently, agriculture has suffered from costly overproduction and is held responsible for environmental pollution. Public opinion appeals for sustainable agriculture.

(c) Land use

Table 7.3.1 shows how built-up areas and infrastructure had covered more than one-third of the land area by 1980. This is caused by our population density of over 400 inhabitants per km^2. The uncultivated area

TABLE 7.3.1
Division of Dutch land area by type of usage
(Thousands of hectares)

Year	Forest in parcels > 0.5 ha		Heathland, peatmoor and drifting sands		Cultivated land		Built-up areas, infrastructure, waters > 6 metres wide		Total registered area	
	Area	Per cent	Area	Per cent	Area	Per cent	Area	Per cent	Area	Per cent
1800	200	6	1,100	33	1,700	52	300	9	3,300	100
1833	170	5	910	28	1,900	58	320	10	3,300	100
1885	230	7	600	18	2,100	64	370	11	3,300	100
1900	250	8	590	18	2,100	64	360	11	3,300	100
1920	250	8	480	15	2,200	67	370	11	3,300	100
1940	250	8	200	6	2,300	70	550	17	3,300	100
1960	260	7	150	4	2,300	64	890	25	3,600	100
1980	330	9	120	3	2,000	54	1,250	34	3,700	100

almost vanished. Up to 1960, agricultural land use increased and then dropped, even though most of the reclaimed land in the former Zuiderzee was allocated to arable land (see Introduction).

Forests gained only a little from the reclamation of large areas of wasteland. A sizable proportion of heathland was turned into forest, but at the same time forest was cleared for arable land. For example, between 1901 and 1927 the reclamation of 158,000 hectares of heathland and drifting sands yielded 37,000 hectares of forest. In the meantime, between 1903 and 1927, 20,000 hectares of forest were cleared for arable land. For a long period forests held a share between 7 and 8 per cent. Since 1960 their share has grown to 9 per cent of the (increased) total land area.

(d) Wood consumption, construction, shipbuilding and industry

The Netherlands industrialized later than other countries in western Europe. Trade and transport services remained important. For two decades after the Second World War, large-scale industries developed: steel, aluminium, (petro-)chemicals, fertilizers, paper. Shipbuilding flourished until the 1960s. In this period coal-mining developed, reaching an annual production of 10 million tonnes, to be replaced rapidly in the early 1970s by natural gas. Huge natural gas reserves were developed and the Netherlands has had a positive export figure for energy ever since.

In the nineteenth century, coal, kerosene and generator gas replaced wood and peat in the urban regions; the same occurred in rural regions between the world wars. Presently, wood is only burned in domestic fireplaces for decoration. In the construction industry, timber remained an essential material for flooring and roofing until deep into the twentieth century. Walls are made of brick or pre-fabricated concrete. In 1927, wood consumption was estimated at 4 million m³, or 500 m³ per 1,000 inhabitants, while other west European industrialized countries consumed 750 m³ per 1,000 inhabitants. In the final decades of the twentieth century, wood consumption is at a level of 15 million m³ per year, or 1,000 m³ per 1,000 inhabitants per year.

(e) Timber trade

In 1927 the contribution of domestic wood production to total consumption was 50,000 m³ or 12 per cent. The balance of 88 per cent was imported. Domestic production covered 10 per cent or 1.5 million m³ of the consumption in 1990, while 90 per cent was imported. Sawn softwood is still an important part of imports, as it was in the seventeenth and eighteenth century, followed by modern-age products such as woodpulp, sawn (tropical) hardwoods and wood-based panels.

TABLE 7.3.2
Historical development in forest ownership
(Per cent)

Ownership	1980-83	1964-68	1952-63	1938-42
Private	41	54	59	65
State	31	24	21	15
Municipalities	15	16	15	15
Nature Conservancy Assn.	11	5	4	5
Others	2	1	1	1

Although domestic production rose from 0.5 to 1.5 million m³ in the period 1927-1990, imports rose from 3.5 to 13.5 million m³. The source of imports diversified substantially: in addition to the traditional Baltic and Scandinavian sources, wood is now imported from western and central Europe, north and south America, Africa and Asia.

(ii) Development of the forest resource and its use

(a) Attitude and behaviour of man toward the forests

In the first half of the nineteenth century, the Physiocrat's opinion ruled with regard to land use: only food crops formed respectable goals and to that end uncultivated lands should be reclaimed. If reclamation for arable land could only be achieved after a short rotation forest crop, forestry was acceptable as "second best". In this opinion, forests were even regarded as unprofitable when they covered sites suitable for arable crops. The Physiocrats stimulated the reclamation of uncultivated lands. Because almost all high forest was gone by 1800 and most of the heathlands were not immediately suitable for crops, they stimulated the afforestation of 53,000 hectares of uncultivated land, as the second best option, in the relatively short period 1833-55.

A turning point in the political thinking on the influence of forests on their environment was provided by Moreau de Jonnes in 1825. In his answer to a question posed by the Royal Academy of Sciences at Brussels, he found positive effects of forests on local climate, hydrology and site quality in general. It took several decades before his ideas became more widely accepted. Long-term rotation forestry for timber trees was

TABLE 7.3.3
Forest area and composition in the province of Gelderland between 1833 and 1983
(Thousands of hectares)

	1982		*1966*		*1923*		*1833*	
	Area	*Per cent*	*Area*	*Per cent*	*Area*	*Per cent*	*Area*	*Per cent*
Hardwoods & shrubs	28	30	32	38	37	46	45	81
Softwoods	66	70	52	61	43	53	10	18
Osier beds	pm	-	1	1	1	1	1	1
Total	94	100	85	100	81	100	56	100

TABLE 7.3.4
Area, growing stock and current annual increment of Dutch forests outside towns, by plantation type, 1938-90

	> 0.5 hectares				
	Productive	*Semi- and non-productive*	*Less than 0.5 hectares*	*Line*	*Total*
Area *(Thousands of hectares)*					
1938-42	170	80	n.a.	38	-
1952-63	190	70	15	37	312
1964-68	200	80	12	37	328
1980-90	290	45	47	66	447
Growing stock *(Million m^3)*					
1952-63	14.9	n.a.	n.a.	2	-
1964-68	17.5	2	n.a.	2.1	-
1980-90	47.4	2.1	5.9	7.6	63
Growing stock *(m^3 per hectare)*					
1952-63	79	-	-	-	
1964-68	87	-	-	-	
1980-90	164	47	125	116	
Current annual increment *(m^3 per hectare)*					
1952-63	4.7	-	-	-	-
1964-68	5.7	-	-	-	-
1980-90	9.0	-	-	-	-

considered a task for the central government on Crown Lands. However, legislation was introduced in 1822 for the sale of Crown Lands to the public. Short-rotation tree crops were more attractive for the landed gentry and farmers because they allowed greater flexibility to change to food crops and vice-versa.

Because of this complex of reasons and the ruling position of agriculture, between 1800 and 1880 the majority of forests consisted of coppice followed by short-rotation softwoods to prepare the site for arable land. The remainder consisted of high forests on country estates. Between 1875 and 1885 the following global developments coincided that drastically reduced the attractiveness of coppice and short-rotation softwoods: tanning extracts from South Africa destroyed the market for domestic oak bark; wool from Australia destroyed the market for domestic wool; coal became a substitute for fuel wood; chemical fertilizers became a substitute for livestock manure; and prices of agricultural products were under severe pressure due to global oversupply. In addition, demand for pit props developed in Holland while new Dutch legislation enabled the partitioning of collectively used forests.

As a result, the reclamation of heathland and drifting sands came to a halt between 1885 and 1900. We find this confirmed in the land-use statistics (table 7.3.1). Coppice cultivation lost much of its attractiveness as an alternative to food crops. A large area previously under coppice was planted to high forest, mainly Scots pine. The rotation periods for Scots pine were relatively short compared to today's practice: 40 to 60 years, enough to produce pit props ranging in diameter from 6 to 20 cm underbark.

Towards the end of the nineteenth century, public opinion with regard to forestry definitely changed. Apart from economic returns, idealistic values found recognition, such as scenic and natural beauty, recreational possibilities and prosperity. The 1822 legislation on the sale of Crown Lands was withdrawn in 1890. The Government started the afforestation of coastal dunes and bought an area of 2,500 hectares of drifting sands for afforestation near Kootwijk (see 7.2 (i)(c)).

One year before the turn of the century, the National Forestry Service was founded. Its commission was the management of existing state-owned forests and the enlargement of this area through the afforestation of heathland which would be bought for this purpose. In 1928, 40,000 hectares were under management; by 1990 this area had increased to 200,000 hectares, of which 80,000 hectares were forest. In the 1960s the afforestation of heathland was terminated in order to conserve the remainder as national heritage.

Legislation also stimulated private persons to establish forests. For example, the forest law of 1922 obliges forest owners to replant every clear-cut area within three years with timber trees, but also grants him a tax holiday on forestry generated income. Local communities were granted interest-free loans for afforestation of their uncultivated lands. Even today, local communities hold a share of about 15 per cent in the Dutch forest area (table 7.3.2).

In 1883, the education of State foresters began at the Agricultural Polytechnic at Wageningen. In 1917 this was made into the Agricultural University. The Forest

Research Institute was founded in 1919 and became a member of IUFRO. In 1928, the Forest Fire Insurance Association was founded, which is still active, covering the majority of private forests.

(b) Forest area and composition

Since 1938, country wide forestry statistics have been gathered. For one of our provinces, Gelderland, we have statistical data for an even longer period of 150 years, i.e. 1833-1983 (table 7.3.3). These data clearly illustrate the transition from over 80 per cent of hardwoods and shrubs in 1833, to forests composed of 70 per cent softwoods in 1983. The province of Gelderland can be regarded as representative of the entire country. Attention is drawn to the fact that the category "Hardwoods & shrubs" did not fit the concept of "high forest" in 1833.

Forest ownership changed substantially between 1938 and 1982, as shown in table 7.3.2. We observe that in spite of governmental efforts to stimulate private ownership, the latter's share fell from 65 to 41 per cent over the period examined. In the same period, the share owned by the State increased from 15 to 31 per cent. The explosive increase of labour costs which started in the early 1960s was not offset by a comparable rise in wood prices. In 1960 the sale of 1 m³ standing volume of timber might compensate for the cost of approximately 5 hours of forest labour. Today the ratio has worsened to 1:1, notwithstanding the fact that diameters of harvested timber have risen markedly since 1960. Therefore, forest management is hardly profitable for private owners who still have to invest in the growing stock of their relatively young plantations.

(c) Growing stock, increments and removals

Table 7.3.4 shows that by the end of the 1950s, the growing stock of the productive high forests amounted to 81 m³ per hectare in the young stands of that time. In the relatively short period to 1990, the growing stock had doubled to 164 m³ per hectare. This excellent performance was caused by somewhat restrictive wood harvesting policies and by an unexpected favourable development of the current increment.

We observe that stands grow longer and at a much higher rate than previously supposed. We may regard this as a sign that 80 to 100 years of proper forest management recovered much of the original site quality after centuries of degeneration in which organic matter was taken out of the forest to maintain the soil fertility of arable plots. However, the fertilizing effects of nitrogen emissions on the current annual increment cannot be overlooked.

The current increment of the productive forests equals 9.0 multiplied by 290, or 2.6 million m³ per year. Annual removals from all types of forest are of the magnitude of 1.5 million m³, so a substantial further investment in growing stock remains. This must be seen in connection to the present multiple-use management policy of Dutch forest resources: striking a balance between wood production, nature conservancy, recreation and landscaping. The total growing stock of 63 million m³ equals roughly four to five times the total annual wood consumption.

We saw earlier that for centuries a very high proportion of our wood consumption had to be imported. Until the middle of the twentieth century that fact was not a real basis for forestry activities. But in 1986, the Dutch Government published the policy paper "Meerjarenplan voor de Bosbouw", [Long-term planning for forest development]. In this Government paper, the further expansion of the forest area is foreseen. By the year 2050, one quarter of Dutch wood consumption should originate from domestic production. This was the first Governmental paper in which possible constraints in wood imports due to global developments were seriously taken into consideration.

(d) Non-product functions

Hunting stock is still kept. The Government position is that hunting stock will be kept under the level which would threaten fence-free forest regeneration. The grazing of domestic animals no longer occurs in multiple-use forestry. In those forests primarily dedicated to nature conservancy, some grazing of livestock is re-introduced to help develop more variety in forest build-up: high-low, open-closed, light-dark, etc.

Recreation became an important issue in forest management in the second half of the twentieth century. According to recent surveys, about 200 million individual visits are paid to the forest area annually. In principle, every forest is freely accessible. To cover the resulting costs, private owners are reimbursed by the State with an amount of DFL 90 per hectare annually. Eighteen per cent of the forest area is primarily dedicated to nature conservancy, be it with or without wood harvest. Presently, we hardly realize that our forest resources partly originate from the afforestation of drifting sands. In the nineteenth century, 15,000 hectares of forest were planted to consolidate drifting sands in the eastern provinces, and in the twentieth century 23,000 hectares followed. At the turn of the century, 4,000 hectares of coastal dunes were afforested.

7.4 Summary

In spite of the podzolic climate, a large part of the original forest cover was caught in the fatal sequence of: high forest on diluvial sandy soils of moderate fertility; over-use and grazing causing site deterioration and obstructing recovery; transition into heathland with some shrubs and bushes; over-grazing and sod extraction causing further deterioration of the site and loss of cover; transition into drifting sands; and threats posed by arable plots and living places.

