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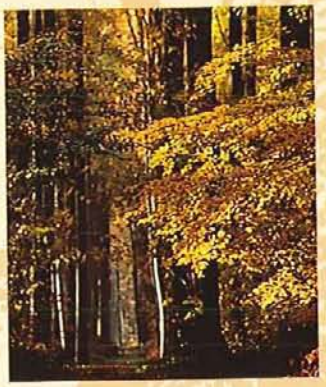

INDICATORS FOR THE SUSTAINABLE MANAGEMENT OF FRENCH FORESTS

A French document for implementing decisions taken by countries attending the Ministerial Conferences on the Protection of European Forests.

INDICATORS FOR THE SUSTAINABLE MANAGEMENT OF FRENCH FORESTS

The document titled The Sustainable Management of French Forests, published in April 1994, describes the commitments undertaken by France at the United Nations Conference on the Environment and Development (Rio de Janeiro, 1992), and at the Ministerial Conferences on the Protection of European Forests (Strasbourg, 1990; Helsinki, 1993). This document is an illustrative complement to it.

It is based on deliberations regarding criteria and indicators for the sustainable management of northern and temperate forests made at the Montreal seminar (1993) and fleshed out at the Geneva Meeting (1994), which involved every country in the European continent. A criterion has to do with a major concern of forestry policy, and steers a series of decisions. An indicator helps to assess the tangible results of programmes undertaken. The publication of this list of criteria and indicators for sustainable management at national level represents the first collective endeavour by the European countries to give all citizens the means to verify, for themselves, the conformity of current forest characteristics and of developments chalked up over the past ten years in official discussions about the forestry policy of their own country and of the other countries in the European continent. It is patently clear that this list of indicators makes no claim to give a representative picture of all the regions of France.

This concern for clarity is aimed at providing good quality quantitative information to all those interested by the debate concerning sustainable forest management, about all issues for which it is currently possible to assemble scientifically relevant and technically measurable data at reasonable cost. The advances of scientific knowledge, the questions raised by public opinion, and the development of new and reliable techniques for gauging sustainable management indicators should permit the subsequent completion of this already lengthy list. Each sustainable

management indicator is presented with a figure or a table of figures. To help everyone to verify the reliability of these figures, the source is clearly indicated, as is the calculation method, when the value of the indicator is not directly measured. A brief commentary introduces the analysis of most forest managers, sometimes by specifying the limits on indicator interpretation.

This project, coordinated by the Countryside and Forestry Department of the Ministry of Agriculture and Fisheries, has involved various agencies of the central administration of the Ministry of Agriculture and Fisheries and the Ministry of the Environment, the National Forest Inventory (IFN), the Office National des Forêts (ONF), the French Environmental Institute (IFEN), the National Hunting Office (ONC), the Fauna and Flora Secretariat of the National Museum of Natural History, the National Association of Regional Centres of Forest Ownership (ANCRPF), Regional and Departmental Offices of Agriculture and Forestry (DRAF, DDAF), the Technical Centre for Wood and Furniture (CTBA) and the six Water Boards. Whenever possible, it is based on statistical publications of the Ministry of Agriculture and Fisheries, the Ministry of the Environment, the Ministry of Industry, and the Ministry of the Interior, all accessible to the public.

It has also benefited from criticisms and suggestions made by the National Federation of French Forest-owning Local Authorities, the National Federation of Associations of Tree-farming Forest Owners, the Institute for Forest Development, the Department of Forestry Research at the INRA, the French Institute of Agricultural and Environmental Engineering and Research (CEMAGREF), the Forest-Cellulose Association (AFOCEL), the General Council of Waterway and Forest Management, France Nature Environment, WWF-France, and experts from the French Institute of Forestry, Agricultural and Environmental Engineering (ENGREF), the National Centre of Scientific Research (CNRS), and the College of Advanced Studies at Fontenay-Saint-Cloud.