Up to 1800, the single fact of a population of 2 million cannot be considered as the only factor in this process of the almost complete destruction of the high forest; perhaps even more important were conflicts of interest between different user/owner categories, and

private interests overruling common interests. One might even suspect that a heathland with bushes was considered more useful to the farmers than the original high forest.

Even when the forest resource had disappeared there were no constraints on the availability of construction timber or fuel: construction timber was imported and fuel wood was replaced by turf. A strange conclusion could be that the availability of alternatives to domestic wood production contributed to forest destruction.

Until the end of the nineteenth century, agricultural production had priority in land-use policies while forestry activities were relegated to farmers. In this context, intercropping food crops with coppice or short-rotation softwoods must be viewed as agro-forestry *avant-la-lettre*.

In recent times a multiple-use approach has become the leading philosophy in forest management. It seems probable that 80 to 100 years of proper forest management on degenerated former forest sites can regenerate much of the original site quality.

For the first time, possible constraints in future wood imports influenced the forest resource management strategies contained in a 1986 Government forestry planning paper.

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Chapter 8

SWEDEN

Erland v. Hofsten

8.1 Background

The aim of this paper is to describe certain features of the history of forests and forestry in Sweden, as a contribution to the "Study of Long-term Changes in Temperate-zone Forest Resources" described *inter alia* in document TIM/EFC/WP.2/R.119.

Paragraph 10 of that document states "that a historical review of such changes could be a valuable contribution to the debate on global forestry developments and the factors explaining them". It is believed, for the purpose of the study, that modern Swedish forest history - that of the latest 150 years - is of particular relevance in this context. Emphasis will therefore be placed upon that part of the history, stamped above all by an increasingly important role of the forest as a producer of wood raw material to forest industries. The territory referred to in the paper is that of present-day Sweden.

8.2 Introduction and general trends

Sweden (approximately 450,000 km²) is indeed a forestland: 57 per cent of the land area is productive forestland and about four-fifths make up the "forest landscape" including features such as swamps, smaller mountains and sub-alpine woodlands.

Variations from north to south are pronounced. The vegetation period is about 120 days in the land around the Arctic Circle in the extreme north and about 240 days in the south. This is one of the two reasons why there is not one, single history of Swedish forests. The other reason is the fact that iron and copper making radically stamped the forests of Central Sweden for several centuries.

FIGURE 8.2.1
Sweden

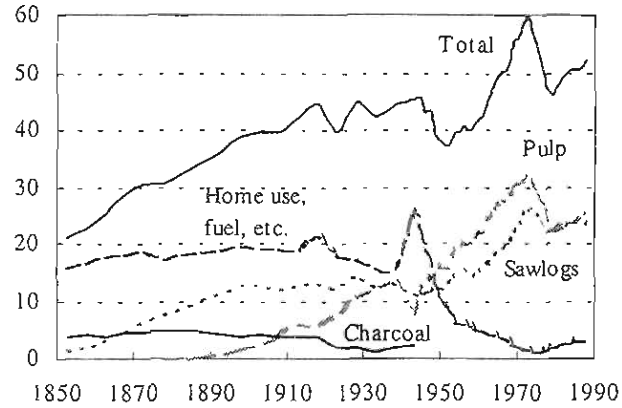
For the purpose of this analysis we shall therefore, somewhat arbitrarily, divide the country into three parts, which we shall name Northern, Central and Southern Sweden, coinciding with the three regions Norrland, Svealand and Götaland, which occupy 60, 20, and 20 per cent of the total land area respectively (figure 8.2.1). Each of the regions have gone through stages of serious forest degradation, though at different periods of time and for different reasons.

One way of showing how the pressure on the Swedish forest has mounted over time is to depict the wood consumption for various purposes, which, with the small volumes of roundwood traded over the borders, narrowly corresponds to the volumes of wood logged in Swedish forests, particularly in older times (figure 8.2.2). The general features are an almost three-fold increase in overall wood consumption since 1850, and large variations over time with regard to the distribution on assortments.

Further comments on figure 8.2.2 will be given later. Initially, and given the purpose of this paper, we will seek an answer to the overriding question of how the forests reacted to this mounting pressure - particularly since the initial stage was by no means characterized by well-managed, high-yielding forests, as we shall see.

Figure 8.2.3 shows the balance between gross

FIGURE 8.2.2
Wood consumption from Swedish forests, 1853-1990
(Million m^3 f.u.b.)



Note: From 1944 charcoal is included with wood for home use, fuel, etc.

FIGURE 8.2.3
Annual increment and total annual drain for all land-use classes in Sweden, 1926-90
(Million m^3 o.b.)

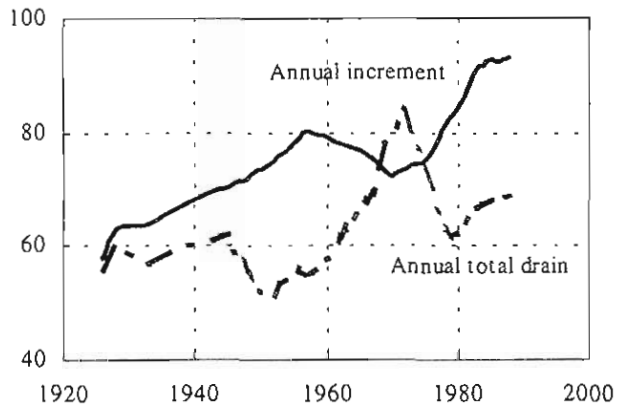
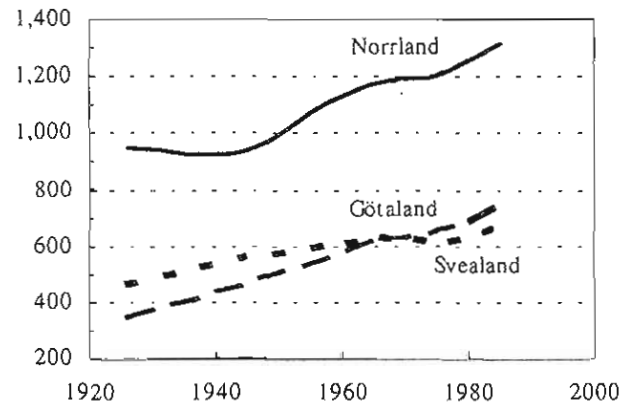


FIGURE 8.2.4
Growing stock for all land-use classes by region, 1926-90
(Million m^3 o.b.)



fellings and growth in all Swedish forests since the mid-1920s, which is as long back as reasonably accurate estimates exist. The fact that growth has continuously exceeded fellings (with a short exception only) has given the result that the standing volumes have increased considerably - by more than half since 1925 (figure 8.2.4). In value terms the increase is much bigger, and the process is still ongoing.

The general trend in modern Swedish forest history is thus: from unsatisfactory forest conditions 150 years ago due to drastically increased fellings, to even more high-yielding forests. It is emphasized that this judgment refers to the wood-producing capacity of the forests, which has been the predominant aspect of forest management during the period mentioned. It simultaneously deserves to be recorded that some modern critics have made the point, in Sweden as elsewhere, that this transformation process has been carried too far and has in fact been harmful to other aspects of forest management, i.e. the biodiversity in the forest ecosystem.

It is easily assumed - against this background - that a positive relationship has existed in Sweden between increased fellings and improved forest conditions, even if the contrary prevails in so many other regions of the world. This is a theme that will be discussed throughout this paper.

8.3 Regional histories

(i) Central Sweden

The influence of a successful forest industry on the forest that has been its foundation for centuries may be studied here in a unique way. It may seem misleading to call the mining industries of the region forest industries, for it was metals - iron, copper, silver - that were won from the ground. But the early mines and metal works were totally dependent on an abundant supply of wood and charcoal. The very fact that the deposits were situated in a well-forested district was of decisive relevance for the industry's competition with rivals elsewhere. Important chapters in the history of Sweden can be linked to this fact. The extraction of copper from the Falun mine was of the utmost importance for Sweden's position as a great power in the seventeenth century. And the iron extracted from many other mines gave Sweden a dominant position on the European market right into the nineteenth century.

The dependence of the iron industry on the forests is clearly revealed by a map of Central Sweden showing the location of the iron works in 1860. The many blast furnaces, where pig iron was extracted from the ore, are concentrated in the iron-ore fields in the centre of the map. The even more numerous forges, where the pig iron was turned into malleable metal, are located in a much wider circle covering the whole of Central Sweden.

The integration of forests, mines, blast furnaces and forges depended on a comprehensive transportation system, not only for ore and iron but above all for wood to the charcoal stacks, and for charcoal from the stacks to the iron works. In the mid-nineteenth century there were about 230 blast furnaces and 450 forges in operation. Each of these demanded large quantities of charcoal. It would have required a far more complex system to carry the charcoal to the centre than to carry the pig iron to the periphery. This was one reason why the Swedish iron industry was divided up into so many small units. Another reason was concern for the forests, officially advocated by the mighty Board of Mines, which granted privileges for the iron industry and functioned for two centuries from the middle of seventeenth century.

Forest maps of the early twentieth century show how the forests in Central Sweden were affected by charcoal burning. The plots where charcoaling took place were painstakingly marked on the maps. Placed at a distance of only a few hundred metres from each other, they were used over and over again, perhaps at 50-year intervals, and were spread out over the whole forest. Practically every old forest map shows a similar picture, whichever part of Central Sweden it represents.

For several centuries, forestry in Central Sweden was thus linked, via charcoaling, to an industry that remained profitable - indeed the forests were a prerequisite for the iron industry. The forests themselves were of course radically affected by this state of affairs.

In an introductory phase - up to the year 1800 or somewhat later - felling for charcoal was done without any thought of silviculture, that is, in a purely exploitative manner. Felling was carried out according to need. But the forest was often clear-cut round the charcoaling plots, since trees of all dimensions could be utilized for charcoal making; and clear-cutting encouraged the establishment of self-sown, even-aged and reasonably dense new forests. There are many indications, however, that the forests eventually became over-exploited during the first half of the nineteenth century.

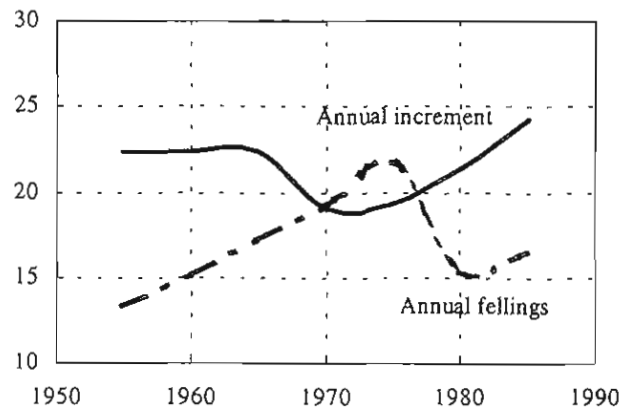
A factor then arose which was to prove significant. From the beginning, the iron work owners had relatively little forest of their own, but towards the middle of the nineteenth century it became possible for companies to buy up forestland from both the state and farmers. These opportunities were in fact seized on a large scale. Company owners, now in control of forests which were to be used over a long period for the companies' own need, gradually adopted a positive attitude towards silviculture. They were willing to invest the necessary capital, and flourishing times for the iron trade made it possible. It is quite evident from the results of the first national forest inventory in the 1920s that the extent of the new forests created in this way was quite large.

The principles of forest management, which were now applied for the first time on a large scale in Sweden, signaled a transition from exploitative to productive forestry, inspired by imported German foresters. Starting in Central Sweden, these principles, modified and modernized but in essence unchanged, spread southward and northward. They form today the basis for silviculture in the country.

The old iron works owners' ambitions to create new forests were in a sense misdirected, inasmuch as their aim was never achieved. New production methods in the iron industry were something the earlier industrialists could not foresee. Charcoal burning was phased out completely around 1950, and the forests that had been created were no longer needed for the manufacture of iron.

But both biologically and financially, the efforts were in the end a great success. The newly created forests served first the sawmills and later the pulp mills erected in the region. This was all closely connected with what happened in the rest of Sweden. Growth and fellings in the forests of Central Sweden are shown in figure 8.3.1 for the last 40 years - the period for which reliable records exist.

FIGURE 8.3.1
Annual increment and fellings for all land-use classes in Svealand, 1955-85
(Million m^3 o.b.)



(ii) Northern Sweden

While all this happened in Central Sweden, the vast forests in the north still bided their time. Because of the undeveloped transport systems at the time, they were not more than marginally drawn into the process just described. Minor parts of these forests - those close to the coast - did, however, form the basis for a forest industry for centuries. Potash and particularly tar were the products won by these cottage industries; tar was indispensable for shipbuilding at the time, and Swedish trading companies maintained a lucrative monopoly position on the European market in the seventeenth and eighteenth centuries. Likewise, some sawmilling took place, but it was - until 1850 - technically primitive and of a limited magnitude. Lapps traditionally roamed the region with their reindeer herds; they were challenged by a small but growing number of settlers, mainly cattle owners. Generally, the land remained very sparsely populated.

What is remarkable about these forests, forming the north-western tip of the Siberian/north European taiga, is the fact that they largely remained in their natural, virgin stage, virtually unaffected by human influence for so long. When, around 1850, a number of fortunate circumstances for a sawmilling boom in Sweden coincided, it was here that the expansion primarily took place.

For a proper understanding of forestry's position in Sweden ever since, it is important to realize that the sawmilling boom between, say, 1850 and 1900 was a turn of events of exceptional significance in the Sweden of those days: it was a contribution to the country's economic development second to none. Later on, the pulp and paper industry experienced a similar, and in some respects an even more dynamic development (see figure 8.2.2 illustrating those industries' wood consumption). And even if, self-evidently, the Swedish economy has since developed many new branches, still the forest industries play a significant role: they are by far the biggest net export earner.

Some of the factors behind the boom were: the demand for sawn goods increased dynamically in the wake of the industrial revolution, particularly in England; Norwegian forests and sawmills, previously in the lead, could no longer satisfy the market; England's preferential treatment of sawn goods from Canada ceased (the Navigation Act abolished in 1849); a technical breakthrough in sawmilling took place with the steam engine. The water power needed previously forced sawmillers to locate their activity in-land making it

difficult to reach the sea with their products. Mills could now be placed at rivermouths instead, and sawtimber could be taken from entire watersheds enabling economies of scale. Shipping was made easier; following the clearing of boulders, stones and other obstacles, the rivers became perfect for floating; forest ownership structures were painstakingly established through a century-long land survey process. With the ideology prevailing during the nineteenth century, a predominating share of the forests was allotted to settlers and farmers, many of whom sold the property to newly established sawmill companies. The state retained its ownership of less-attractive land, mainly that along the mountain range. All through the twentieth century, ownership in Northern Sweden has been close to stable: the State now owns 27 per cent of the forestland, private persons own 38 per cent, share-holding companies 29 per cent, and others 6 per cent.

The 1850-1900 sawmilling boom was hardly distinguished by subtle thinking, careful planning, or refinement: rather the contrary. The ruthlessness that so often - perhaps for natural reasons - characterized the sequence of events embraced not only management methods generally but also the treatment of the labour force and, to be truthful, the logging methods and the treatment of the forests.

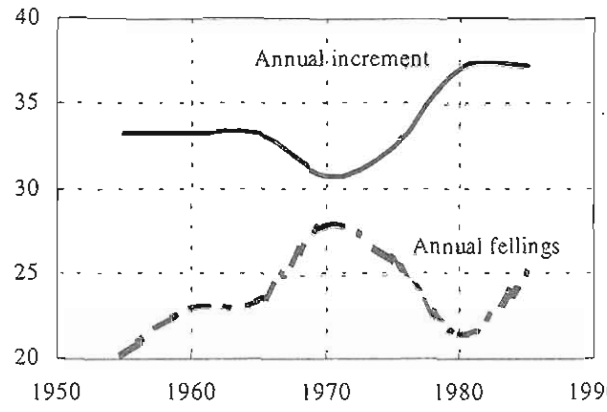
The trees that were extracted were of course only those that satisfied the demand of the sawmills: large trees, healthy and undamaged trees, pine rather than spruce and birch trees. This "dimension logging" created a forest stamped by smaller trees, more damaged trees, and a higher share of spruce than before. Many areas were treated in this way more than once, with intervals of a few decades. With the dynamic development of the pulp industry, starting around 1890, the scene was changed: a high demand was also created for wood of smaller dimensions, and for spruce and pine wood.

Even in cases where the remaining trees were much smaller and much fewer than before, these trees so dominated the scene that they normally and very efficiently prevented small plants from developing. No or very little natural regeneration took place in the forests treated in this way, partly due to the climatic conditions prevailing.

It was not until about 1900 that some pioneering silviculturists, worried about this ruthless exploitation, started to trace a route out of this regeneration dilemma: the hegemony of the old trees would have to be broken down before regeneration - natural or artificial - could take effect. This is the principle behind the silviculture system based on clearfelling. But the wide application of this principle was held back for several decades; the underlying theory was not yet generally accepted, and the forest ecology facts not yet well established. Consequently, a backlash occurred.

Particularly in the 1920s and 1930s, an increasing and eventually predominating number of Swedish foresters - also in Central and Southern Sweden - endorsed the principle of selective felling as the supreme way of regenerating a forest. "Shame on the forester who cannot regenerate with the axe", was one telling and commonly quoted slogan. The theory, supported also by low or non-existent forestry profits in the wake of dwindling timber

FIGURE 8.3.2
Annual increment and fellings for all land-use classes in Norrland, 1955-85
(Million m^3 o.b.)



prices, was very widely applied in all parts of Sweden during the years between 1925 and 1950.

The result was discouraging in the entire country: regeneration normally failed or was unduly delayed. But it was in the north that selection felling - in practice fairly similar to the older dimension felling - proved particularly unsuitable in most sites.

As 1950 approached, many people were of the opinion that forestry in Northern Sweden had reached a crisis stage: over very large areas only tiny and low-valued remnants of the old forest existed, and young forests had not at all or to a very limited extent been created inbetween. It became more and more evident, with research and survey results pouring in, that a complete reconsideration of silviculture principles was needed. Such a reconsideration eventually materialized around 1950 with the introduction of the clear-felling system, which has been predominantly applied ever since - with or without seed trees, with natural or artificial regeneration, with or without the help of controlled burning - increasingly with the use of the native *Betula pendula* and the exotic *Pinus contorta 9* and genetically improved plant stock. The thinning of young stands has also become routine treatment.

By and large these silvicultural principles, applied during four decades of reforestation over very vast areas all over Northern Sweden, have yielded the results desired. The process can be described as a decisive step from exploitative towards productive forestry in a comparatively short time span. The result can be studied in figure 8.3.2.

However, this is not to say that forestry, as practised in the way described, has been accepted without criticism. On the contrary, a number of issues of a varied nature have been under heavy debate. But these discussions are of a comparatively recent date and have not had any big influence on the historic trends discussed in this paper.

(iii) Southern Sweden

This region is, from several points of view, more heterogeneous than the other two. It embraces Sweden's best agriculture land mainly risen from the sea but also

more less-productive land on moraine soil, where most of the forests grow (57 per cent of all land is now productive forestland). The climate also varies a lot - rains are much less frequent in the eastern counties. Politically, several counties in the west and south were under Danish rule until the mid-seventeenth century. Private ownership dominates in these areas, with small estates abundant in some counties and large estates in others.

Historically, the forests of the region are stamped by all these variations but also by the fact that the land has been so intensely cultivated for such long periods. Also, large tracts of land now under forests were for centuries drawn into the farming and cattle husbandry systems practised at the time.

Shifting cultivation, more or less along the classical pattern, was widely applied on comparatively low-yielding land - though very often opposed by the authorities. In 1751, Carl von Linné, in one of his famous travel reports, expressed the opinion that shifting cultivation was a method well adapted to large tracts of land in Southern Sweden, but he was forced to delete this passage from his manuscript. After a few years' harvests of potatoes, turnips and rye, the land was often used for grazing - and also managed for that purpose, by holding back spruce and pine and favouring grass and leaf trees.

More high-yielding land was intensively managed for cattle food production. Two different types of land-use crystallized. The meadow, cherished in Sweden as the most graceful and flower-rich of all landscapes, served mainly for the production of hay used for stall-feeding in wintertime - a practice necessitated by our harsh climate. Other large areas were used as permanent summertime pastures. In both, considerable numbers of broad-leaved trees were allowed to grow, and these were utilized in many ways in the agrarian society. But the main product in this land-use system was fodder.

Farming was practised on a comparatively small area. It was the number of cattle and the quantity of manure produced that set the limits to the area that could be fruitfully tilled. In this manner a balance was maintained for centuries between meadows, pastures, and farm land. It lasted until 1900.

In the western part of Southern Sweden, with its higher precipitation, it was not possible to maintain such a balance. Rather, the land reacted, in the long run, with heath formation with the sturdy heather (*Calluna vulgaris*) dominating very large areas as late as a century ago. A common practice, in order to maintain the grazing capacity, was to burn the heather regularly, and the heaths became devoid of trees. Similar formations were found in many areas around the North Sea - in south-western Norway, Scotland, Holland, Germany, and Jutland, otherwise known as "the Atlantic Heath".

Contributing to the forest degradation in the western counties were some large-scale fellings. There are reports about big deliveries of oak timber to the Danish rulers in the sixteenth century and about large volumes of wood used during the peak periods of herring fishing along the west coast - the latter occurred with a remarkable intensity and a peculiar regularity a few decades each century. It required large volumes of wood for the manufacture of barrels and for making herring oil (by simmering the fish).

Wood consumption in this agrarian society - for house building, heating, fencing and other purposes - was also considerable. Some sawmilling, often of a cottage industry nature, developed early on.

Because of a natural lack of data, it is not easy to say which of these activities played the major role in the forest degradation that took place. Nor is it easy to estimate the extent of the various types of land-use mentioned. Trends in these respects are known for small areas only.

However, it should be emphasized that the degradation of the forests was made fully on purpose over the large areas required by the animal husbandry system applied at the time. Some nineteenth century authors from abroad, lamenting over "forest mismanagement rather than management" in Southern Sweden seem to have overlooked this aspect on the land-use system in place. A dramatic change in land use has however been brought about in Southern Sweden during, say, the last century. It has meant the total disruption of the age-old system and the establishment of a new one.

Even if the old system was a comparatively effective one, given the preconditions prevailing, signs of strain became more and more frequent during the nineteenth century. Sweden was one of Europe's poorest countries at the time and had difficulties feeding its growing population. A fairly large rural proletariat living under miserable conditions developed, and when openings for a new life gradually appeared they were indeed inclined to move. Between 1865 and 1915 more than 1 million people emigrated, representing one-fourth of the population at the beginning of the period. And a much larger number of people moved, somewhat later, internally in the urbanization process in the wake of the industrial revolution, which coincided with an agrarian revolution marked by productivity increases unthought-of under the old system. The migrants came from all parts of Sweden, but the exodus had the biggest influence on land use in regions with a high pressure on land, not the least in Southern Sweden.

With the drastic reduction of the pressure on land that now occurred in a comparatively short time, virtually all productive land besides farmland could be freed for forestry. The meadows, the pastures and the heaths no longer had a role to play in cattle husbandry; today they have more or less completely disappeared, much to the regret of most Swedes.

From a forestry point of view, the status in Southern Sweden was thus not very favourable a century ago. A number of reports from that time talk of a rather miserable forestry status, which might be interpreted either as an over-exploitation and lack of silviculture or - as we have seen - as the outcome of an alternative land-use system, now outmoded. Both interpretations seem to be simultaneously valid.

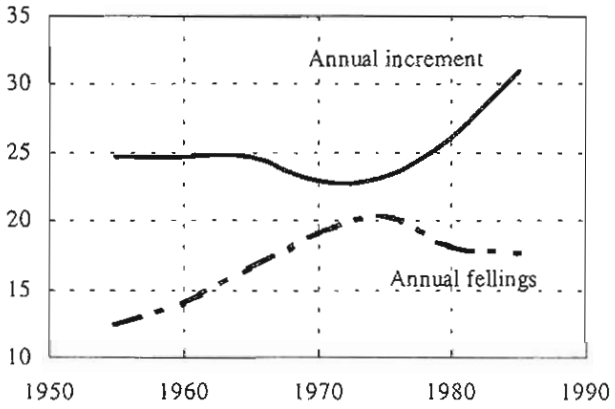
There were, however, also some brighter spots in the picture. Some reforestation programmes, starting in the 1860s, had been carried out on land bought by the State for the purpose. Likewise, organized silviculture had been

introduced on some of the larger estates and in forests belonging to glass or iron works. These early achievements showed promising results which served as good examples to other forestland owners.

One such example was a 400 hectare oak plantation carried out already around 1830 on the Visingsö Island in Lake Vättern as a response to a request by the Swedish Navy, worried about dwindling supplies of oak timber. A beautiful oak forest came into being - and around 1980 a letter was sent to the then admiral-in-chief reporting, perhaps not entirely seriously, that the timber was ready for delivery. "In the meantime", replied the admiral, "we have found out another way of building ships. My congratulations to the fine forest created, to the delight I hope of tourists for another century or so." The incident brings to the fore a forestry problem typical of our latitudes: the long rotation periods make it impossible to know, at the time of planting, to what use the forest-to-be will be placed. The graph showing how wood use has varied unpredictably over time attests to the same (figure 8.2.2).

This century has seen a massive reforestation process in Southern Sweden, resulting partly from large-scale, though scattered, planting or sowing operations, and partly from a self-healing, natural regeneration as the old land-use system was abandoned. The activities of the newly formed county forestry boards and the Forestry Act have been instrumental in this process.

FIGURE 8.3.3
Annual increment and fellings for all land-use classes in Götaland, 1955-85
(Million m^3 o.b.)



With the excellent conditions for tree growth in this region, the new forests created here grow more rapidly than in the other regions. An obvious "pushing southward" of forest production in Sweden has thus been achieved and a new, large sawmill and pulp industry was established in the region. Still, it is here that the potential for further forest industry developments are biggest, provided the threat from pollution can be successfully counteracted. Figure 8.3.3 shows how growth and fellings have developed over the last few decades.

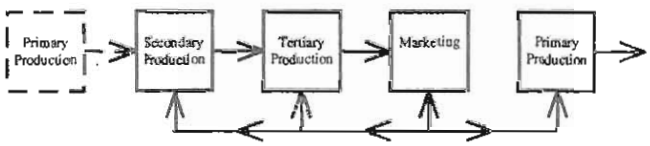
8.4 Discussion

The older forest histories of the three regions are thus quite distinguished from one another, even if much overlapping occurred. In this century, in contrast, differences between the regions have been leveled, as the influence of forest industries has increased all over the country. Growth now considerably exceeds extraction in all these regions, and practically all forests outside reserves are stamped by productive, as distinct from exploitative, forestry. Even today, foresters are often told that they or their predecessors have been over ambitious in their efforts to reforest the country, at the expense of other forest values. Some of the driving forces and circumstances behind the developments will be discussed in the following paragraphs.

(i) Financing

A key question has of course been the proper financing of the reforestation programmes. For the purpose of discussing this aspect, the simple diagram in figure 8.4.1 is introduced. It shows the principle of integrated, sustained forestry: goods of some kind are produced in the forest (primary production), then collected and transported out of the forest (secondary production), modified in some way (tertiary production) and then sold on the market. The money earned in the market must pay not only for the secondary and tertiary but also for the primary production (reforestation and other silviculture work in future rotation periods). If the money earned is insufficient, or, for any other reason, does not reach the

FIGURE 8.4.1
Flow chart of sustainable forestry in principle



forest owner, or if the latter is unwilling to reinvest in forestry, the system will of course fail to work. If financing from outside is required, the forest system is not considered economically sustainable.

The cradle of silviculture in Sweden stood, as we have seen, in the central region some 150 years ago. One obvious explanation is the persistent profitability of the iron industry and the need for sustained wood production felt by the industrialists, who also to a large extent became forest owners; the process took place largely independent of measures by the authorities.

On the contrary, such happy circumstances did not prevail in Southern Sweden at the time. Tertiary production of the same profitability as in Central Sweden was not at hand. A degradation of the forest took place. In Northern Sweden, tar production was organized in such a way that very little of the money earned reached the forest owner, in any case not enough for reforestation work. The same could be said about the booming sawmilling period; in spite of the fact that such a large

TABLE 8.4.1
Selected forest industry costs in Sweden, 1985

	SEK Million	*Per cent*
Total costs within forestry:	7,615	9
logging	5,067	6
silviculture:		
reinvestments	1,575	2
investments for increased production	973	1
Forest owners' surpluses	5,359	6
Total costs to the primary forest industry (a):	16,800	19
value of wood at roadside	12,974	15
purchase, transport and stock	3,829	4
Processing costs (b)	44,400	50
Value added (c)	27,700	31
Total production value (a+b+c)	88,900	100

Source: National Board of Forestry

capital was obtained from the virgin forests during half a century, no or very little money was made available for silviculture work. The forest degradation continued for another half century despite the fact that the pulp industries were added to the sawmills. Two circumstances contributed to the late start of efficient reforestation: an abundant supply of wood and, later, lack of proper know-how.

Again in the south, we may observe certain examples of reforestation financing from outside the system. It is typical of the Swedish case, however, that such outside financing has been rare and that the reforestation programme carried out has been financed, to a very high degree, by profits generated in the forest industries.

Table 8.4.1, referring to one particular year (1985) and embracing the entire forestry and forest industry sector of Sweden, shows the small share of the total production value that was needed even for this fairly dynamic silviculture programme in the established system.

Total silvicultural costs in 1985 thus amounted to around SEK 2,500 million. This corresponded to 15 per cent of the value of the wood at the industries and only 3 per cent of the total value of all forest products (sawn goods, pulp, paper, board, veneer, etc.). Expressed in other terms, participants in the Swedish forest industry are economically strong actors; a very small share of their production value diverted into the silviculture field has enabled a dynamic forest development.

We may conclude this section by establishing that one prerequisite for the long-term reforestation programme has been the values created by successful forest industries: a sound utilization of the forest resources has in the long run improved forest conditions. But this positive relationship has seldom been accomplished automatically; other favourable circumstances or promoting actions, some of which will be discussed below, have also been needed.

(ii) A free market

For more than a century, forestry in Sweden has been marked by the fact that the lion's share of its industrial production has been exported overseas. Thus, the conditions on the world market and the strong competition there have continuously formed the economic framework for forestry activities. The State has by and large refrained from market interventions (very much contrary to what has been the case in agriculture). Buyers and sellers have thus luckily remained free to negotiate and settle on prices and other delivery terms, and forestry, large- and small-scale alike, has been forced to streamline to accommodate the prevailing economic conditions. These have at times been severe, necessitating silviculture, logging, transport and marketing rationalization, and generally many other research and development efforts, but by and large favourable enough to allow the ploughing back into reforestation as described above.

(iii) Legislation

The eighteenth and nineteenth centuries saw a number of forest laws promulgated, often extremely detailed and aiming at the protection of the existing forests; they were, however, as a rule ineffective due to lack of acceptance by the people concerned and lack of means to enforce the rules.

After several decades of alarming talk about forest degradation, official investigations and debate on suitable policies, modern forest legislation was initiated in 1903 with the first Forestry Act. It stated that an owner of forestland is obliged to undertake reforestation measures after a final cut so that a new, good stand replaces the old one. This law, considerably widened and strengthened on later occasions, has been the cornerstone of productive forestry ever since. The principle is nowadays generally accepted by forest owners. The initial paragraph in force reads: "Forest and forestland shall, through suitable utilization of the timber production capacity, be managed so as to produce a high, valuable and continuous timber yield. Consideration must be given to nature conservation and other public interests." In this context, "forestland" is defined as *all* productive land not used for a purpose other than forestry.

Gradually the Act has been made more detailed. It now stipulates: compulsory regeneration after clearfelling, normally with softwood species; broad-leaved species and natural regeneration are accepted on suitable sites; planting normally to be carried out within three years after clear-felling; regulation of seed supply; seed, plants, spacing according to defined minimum standards; compulsory cleaning of young stands, especially to control unwanted broad-leaved brush; thinning operations designed to promote the growth of the remaining stands; clearfelling of normal- and well-stocked stands prohibited before a certain minimum age; unproductive stands, however, the current growth of which is less than half of what is normal for the actual age and site, are to be removed and replaced by new better stands; clear-felling to be reported in advance; minimum and maximum areas of mature forests for clear-felling within a 10-year period; compulsory forest management plans; environmental and other common interests to be promoted.

It may be mentioned here that a Parliamentary Committee has recently suggested substantial relaxation of these rules and more emphasis on environmental aspects other than wood production.

Complementing the Forestry Act, and in certain respects placed above it, is the Nature Conservancy Act.

Goals and rules are thus formulated with regard to national parks and other reserves, such as those aiming at the preservation of virgin/semi-virgin forests, wetlands and recreational areas, and also for certain flora or fauna species. In charge of all of this is the National Environment Protection Agency.

(iv) Specialized institutions

County forestry boards were instituted in 1905. They were given the task to promote private forestry through law enforcement, but mainly through word and deed. Herein lies a specific Swedish feature in forest administration that has proved important: the separation of the two tasks to manage the state-owned forests and to promote private forestry. Behind this separation, in force ever since, is a recognition of the profound difference in the nature of the two tasks. Thus, Sweden has two "forest services", or rather one national forest enterprise, called Domän AB, and one National Board of Forestry.

In order to secure profitable wood prices, small-scale forest owners felt a strong need to collaborate and form cooperatives, the basic task of which was to strengthen an otherwise weak market position. With time, several of these cooperatives have grown into powerful actors engaging in both secondary (rendering services to members, e.g. in logging) and tertiary production (owning large sawmills and even some of Sweden's biggest and most modern pulp mills).

(v) Control

Continuous control of the status of the forests has proved indispensable - it is obvious that many early mistakes could be attributed to false or scanty information about forestry at the time. Control at the national and regional levels is carried out by the National Forest Inventory of Sweden, established in the 1920s, and integrated into the Swedish University of Agricultural Sciences. Through repeated, nationwide surveys, now carried out annually, it has been possible to follow closely the development of forest areas, standing volumes and growth by regions, owner categories, species, ages, dimensions, etc. Further analyses of the data collected - such as cutting calculations - have been carried out by the National Forest Survey or by the Forecasting Department of the National Board of Forestry. Invaluable signals regarding, for example, further investments in forest industries and general forest policy developments have thus been recognized during the last seven decades.

Control of forestry practices on individual farms or forest estates has also proven more or less indispensable. It is made possible in a systematic way through stand inventories carried out by the county forestry boards or by the forest owners themselves. In addition, all clear-fellings must be reported to the authorities, enabling the county forestry boards to check on reforestation operations.

(vi) Other factors

Proper financing, legislation, institutions and control have proved necessary for the happy outcome of the Swedish reforestation campaign during this century. It is, however, easy - and no doubt trivial - to point out other factors behind the developments; it may be said about each of them that the turn of events would not have been the same without them. Some such necessary factors are: change in land use (already discussed); improved silviculture (already discussed); technical revolution in forest work and industrial processing; know-how development generally, through research and development facilities and programmes; training of skilled personnel at all levels and extension of knowledge to all actors.

Another factor behind the recent improvements in forest growth has, absurdly enough, been pollution, particularly over Southern Sweden, which has caused fertilization through nitrogen downfall. But if continued, this is of course will eventually kill the forests.

It should be emphasized that some factors having a strong influence on forest development in many other countries have not played an important role in Sweden: the fragmentation of forestland; though silviculture practices vary somewhat between small- and large-scale forest owners, none of the categories could boast a "superiority" in this field; standing volumes per unit area are today in fact higher in small-scale forestry, on average, indicating over the years a more conservative cutting policy among private forest owners; state subsidies in reforestation programmes have played a minor role.

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Chapter 9

THE UNITED STATES OF AMERICA

Douglas W. MacCleery

9.1 Historical significance of US forests

In our highly urbanized society, it is easy to overlook the critically important role that forests have played in the history and development of the United States. The single-most important event in the evolution of the American landscape as we know it today was the clearing of forests for agriculture. This clearing was essential to provide food for a rapidly growing nation.

In addition to clearing for agriculture, forests were utilized for a wide variety of products and ends. The forests were a habitat for wildlife, which in turn formed the basis for a lucrative export market; the forests also provided an important supplement to the diet of millions of Americans.

Wood was virtually the only fuel used for most of this country's history. It warmed its citizens, produced its iron, and drove its locomotives, steamboats, and stationary engines. Lumber, timbers and other structural products were the primary material used in houses, barns, fences, bridges, dams and locks. Such products were essential to the development of rural economies across the nation, as well as to industry, transportation, and the building of cities. American forests - the products derived from them and the land they occupied - were the economic foundation of the nation.

In a spiritual sense, the forest, and the wilderness values it represents, has also played an important role in the identity of the nation. This has been expressed in the writings of Thoreau, Emerson, Marsh, and others and was first evidenced politically in the late 1800s amidst efforts to address concerns over wildlife destruction and forest depletion. There is no question that without its forests America would have had a decidedly different history and would be a decidedly different place than it is today.

In the past few years, we have seen an increased interest in all aspects of the environment. A portion of this interest has focused on concerns over the condition of the nation's forests and the associated wildlife. An enlightened perspective on the current condition and trends of our forests and wildlife should be based on a general understanding of how they came to be what they are today. This paper seeks to fill that need by briefly outlining the natural and human influences that have shaped our forests over the years.

9.2 Nature and extent of North American forests prior to European settlement

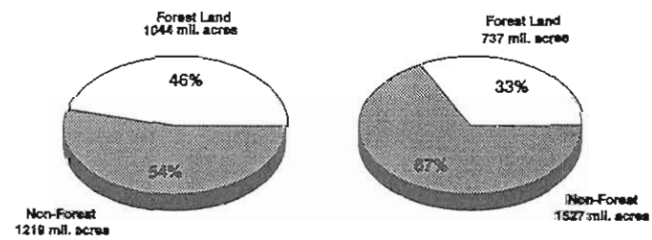
Early European settlers to America were awed by the ocean of trees which greeted them. Forests blanketed much of the eastern third of the US, extending from the Atlantic Coast to the prairies beyond the Mississippi. These vast forests were a sharp contrast to those of England and much of the rest of Europe, which had been severely depleted for fuel and building materials. The original American forest covered a little over 1 billion acres, or about half of the current US land area (including Alaska).

Today, about one-third, or 737 million acres, of the nation is forested: about 70 per cent of the area that was forested in 1600. Since that time, approximately 310 million acres of forest have been converted to other uses, primarily for agricultural ends (figure 9.2.1).

Forests remained the dominant feature of the landscape in eastern North America for centuries after initial settlement. In 1796, almost two centuries after the first European settlements, a French naturalist visiting the new American nation wrote that, "The most striking feature [of the country] is an almost universal forest, starting at the Atlantic and thickening and enlarging to the heart of the country."

About three-quarters of the nation's original forest was in the eastern third of the country. West of the Mississippi, as rainfall diminished, forests and woodlands gave way to vast, treeless prairies and deserts. However,

FIGURE 9.2.1
Forests as a per cent of US land area, 1600-1992



Source: 1992 RPA Assessment Update
USDA/FS, 5/93.

in mountainous areas where rainfall was sufficient, and along the Pacific Coast, extensive and often magnificent forests developed.

One popular myth is that, prior to European contact, America was dominated by impenetrable, relatively uniform ancient forests that cloaked the landscape in a long-term static balance with the environment. The reality was quite the contrary. Pre-settlement forests were exceedingly dynamic - shaped by a myriad of both natural and human influences, disturbances, and catastrophic events that had a profound effect on the age, plant species, and wildlife of the forest environment. Pre-settlement forests in both the east and west were a diverse mosaic of forest stands whose age, tree species, and wildlife varied widely and reflected the disturbance history of the area.

America's original forests were not pristine in the sense of being uninfluenced by humans. In both the east and the west, forests were strongly influenced by Native Americans. In the eastern forests, most Native Americans lived in fixed villages. Domesticated crops accounted for more than half of their diet, with maize being the predominant crop. Population densities were at least five times that of the nomadic, hunter/gatherer societies to the north and west. Hundreds of thousands of acres were cleared for fields. Tens of millions more were burned frequently to improve game habitat, facilitate travel, reduce insect pests, remove cover for potential enemies, enhance conditions for berries, and to drive game. It was a shifting type of agriculture. Fields were abandoned when their natural fertility ran out, new forests were cleared, and the abandoned lands quickly reverted back to forest.

European settlers spoke of the open park-like forest that they encountered (a condition created by frequent burning) and of the frequency of Indian burning. Settlers in New England reported that Native Americans burned the woods twice a year. A general statement can be made that, wherever there were Native Americans, there were forest fires.

The abundant wildlife that was reported also gives an indication of the frequency of disturbance: deer, wild turkey and a variety of game birds abounded. Even elk and bison, normally associated with the western prairies, were common in the eastern forest; bison were reported as far east as Massachusetts.

The South was dominated by fire-created forests - such as long-leaf pine savannas on the coastal plain and piedmont. The hardwood forests of the Appalachian Mountains were also burned frequently by Native Americans. In Virginia, the Shenandoah Valley - the area between the Blue Ridge Mountains and the Alleganies - was one vast grass prairie. Native Americans burned the area annually.

On the western fringe of the forest, fire-dominated forest types, such as oak and pine savannas, covered tens of millions of acres. These forests were heavily influenced by fires sweeping in off the western prairies. Fire-created prairies extended well into Ohio. Evidence of the dominant role fire played in these forests is demonstrated by the fact that, when farms finally began to move out onto the prairies and cut off prairie fires, millions of acres of open oak savannas and treeless prairies to the east of these farms became dense woodlands and forests within two decades.

As we see rising interest in protecting some of our forests in their "natural" condition, the complex natural and pre-settlement human history of US forests raises equally complex technical and policy questions over whether to allow wildfire to assume its natural role in these areas, as well as whether to seek to replicate pre-settlement human influences. We know that it is virtually impossible to separate natural from human-caused influences in pre-settlement forests - North American forests have been both occupied and influenced by humans from the time these forests advanced north before the retreating continental glaciers more than 8,000 years ago.

9.3 European view of the forest

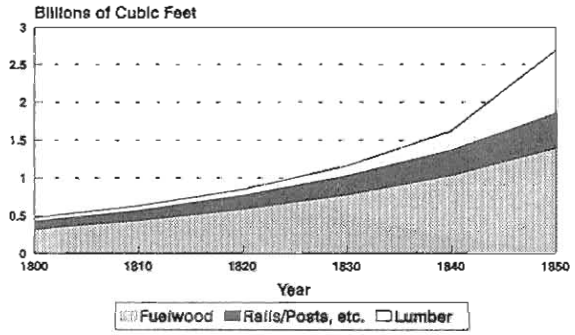
There can be no doubt that the era of European settlement greatly increased the impact of humans on the forest. The abundance of land and resources, and the scarcity of labor was a defining difference between America and Europe, where the situation was the reverse. This difference affected everything we did, from the stewardship we applied to our resources (or the lack thereof), to the adoption of the institution of slavery.

The seemingly endless forest was viewed as a mixed blessing by early European colonists. On one hand, it provided an abundant and readily available source of fuel and building materials. It yielded abundant game which remained an important source of food for decades after settlement. But the forest was also habitat for wolves, eastern panthers, and other predators that found colonial livestock easy prey and against which the colonists waged an unrelenting war. It also provided cover for sometimes hostile Indians. But most importantly, it occupied potential cropland that could be liberated only after intensive and back-breaking labor using the now-primitive hand tools of the period.

For the first three centuries of our history, most Americans were farmers. In 1800, 95 per cent of the people lived on the land. Except for a relatively few people engaged in plantation agriculture in the South, most were subsistence farmers. The predominant view that emerged in the early 1600s, and that continued for almost 300 years, was that the forest was both inexhaustible and an obstacle to the much-preferred agricultural use of the land.

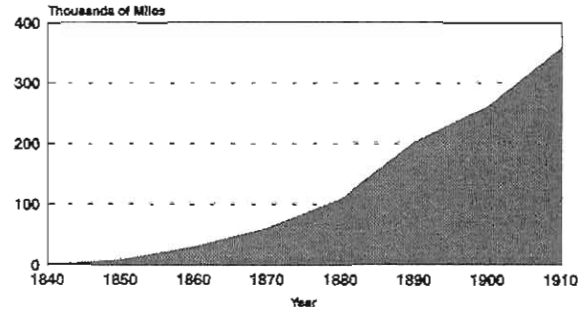
After all, the forest was vast and cropland was scarce. The nation was much more concerned about feeding itself than it was over the spiritual value of the forest. Forest clearing became a win/win situation. It liberated cropland and pasture while providing fuel, fencing, and material for building homes, barns, mills and factories. Indeed, often selling the fuelwood and potash

FIGURE 9.3.1
Domestic production of forest products, 1800-50



Source: Fredrick & Sedjo, RFF (1991)

FIGURE 9.3.2
Miles of US railroad track, 1840-1910



Source: Olson, The Depletion Myth

that could be made from wood ashes would pay most of the cost of buying the land.

(i) Use of wood for fuel

Energy was the dominant use of wood on a volume basis until well into the late 1800s. In the late 1700s, about two-thirds of the volume of wood harvested was for fuel (figure 9.3.1). By 1850, wood still provided over 90 per cent of the nation's energy BTUs. By far the dominant use of fuelwood was for domestic heating and cooking. However, it was also the primary industrial fuel. Until after the Civil War, virtually all steamboats, railroads, and stationary engines used wood fuel. The per capita consumption of fuelwood averaged over four cords per year for most of the nineteenth century, and the volume of fuelwood consumed rose 15 times between 1800 and 1900.

Even before 1800, fuelwood cutting was depleting the forests around population centers. In 1759, one visitor described the area around Philadelphia as "bereft of forest." In the late 1700s, fuelwood was hauled nearly 100 miles to several coastal towns, causing the price to rise beyond the reach of the poor.

(ii) Fences

Until the middle of the nineteenth century, next to energy, the most important use of wood on a volume basis was for fences. Fences were not ornamental. Because labor was scarce, herding livestock, as had been common in Europe, was generally not practiced. Instead, hogs, cattle, and other livestock were turned untended into the woods. Fences were needed to keep them out of crops and gardens. Fence construction was one of the most labor-demanding tasks of farm-making, second only to forest clearing in its labor requirements. In 1850, there were 3.2 million miles of wooden fences in the US - enough to circle the earth over 120 times.

(iii) Early industrial use of wood

Most mechanical power for textile mills, grist mills, sawmills, and other mills and factories was provided by water. But most mills were built of wood, the dam in the river was most likely made of wood, even most of the machinery inside the mill was built of wood, tipped with iron.

The production of iron itself depended upon wood. Until 1850, the majority of US iron was made from wood charcoal. Virtually every state east of the Mississippi had a number of iron-making furnaces and forges fired with wood. In the 1850s, the tonnage of coke iron finally exceeded that of charcoal iron. Even so, the tonnage of charcoal iron produced continued to rise until 1900.

Wood was also used as process heat for breweries, tanneries, salt evaporation plants and anywhere else industrial process heat was necessary.

(iv) Transportation

By the early 1800s, the US was one of the largest nations in the world. The element that tied such a large group of disparate and often quarreling states together more than anything else was a transportation system. America's forests figured predominantly in this task as well.

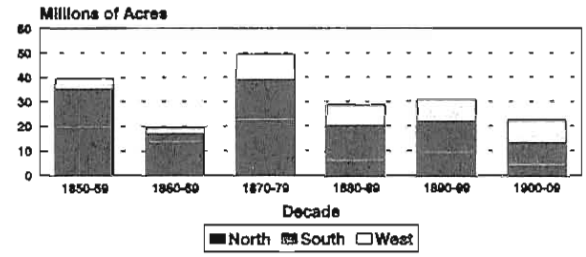
The nation's first highways were its rivers. Wooden keelboats were followed by steamboats, which proliferated after 1830. Steamboats were made of wood, and, until the Civil War, used wood for fuel. In 1840, almost 900,000 cords of wood were sold for steamboat fuel, or a fifth of all fuelwood sold.

Railroads followed the steamboats. After 1850, the railroads began to expand rapidly to link the growing cities and to provide access to the cities from the agricultural and forestland upon which they depended. Although called the "iron road," railroads used far more wood than iron. Except for the engine and rails, railroads were made of wood. The cars were wood, the ties were wood, the fuel was wood until the Civil War, the bridges and trestles were wood, and station houses, fences, and telegraph poles were also made of wood.

The mileage of US railroads increased more than 35 times between 1850 and 1910, from less than 10 thousand miles to more than 350 thousand miles (figure 9.3.2). By the late 1800s, railroads accounted for between 20-25 per cent of the total consumption of timber in the country.

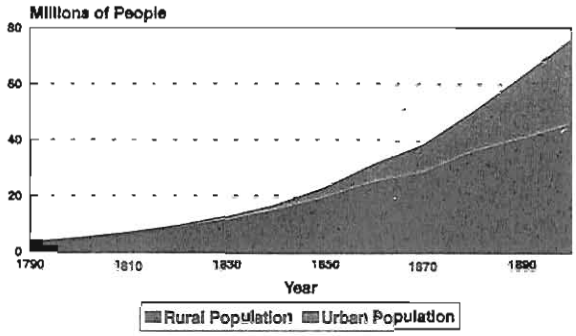
By far the most significant railroad use of wood on a volume basis was for cross-ties. Each mile of track required over 2,500 ties. Cross-ties were not treated until after 1900. Because of their rapid deterioration caused by contact with the ground, ties had to be replaced every five

FIGURE 9.3.3
Farm clearing of forest in the US by decade and major region, 1850-1910



Source: M.Williams, Americans and Their Forests. An Historical Geography, 1989.

FIGURE 9.3.4
US population by rural and urban location, 1790-1900



Source: U.S.Bureau of Census Figures

to seven years. Given the mileage of track in 1910, that would be equivalent to replacing the ties on over 50,000 miles of track annually. It is estimated that in 1900, just replacing railroad ties on a sustained basis required between 15 and 20 million acres of forestland.

(v) Farm clearing

While the use of wood for industrial purposes and transportation was certainly significant, especially in the latter half of the 1800s, clearing for agriculture has been the dominant cause of reduction in forest cover. Since there was no improvement in crop yields per acre throughout the nineteenth and well into the twentieth century, farm clearing increased at about the same rate as the growth in population. Between 1850 and 1900, the US population increased over three times, from 23 to 76 million people, while the area of cropland increased four times, from 76 to 319 million acres. For every person added to the US population during the nineteenth century, farmers were putting another 3 to 4 acres of cropland under the plow. The area of pasture and hayland increased even more than that of cropland. In the sixty years from 1850 to 1910, American farmers cleared more forest than the total amount that had been cleared in the previous 250 years of settlement - about 190 million acres (figure 9.3.3).

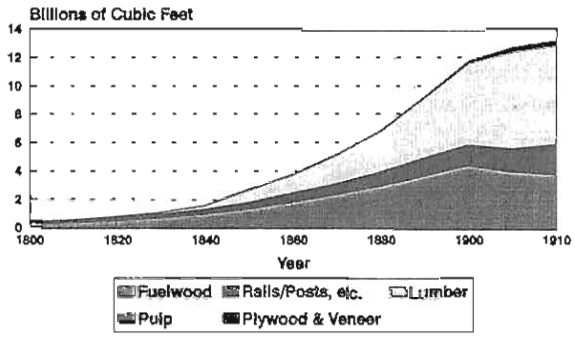
To put forest clearing during this period in more clear terms, the nation's farmers were clearing forest at an average rate of 13.5 square miles per day every day for 60 years.

(vi) Increase in lumber production after 1850

The nineteenth century was a period of rapid population growth. During the century the US population rose over 14 times - increasing from 5.3 to 76 million people. The America of the early 1800s was overwhelmingly a nation of largely self-sufficient farms. However, after 1850 the US began to restructure from a rural, agrarian society to one increasingly urban and industrialized. Between 1850 and 1900, the population of the nation's cities increased at twice the rate of the general population, causing a profound change in the demands the nation placed on its forests (figure 9.3.4).

In addition to increased resource demands resulting from the growing cities, farms were pushing out onto the treeless prairies. These prairie farms themselves began to

FIGURE 9.3.5
Domestic production of forest products, 1800-1910



Source: Fredrick & Sedjo, RFF (1991)

demand large quantities of lumber for barns, homes, outbuildings, and fences.

Logging and sawmilling increasingly began to be organized as large-scale industrial operations. The consumers and the forests upon which they depended for their natural resources began to be separated by hundreds of miles.

Lumber production increased dramatically. It rose more than eight times between 1850 and 1910, from 5.4 billion board feet to 44.5 billion annually, or more than twice the rate of population growth (figure 9.3.5). Vast areas of the Midwest, South, and Pacific Coast were logged, and often relogged. The tree limbs, tops, and other debris that remained after logging were often burned in the belief that the logged areas could be converted to cropland or improved pasture. These uncontrolled slash fires burned more or less continuously, and when weather conditions were right, sometimes resulted in massive wildfires, property damage, and major loss of human life.

Repeated wildfires also killed residual trees and seedlings left by logging and created tens of millions of acres of what came to be called "cutovers" or "stumplands" that remained idle, unstocked or poorly stocked with desirable tree species for extended periods of time.

(vii) Wildlife depletion

The nation's wildlife faced many of the same pressures as its forests. A wide variety of wildlife species, which at the time of settlement had been present in huge numbers, were being severely depleted. The most significant factors were virtually unrestricted market hunting of all kinds of wildlife for food, furs, and feathers (which in the late 1800s were in great demand for women's hats), as well as habitat modification caused by farm clearing, logging, and massive wildfires. Even many species of songbirds, such as robins, meadowlarks, and others, were being adversely affected in some areas by hunting for food.

9.4 A call for action

Before the turn of the century, a growing number of people began to be increasingly concerned about what was happening to much of the nation's woodlands. Fears about future supplies of timber were mixed with apparent implications of increased flooding and watershed damage, depleted wildlife populations, loss of the beauty of the American landscape, and even concerns about how forest clearing was affecting the climate itself. All of these concerns began to call into question the myth of forest inexhaustibility. Predictions of an impending "wood famine" were raised frequently, beginning in 1865 with Frederick Starr. Use of the term "famine" was an apt one, for wood in its various forms was one of the most widespread and essential materials in both domestic and industrial use.

Bernard Fernow, a German forester, began to promote the revolutionary idea that forests were a renewable resource that could be managed on a sustainable basis over the long term. George Perkins Marsh, who grew up in Vermont in the 1830s, began to raise concerns about the adverse effects of farm clearing on watersheds and other environmental values. In 1864, he wrote *Man and Nature*, which became a catalyst for public concern. In 1855, Henry David Thoreau retired to Walden Pond in Massachusetts, to reflect on the intrusion of civilization and to mourn the loss of America's wild places. Thoreau's was one of the earliest voices which began to put a value on "unspoiled" places for human spiritual renewal in a society increasingly urban and artificial. Teddy Roosevelt, a well-borne, but sickly New Yorker, went out to the western frontier to test his mettle. He came back transformed and became a life-long sportsman and conservationist. In 1901 and assassin's bullet propelled Roosevelt into the Presidency. In that position he had a profound effect on the conservation history of the nation. The "conservation movement," if it could be called that, was made up of a disparate of group of sportsmen, foresters, concerned citizens, and intellectuals, all concerned about what they saw going on.

The rapidity of the changes was a factor in the public concern. People could clearly see the changes in the forest landscape within their lifetime. In 40-50 years, many areas went from 80 per cent forest to 10 per cent or even less. Two wildlife species became the symbols of the deterioration of American wildlife. Bison, which had covered the plains in the tens of millions in 1870 were reduced to scattered remnant bands in 15 short years. The passenger pigeon, probably the most abundant bird in North America, had darkened the skies over much of the Midwest in 1870. It was virtually extinct 20 years later in 1890.

Early responses to such concerns were expressed in setting aside land in protective categories, such as Yosemite in California (1864), Yellowstone in Wyoming (1872), and the Adirondack Preserve in New York (1885). In 1891, Congress authorized the President to designate Forest Reserves out of Public Domain lands, but made no provision for their management. The Forest Reserves, unlike the park preserves, were generally not tied to the preservation of a nationally significant unique area. These designations, which had grown to 40 million acres by 1897, generated much opposition because it was unclear how such set-asides would address society's need for grazing, wood products, and other resources.

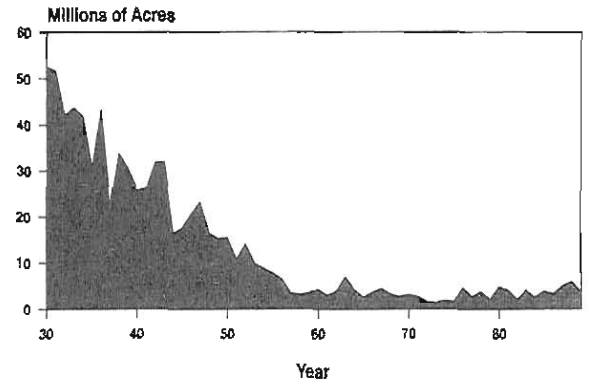
Out of this debate emerged a new idea, one rooted in the sustainable forest management concepts practiced in Europe. Conservation, the notion that forests, wildlife, and other renewable resources can be managed under scientific principles on a sustainable basis over the long term, increasingly began to be promoted by professional foresters, such as Fernow, as well as by hunter/sportsman's groups concerned about the depletion of wildlife. As the result of these efforts, in 1897 Congress finally gave the Forest Reserves a management mandate, i.e. to "preserve and protect the forests," to "secure favorable conditions of water flows," and to "furnish a continuous supply of timber for the use and necessities of the citizens of the United States." The idea of conservation as wise use received widespread public support under the dynamic advocacy of Gifford Pinchot, first Chief of the Forest Service and his close friend and mentor, Theodore Roosevelt.

Thus, the Forest Service emerged as a product of the nation's first conservation movement. The agency became a major instrument for the practical application of conservation as the wise use of forest resources. That role encompassed much more than the management of the National Forests. It also included leadership in working with the states and private landowners in advocating the protection and productive management of non-federal forestlands, as well as research in forest management and improved utilization of wood products.

(i) Policy framework for forest and wildlife conservation

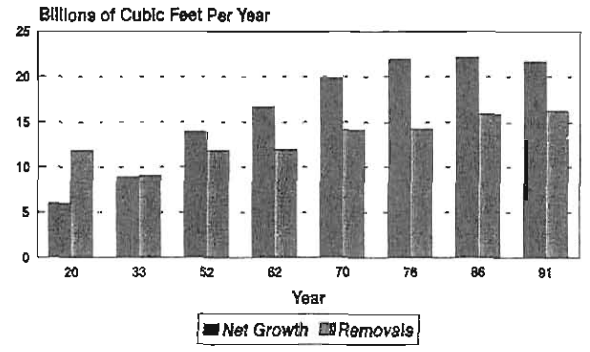
The policy framework that had emerged by the 1930s to address these issues focused on (i) promoting and encouraging the protection of forests, regardless of ownership, from wildfire, insects, and disease; (ii) the acquisition of scientific knowledge on the management of forests and wildlife, and on the improved utilization of wood products; (iii) encouraging the productive management of private forestlands through tax incentives

FIGURE 9.4.1
US wildfire trends: area burned, 1930-89



Source: Wildfire Statistics, USDA-FS

FIGURE 9.4.2
US timber growth and removals, 1920-91



Source: USDA/Forest Service

and technical and financial assistance; (iv) the adoption and enforcement of strong state and federal wildlife conservation laws; and (v) the acquisition and management of public lands for both commodity and amenity uses and values. See the Appendix for a further description of this policy framework.

A key element of the public policy framework was strong cooperation among federal, state, and private sector interests to achieve common goals. A stronger, more coercive federal role in the direct regulation of private forestlands was considered and debated, but was ultimately rejected.

(ii) Condition of US forests and wildlife in 1990 vs. 1900

It is a measure of both the inherent resilience of our forests, and of the success of the policies that were put in place in response to public concerns in the early decades of this century, that forest conditions over much of the US have improved dramatically since 1900. The following is a snapshot of the forest and wildlife situation that existed in the 1900s, as contrasted with 1990:

(a) 1900

- In the early 1900s, wildfire commonly consumed 40-50 million acres annually, an area the size of Virginia, West Virginia, Maryland, and Delaware combined.

- Due largely to such wildfires, there were perhaps 80 million acres of "cutovers" which continued to remain idle and unstocked or poorly stocked with desirable tree species.

- The volume of timber harvested, nationally, greatly exceeded that of forest growth.

- No provision for reforestation was being made. In fact, no long-term forest management of any kind was being practiced.

- Large quantities of wood were left behind after logging, sawmills were inefficient, use of wood in buildings was based on custom rather than sound engineering, and huge volumes of wood were lost to rot and deterioration.

- Large-scale disastrous flooding in the east was tied to farm clearing and to logging and wildfires.

- Clearing forests for agriculture continued at very high levels. In the last decade of the century, America's farmers cleared forests at the average rate of 13.3 square miles per day. In the five decades ending in 1900, forest cover in many areas east of the Mississippi had been reduced from 60-70 per cent of the land to 20 per cent, or even less in some areas. Many of the areas being cleared were on steep slopes, were marginal for growing crops, and often were highly erodable.

- By 1900, many wildlife species, which were formerly abundant, were severely depleted or were on the brink of extinction. Examples included game animals, such as white-tailed deer, wild turkey, pronghorn antelope, moose, bighorn sheep, and, of course bison. Fur-bearers, especially beaver, had been eliminated from significant portions of their ranges. Waterfowl were also severely impacted, including wood ducks, and several other species of duck, Canada geese, all manner of plumed wading birds, such as herons, egrets, ibises, and others. The passenger pigeon, perhaps the most abundant bird on the North American continent, was for all intents, extinct in 1900; the heath hen, an eastern relative of the western prairie chicken, was also on the brink of extinction. The great auk, a flightless bird living along the Northeast coast, became extinct in 1840.

(b) 1990

- The area consumed by wildfire has been reduced by more than 95 per cent, from 40-50 million acres in the early 1900s to 2-4 million acres today - even in bad fire years (figure 9.4.1).

- The cutovers or "stumplands" that existed in 1900 have long since been reforested. Today, many of these areas contain mature forests. Others have been harvested a second time and regenerated to young forests.

- Nationally, forest growth rates have exceeded harvest rates since the 1940s, with each decade generally showing a greater margin of growth over harvest than the one preceding. By 1986, the volume of tree growth nationally exceeded the volume harvested by 37 per cent; and growth was more than 3 1/2 times what it had been in 1920 (figure 9.4.2).

FIGURE 9.4.3
Tree planting in the US, 1950-90

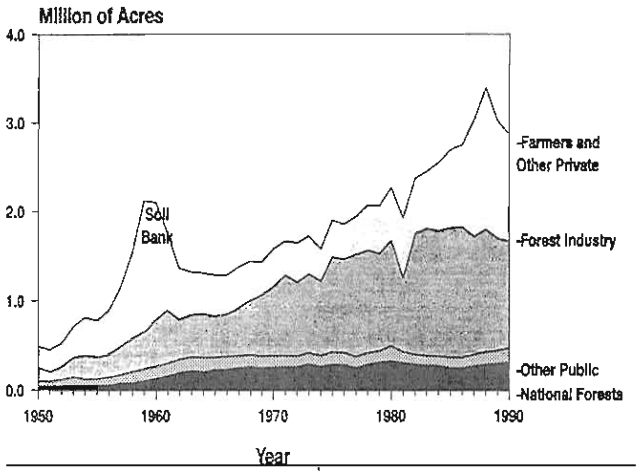
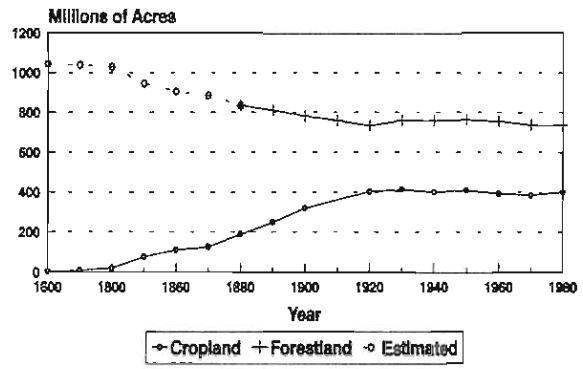


FIGURE 9.4.4
US crop and forestland area, 1600-1980



Sources: Fedkiw, J. Evolving Use & Management of the Nation's Forests...GTP RM-175
1992 RPA Assessment Update, USDA/FS, 7/93.

- Tree planting on forestland of all ownership types has increased dramatically since the Second World War, and was at record levels throughout the 1980s. Many private forestlands are now actively managed for tree growing (figure 9.4.3).

- The efficiency of wood utilization has improved dramatically since 1900. Much less material is being left in the woods, many sawmills produce twice or more the usable lumber and other products per log input than they did in 1900, engineering standards and designs have reduced the volume of wood used per square foot of building space, and preservative treatments have substantially extended the service life of wood. All of these have reduced by millions of acres the area of annual harvest that otherwise would have occurred.

- Eastern watersheds have been reforested. The headwaters of many American rivers are protected from over harvesting by National Forests.

- For the last 70 years there has been no increase in cropland area. About 1920, for the first time in American history, the increase in the area of cleared farmland abruptly stopped, rather than continuing to rise at the rate of population growth. While farm clearing of forests continued after 1920 in some areas, it was offset by farmland abandonment and reversion back to forest in others. The stabilization in the area of cleared farmland had an immensely beneficial effect on US forests (figure 9.4.4).

- Wildlife has been a major conservation success story. Although a number of species, such as the great auk, passenger pigeon, heath hen, and several others, did become extinct, many others which were severely depleted, or even on the brink of extinction in 1900, have staged remarkable comebacks. Many species which would likely have been on the endangered species list, had one existed in 1900, are today abundant. Examples include: wild turkey; beaver; egrets, herons, and many other wading birds; many species of shorebirds; wood ducks, and several other species of ducks; whistling swans; Rocky Mountain elk, pronghorn antelope, bighorn sheep, black bear; and white-tailed deer throughout most of its range. Many other species, although not actually on the brink of extinction in 1900, are today both more abundant and more wide-spread than they were in 1900.

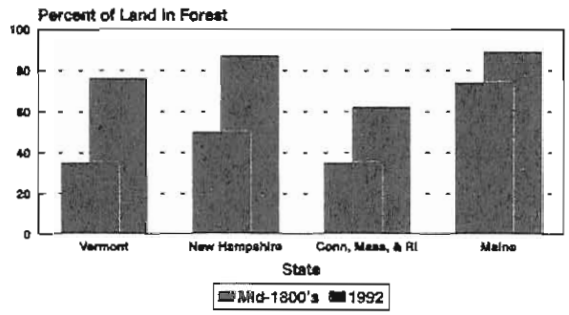
The two primary reasons that the area of cropland stabilized were that (i) rapidly increasing numbers of motor vehicles and farm tractors made it unnecessary to continue to raise large numbers of draft animals. In 1910, there were about 50 million horses, mules, and other draft animals in the US. Fully 27 per cent of all cropland was devoted to growing food for draft animals. By 1950, the number of draft animals had dropped so dramatically, compared to 1910, that the equivalent of some 70 million acres of cropland had been released to grow crops for human consumption; and (ii) after 1935, spurred by the development of genetically improved hybrid crops and by expanded use of chemical fertilizers and liming, agricultural productivity finally began to improve. Yields for corn are typical. Between 1800 and 1935, average corn yields in the US remained virtually flat at about 25 bushels per acre. After 1935, average per acre yields began to rise, increasing to 35 bushels by 1945, to 40 bushels by 1950, and to 120 bushels by 1988. American farmers now grow as much corn on one acre as it took five acres to grow in 1920.

(iii) Forest wildlife today

Several species of American forest wildlife became extinct as a result of forest changes and human uses during this century, such as the passenger pigeon, heath hen, and Carolina parakeet. A larger number of subspecies and wildlife populations were substantially diminished and some disappeared altogether. Many species, however, which were poised on the brink of extinction in 1900, have staged remarkable comebacks. Due to actions that were set in motion in the early decades of this century, most forest-wildlife species are both more abundant and more widespread than they were in 1900.

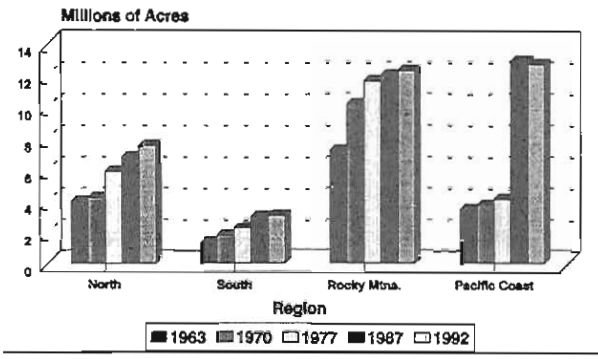
The pattern that has emerged since the 1930s is a substantial increase in forest wildlife that can tolerate a relatively broad range of habitat conditions. The numbers and distribution of the so-called "habitat generalists" have increased dramatically. Fortunately, many US forest-wildlife species are habitat generalists. One reason may be

FIGURE 9.4.5
Trends in eastern US forestland, 1850-1980



Source: Harper, R.M. Changes in the Forestland of N.E. In Three Centuries. J. of For., 16:442-52, 1918; RPA Assessment Update, USDA/FS, 5/93

FIGURE 9.4.6
Trends in reserved productive forestland by region, 1963-92



the natural dynamics of North American forests and the frequency of disturbance in the natural regime.

Some species abundant in North American forests prior to European settlement, particularly large predators and herbivores such as wolves, elk and bison have not returned to large areas of their former range. Yet even many of these species have staged comebacks in areas large enough to accommodate their needs for a large home range.

But saying that many wildlife species have staged remarkable comebacks does not imply the absence of problems. Species with specialized habitat requirements are increasingly of concern today. Examples include the red-cockaded woodpecker and gopher tortoise, which are natives of fire-created southern pine savannas and woodlands; the Kirtland's warbler, which is native of young jack pine forests in Michigan; and of course, the spotted owl, which occupies mature and old-growth forests in the west.

Some forest wildlife species require active management of young forests for their survival, e.g. Kirtland's warbler. Many other species, including a wide variety of both game and non-game species, need a mixture of forest and forest-edge environments. Some need large, contiguous areas of habitat, such as grizzly bears, wolves, elk, and forest-interior birds. Some require old and ecologically diverse forests. Others, although needing mature forests, require specific habitat conditions, such as open savannas and woodlands which are created by frequent ground fires, e.g. the red-cockaded woodpecker. Even the old-growth, Douglas-fir forests required by the northern spotted owl are sub-climax forest types that will eventually move toward different forest conditions without occasional, stand-replacing wildfires.

(iv) The eastern forest comes back

Nationally, the US has about the same area of forests as it did in 1920. However, some areas have considerably more forest than existed in 1920. A growing tide of land abandonment and reversion to forest, particularly of marginal farmland east of the Mississippi, began to increase the area of forestland in some areas. Beginning gradually in the mid-1800s, marginal agricultural land in the east and South began to be abandoned as more productive farm lands in the Midwest were opened up (figure 9.4.5).

The reasons for reversion back to forest are complex. Two related factors were working in concert. The growth of the cities accelerated the transition of US agriculture from subsistence to commercial. At the same time, the nation's progressively improving transportation system opened up more productive western lands to provide for the growing cities. The steep lands, small fields, and less-productive lands of the east and southern Appalachians were unable to compete commercially with the lands of the Ohio Valley and much of the rest of the Midwest. The opening of the Erie Canal in 1825 was the first major step that set the stage for cropland reversion in the Northeast. Cropland depletion was also a factor in some cases, as was the reduction in the need for pasture resulting from declining numbers of draft animals.

The process of farmland reversion back to forest continued into the 1900s and was accelerated by the Great Depression. Under the Resettlement Act, a New Deal program, thousands of farmers in the Appalachians and elsewhere were relocated to more productive land. Between 1925 and 1945, almost 20 million acres of their abandoned farms and depleted woodlands were incorporated into the eastern National Forests under the Weeks Act. Millions of additional acres became state parks and forests.

In many ways, the forest and farmland landscape of many parts of the Appalachians, as well as other areas of the east and South, has come full circle. By the 1960s and 1970s, the pattern of forest, fields and pastures was much like it was prior to 1800. In many areas the rural landscape has taken on an appearance much like it must have had prior to the American Revolution.

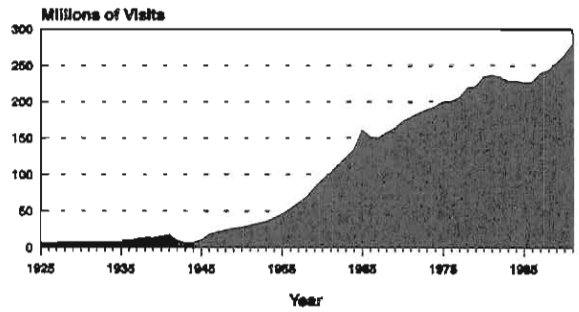
(v) Increasing demands for non-timber uses and values

After the Second World War, steadily increasing national economic growth provided the basis for increasing personal income and leisure time. That, along with the proliferation of automobiles, revolutionized the recreational habits of the American people. Recreational visits to the National Forests increased from 27 million in 1950 to 263 million in 1990, reflecting a pattern that was common to other public lands.

As the nation's population has become more urbanized, mobile, and affluent, interest grew in setting aside land in parks, recreation areas, and reserves. In addition, the success of forest conservation practices began to demonstrate the nation's ability to meet increasing wood product needs from both private and public lands. Consequently, there has been a significant increase in the area of forestland set aside for amenity values in parks, wilderness areas, and similar designations under which timber harvest is prohibited. Currently about 34.5 million acres of productive forestlands have been so designated - about double what was set aside in 1970. This is an area the size of the State of Florida (figure 9.4.6).

Increased recreational demands came at the same time that the nation's public forests were experiencing increased demands for other uses as well. Such pressures have been felt especially in the last three decades as conflicts over the use and management of public lands has intensified (figure 9.4.7).

FIGURE 9.4.7
National Forest recreational use, 1925-90



Source: USDA/Forest Service

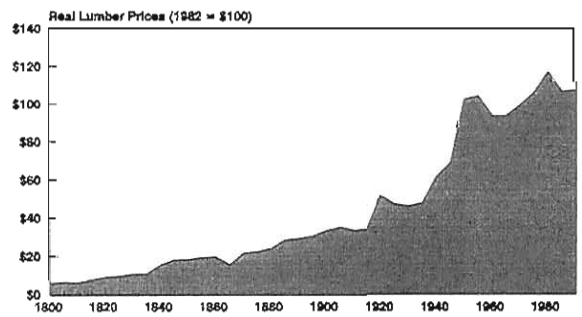
9.5 American forests - a transformed heritage

Today, our forests represent a substantially transformed legacy, certainly in comparison to 1600, which most of us understand. But our forests have also been substantially transformed since 1900 - a dimension which is much less understood by most people.

Views of the nation's forests have changed profoundly over the years. Native Americans viewed the forest in a spiritual context. But they also took a utilitarian approach to the forest. They used and managed it to serve their own ends. European Americans initially viewed forests as an encumbrance to agriculture, or as a virtually inexhaustible resource to be mined. At first they used the forest - its wildlife, wood products and land - to meet their subsistence needs for food and energy, much as Native Americans had done. Later, the abundant wealth of the forests was used to build the homes, cities and transportation infrastructure of a growing nation, and the lands previously occupied by forests were used to feed a rapidly growing population.

Scarcely more than a century ago, it became increasingly clear that old approaches were not sustainable. We began to view forests and wildlife, not as products to be mined or foraged for, but as resources that could be managed over the long term on a scientific basis for both products and environmental services.

FIGURE 9.5.1
Trends in real lumber prices, 1800-1990



Source: USDA/Forest Service

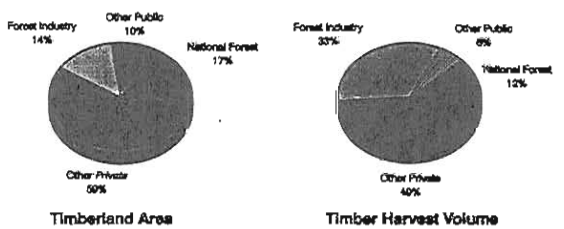
As our population has continued to urbanize, the principle of forest conservation for products and services has remained, but its role and scope have enlarged. A few decades ago we began to view forests as attractive settings for outdoor recreation and as places for human spiritual renewal. Comparatively recently, we have begun to view forests as ecosystems supporting a complex web of life, of which humans are a part. While it is impossible to predict how our view of forests may change in the future, it is important to understand how they came to be what they are today.

(i) Lessons of the past

Today, the US has almost four-times the population it had in 1890, living at a substantially higher standard of living. Yet our forests and wildlife are, in most of their major dimensions, in significantly better condition today than they were a century ago.

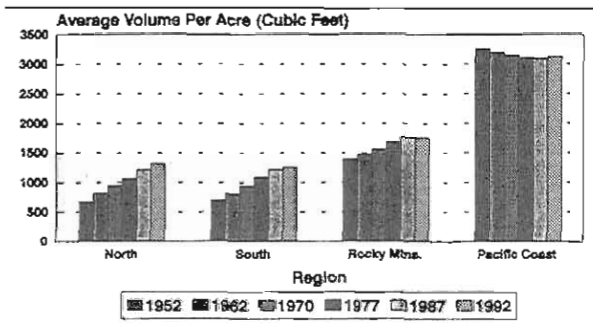
Our forests and wildlife have demonstrated a resilience and responsiveness to management undreamed of by early conservationists at the turn of the century. These leaders were almost universally pessimistic about the future. Gifford Pinchot and others predicted an impending timber famine, coupled with significantly increased wood product prices, and consequent economic

FIGURE 9.5.2
US timberland area and timber harvest by major owner, 1991



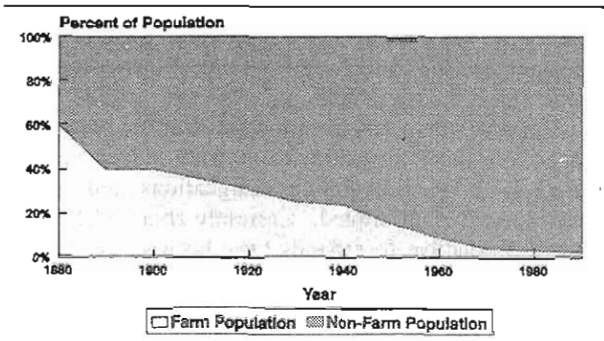
Source: Forest Statistics of the U.S., 1992, USDA/Forest Service

FIGURE 9.5.3
Trends in US standing timber volume per acre for all owners by region, 1952-92



Source: Forest Statistics of the U.S., 1992, USDA/Forest Service, 6/93.

FIGURE 9.5.4
US farm and non-farm population, 1880-1988



Source: U.S.Bureau of Census Figures

hardship and disruption. Wildlife leaders, such as William T. Hornaday and others, predicted the eminent extinction of scores of species. The timber famine never came. Most species whose extinction was prophesied have since recovered; many are even abundant today.

In their defense, the predictions of these early conservationists were logical and understandable given what they saw going on around them. Indeed, they were predicting what they felt would likely occur if past trends continued, and no actions were taken to address the concerns they raised. But action was taken, and new policies were debated and implemented. History has demonstrated that past public policies, coupled with the natural resilience of the resource, have generally served the country well.

In addition to the policy framework already discussed, there were other, non-policy factors, largely unrecognized by early conservation leaders, that have also contributed to the improved condition of our forest and wildlife resources.

One has been the basic resilience of the forest resources of North America in recovering from disturbance and responding to management. In most of its past projections of future forest growth, the Forest Service has consistently underestimated the growth that subsequently occurred. Wildlife specialists have similarly underestimated the resiliency and rates of recovery of many species, once protected from exploitation and placed under management.

Conversion from wood energy to fossil fuels took a huge burden off American forests, particularly as population levels continued to grow. Indirectly, the use of fossil fuels in internal combustion engines substantially reduced the pressure to clear forests for agriculture. It made possible the release of tens of millions of acres of cropland to grow food for humans, rather than draft animals. Petroleum also was also the feedstock for fertilizers and pesticides that substantially increased agricultural productivity after 1930.

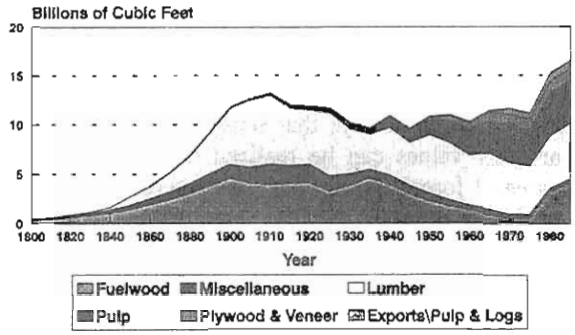
American forests have been one of the many beneficiaries of the remarkable improvement in agricultural productivity that has occurred over the last half century. The inexorable, three century-long conversion of US forests to farmland largely halted in the 1920s. Today, we have about the same area of both forests and cropland as we had in 1920. This has occurred in spite of the fact that the US population has more than doubled since 1920, from 106 to 250 million, and that US farmers also feed, through exports, the equivalent of more than 100 million additional people in other lands. This is a truly remarkable accomplishment. While questions have arisen in the last decade over some of the adverse consequences of intensive agricultural practices, such as pesticide and fertilizer runoff, these problems are being addressed and appear manageable. They should not overshadow the huge contribution to humanity and the environment that has resulted from improved agricultural productivity.

Another factor that was unrecognized by most conservation leaders was the effect that increasing real prices for wood products would have in encouraging both reduced consumption and increased supply. Real price increases for wood created powerful incentives for the more efficient use for wood, e.g. less left in the woods after logging, better utilization by sawmills and more efficient use in end-product applications through improved engineering, protection from rot through preservative treatment, and similar measures. Price increases also encouraged the use of wood substitutes such as steel, concrete, and other materials (figure 9.5.1). These private sector responses are the primary reason that wood consumption did not continue to rise after 1910 as it had in previous decades.

The conventional wisdom at the turn of the last century was that, due to the long time frames and low economic returns involved in growing trees, the private sector could not be relied upon to shoulder much of the burden for producing the nation's wood, once the original forests were harvested. In addition to watershed protection, this was one of the rationales for establishing the National Forests.

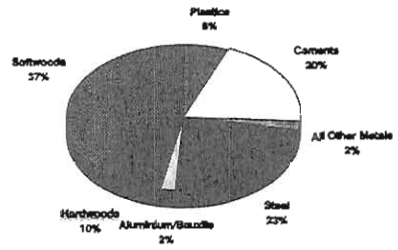
Just as they had encouraged improved wood utilization, increasing wood prices spurred private sector investments in timber growing, although investments other than for fire protection were not significant until after the Second World War, when industrial forestlands began to be managed in earnest for tree growing. Today, private forests comprise 73 per cent of US productive forestland, yet supply 80 per cent of the wood volume harvested (figure 9.5.2).

FIGURE 9.5.5
Domestic production of forest products, 1800-1985



Source: Fredrick & Sedjo, RFF (1991)

FIGURE 9.5.6
US consumption of industrial raw materials, 1987
(Per cent by weight)



Source: J.L.Bowyer, U. of Minnesota

Because forest growth nationally has exceeded timber harvest since the 1940s, the average timber volume per acre has increased by one-third since 1952 - in the east and south the average volume per acre has almost doubled (figure 9.5.3).

As the condition of US forests improved, what had been a central conservation issue at the turn of the last century, whether the nation could assure itself a sustainable level of timber products for the economy, has diminished as a national level concern. While economic sustainability remains an issue in some areas, concerns over an impending "national famine of wood" are a relic of history. Concerns over forest sustainability have re-emerged of late, but tend to find focus in local- and regional-level issues, such as sustainability of natural processes, plant and animal communities, and biodiversity on local and regional scales.

(ii) Challenges for the future

It is inevitable that as past issues are successfully addressed, new issues will emerge. In recent years the growing urbanization, affluence, and mobility of the American population have caused a virtual revolution in the expectations and demands the public places on US forests. Some of these are in direct conflict with traditional forest values and uses.

Issues such as the protection of remaining old growth forests in the west, maintaining biological diversity, protecting endangered species, loss of wetlands, use of herbicides in forestry, the impact that atmospheric pollution may be having on our forests, and similar issues continue to be hotly debated. While most wildlife are in better condition today than a century ago, there are clear exceptions. Some species having specialized habitat requirements remain the focus of concern. The red cockaded woodpecker in the South and the northern spotted owl on the west coast are examples. Declining numbers of some neo-tropical migrating birds have raised concerns over forest habitat loss and fragmentation both in North America and in Central and South America. These are all issues we must seek to successfully address as demands on the resources of our planet increase.

One of the most profound changes in American society in the twentieth century has been its transition from a rural, agrarian society to an urban, industrialized nation (figure 9.5.4). This change has been accompanied by a corresponding physical and psychological separation of its people from the land that sustains them.

In a world of farms, forests, and small towns, the linkages between food and fields and between forests and home and hearth were clear and sustained by personal experience. In a world of cities and suburbs, of offices and air conditioning, those linkages have become more obscure, and for many people, virtually non-existent. Yet today's urbanized society is no less dependent upon the products of its forests and fields than were the subsistence farmers of America's past.

In the last decade, we have seen the debate between those advocating the utilitarian use and management of forests for commodity products and those wanting to minimize human influences and emphasize amenity values (particularly on public forests) become increasingly shrill and divisive. This conflict existed in the early 1900s and found focus in the public debates between Gifford Pinchot and John Muir. As this century draws to a close and the nation's population has become increasingly affluent, mobile, and urbanized, we have seen increasing interest in the natural process/amenity side of the conservation spectrum.

The utilitarian use of the forest for commodities vs. its protection for amenity and natural values are often viewed as irreconcilable: on a personal level, or when the focus is on an individual parcel of land, they frequently are. Yet, in a larger sense and scale, they are not only compatible: indeed, they are inextricably linked.

Somewhat ironically, it has been the success of the scientifically based, utilitarian-oriented forest management concepts advocated by Fernow, Pinchot, and other forestry leaders at the turn of the century that has, to a very large degree, provided society with the forest abundance that has allowed it the capacity, unique to only a handful of other nations, to decide how much of John Muir's brand of forest conservation is appropriate. The fact that this nation now has the resource wealth to consider such choices is itself a clear and positive sign of the success of its past conservation policies.

But, as always, there are limits to such choices. Society remains dependent upon forests for a wide variety of economic products. Indeed, the utilization of forests for

products has never been higher than it is today on a wood-volume basis (figure 9.5.5). Because of this, society's ability to continue to provide for the amenity side of the conservation spectrum will, in no small part, depend upon how much attention is also paid to the production/utilitarian side as well.

Today, the US consumes about as much wood on a tonnage basis as the total for most other raw materials combined - steel, plastics, aluminum, other metals, and cements (figure 9.5.6). Any significant substitution of these other materials for wood products could involve other environmental consequences. Alternatives to wood in most applications are both non-renewable and use considerably more energy per unit of production than does wood.

As human population numbers and resource demands increase, the emerging challenge for society and its land managers is to find ways that both commodity products and amenity values can be realized over time from the same area of forest. This is the challenging new focus for the evolving concept of land stewardship and forest sustainability.

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9.7 APPENDIX

(i) Conservation policies which led to improved forest conditions

A number of forest policies emerged as national goals and priorities in response to public concerns. The success of those policies depended upon effective cooperative relationships among federal, state, and local governments, as well as private forest landowners and other private sector interests. The policies and priorities that had the greatest effect on the improved condition of our forests are the following:

- focusing on fire suppression, prevention, and public education to protect the forest;

- establishing and enhancing the profession of forestry, and later of wildlife management, hydrology, and other natural resource disciplines, through establishment of accredited natural resource schools, professional societies, etc.;

- improving the art and science of forest regeneration and management, including research, the establishment of tree nurseries, and providing technical and financial assistance to forest landowners;

- improving the efficiency with which wood products are utilized in the woods, at mills, and in end-product applications. Such gains are the result of wood-utilization research, its effective application, and the incentive created by increasing real prices for forest products. The Forest Service's Forest Products Laboratory in Madison, Wisconsin, established in 1910, has been a significant contributor over the years to expanding the technical knowledge necessary for improving the utilization of wood products;

- improving the quality of forest management on private lands by improving economic incentives and removing tax and other disincentives;

- establishing the Forest Reserves (later the National Forests) for watershed protection, irrigation, and sustained timber production;

- while not established for forestry purposes, one policy that nonetheless had a significant beneficial impact on the nation's forest resources was the strategic decision made in the USDA in the early decades of this century to emphasize agricultural research aimed at increasing crop yields. Prior to that, the USDA primarily focused on statistical reporting, soil and farm implement testing, and related activities;

- an additional factor that has had a significant positive effect on forest conservation has been the increasing real price of wood over the decades. Between 1850 and 1950, the real price of lumber and of standing timber, increased by more than five times, adjusted for inflation. This has created powerful economic incentives both for growing and managing forests and for reducing wood consumption by using it more efficiently. The power of such economic incentives for the conservation and efficient use of the resource by the private sector was largely unrecognized by early conservation leaders.

(ii) Conservation policies which led to improved wildlife conditions

A significant factor in the conservation of the nation's wildlife was the establishment and proliferation in the late 1800s of politically active sportsmen's organizations. These groups waged a protracted, and ultimately successful, war against market hunting. They also vigorously supported the enforcement of game laws, self-taxation to support state game management, and the acquisition of habitat reserves and management areas. The policies and other factors that had the greatest effect on the improved condition of US wildlife are the following:

- adoption of a variety of strong state and federal wildlife conservation laws, and the establishment of agencies to enforce them effectively. This game law framework includes the following:

  - halting the market hunting of wildlife for meat and most other products, including feathers (market hunting of fur-bearing animals has continued under state regulation);

  - eliminating the spring shooting of waterfowl and other game birds;

  - state regulation of resident game and non-game species;

  - prohibition under federal law of (i) hunting of song birds, plume birds, and other migratory non-game birds, and (ii) interstate commerce in wildlife products taken in violation of state law;

  - federal regulation of the sport hunting of waterfowl and other migratory game birds; and

  - federal protection of endangered and threatened species after 1966.

- improving the art and science of wildlife management;

- establishing professional state fish and game departments devoted to scientific wildlife management and game law enforcement;

- improving habitat conditions, especially in the east and South, where millions of acres of agricultural land have reverted back to forest;

- reintroductions of species into formerly occupied range;

- establishing about 90 million acres of National Wildlife Refuges and 4 million acres of state wildlife reserves. Wildlife refuges and reserves in the contiguous 48 states were financed largely by hunting license fees and taxes on sporting arms, ammunition, and equipment; and

- establishing the National Forests System:

- in the west, National Forests acted as wildlife reserves by providing protection for beleaguered populations of many wildlife species, especially large game, until state and federal wildlife programs and enforcement were put in place in the 1930s and beyond. The National Forests were the source of animals for a number of later reintroductions into formerly occupied habitat elsewhere;

- east of the Mississippi, millions of acres of abandoned and depleted farm and forestlands became National Forest lands after 1920. After acquisition, feral cattle, dogs, and goats were eliminated and the land rehabilitated. Today, these areas provide superb habitats, supporting rich populations of many wildlife species, some of which had not existed on these lands since before the American Revolution;

- the multiple-use mandate of the 191 million acre National Forest System lands provides for full consideration of wildlife values and objectives in land management decisions. It has also encouraged the development of highly constructive joint efforts with state wildlife agencies in the management of wildlife habitats and populations.