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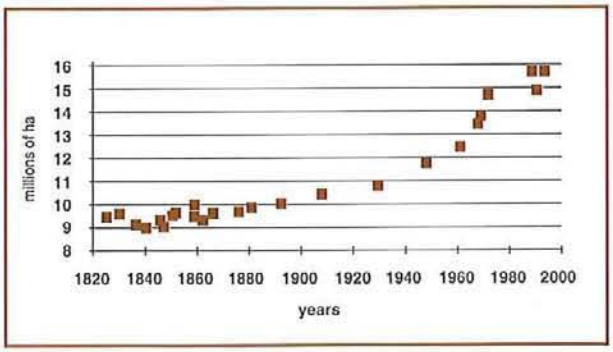
SOMMAIRE

1. EXPANDING FORESTS

1.1 Developments over the past two centuries



(Source: Cinotti, based on a multi-source compilation)

Commentary: the forested land area has increased markedly since the early 19th century. In close on two centuries, the forested land area seems to have virtually doubled. Even though there can be no doubt about the trend of the development, there is cause to tread carefully when it comes to dealing with the different values in this graph. For, up until 1960, it includes estimates of varying origin, often dependent on the land register, which is above all a fiscal instrument that often underestimates wooded and forested areas. Based on certain surveys, it can be estimated that in slack afforestation periods, the land register's underestimation is usually about 20%, but that in periods of busy afforestation activity, the underestimation may sometimes be as much, locally, as 50%. The reliability of the land register figures has nevertheless greatly improved in recent years. From the 1960s, the use of new statistical methodologies using aerial photography (Teruti survey by the Central Office of Statistical Surveys and Studies of the Ministry of Agriculture (SCEES), and the Permanent Inventory of Forest Resources drawn up by the National Forest Inventory (IFN)) has improved forested area evaluation.

This situation, which is shared by most European countries, reveals, in particular, the consequences of increased agricultural yields and the reduced need for land for food production in the 19th and 20th centuries. It has also permitted the recovery, planned and natural, of marginal land which population pressures had caused to be cleared and cultivated. The fight against erosion and floods has thus been simplified, within national policies. This development of forested areas may be regarded as very positive, the forest being recognized as having great economic, ecological and social interest by public opinion, by scientists and by the law. But the doubling of forested areas over two centuries must not tempt us to overlook the land clearance phenomenon occasioned by urban growth and infrastructural development, especially around large built-up areas, or the reduction in area of very specific forest environments, like alluvial forests during major works to modify the course of large rivers.

1.2 A consistent increase in forested areas

total area of woodland-forests-poplar plantations (in thousands of ha)

old statistical series		new statistical series	
1981	1991	1991	1993
14 003	14 230	14 640	14 810

(Source: SCEES/Teruti agricultural statistics: Agreste nº 56 for new series, nº 48 for old series; see inventory definitions and methods in the appendix).

Commentary: the forested areas in the old 1991 statistical series are definitely underestimated (according to the SCEES: Cf. Agreste/numerical data Agriculture nº50, p.10), because the new sampling introduced from 1991 onward shows a progressive "leap" in the size of the forested area when compared with the old sampling, of some 400,000 hectares/ 1,000,000 acres. Depending on whether the old or new series is used to compare the total 1991 area with the only area known in 1981 (old series), the rate of increase ranges from 1.6% to 4.3%. The real situation probably lies somewhere between these two rates. Furthermore, the National Forest Inventory, specific to forests, which is not updated annually but on average every 10-12 years, undoubtedly gives more accurate measurements of the real growth of forested areas. Between the two most recent inventories in each *département*, it shows an average rate of increase of 3.1% over 10 years. It can thus be estimated that the rate of increase of the forested area over 10 years must be around 3%.

The increase in forested areas, which began almost two centuries ago, is thus continuing. According to the IFN, the gross increase in the forested area (before deducting cleared land areas) occurs up to almost 84% as a result of natural afforestation, with planned afforestations as extensions of forested areas covering just 16% of new forested areas.

1.3 Uncertainties about the extent of the growth of different areas, outside forests, containing trees

thickets and groves—hedges and scattered trees
heathland, maquis and garrigue
(in thousands of ha)

	old series		new series	
	1981	1991	1991	1993
thickets and groves	598	590	681	643
hedges and scattered trees	858	706	1 032	1 021
heathland-maquis-garrigue	2 208	2 012	1 928	1 934
total	**3 634**	**3 285**	**3641**	**3598**

(Source: SCEES/Teruti agricultural statistics: Agreste nº 56 for new series, nº 48 for old series)

Commentary: the old statistical series suggests a relatively stable situation for thickets and groves, a very marked reduction for hedges and scattered trees in the 1980s, and a less rapid reduction of heathland, and maquis and garrigue scrubland. The new statistical series suggests an accelerated disappearance of thickets and groves, a definitely slowed down reduction for hedges and scattered trees, and a relatively stable situation for heathland, and maquis and garrigue scrubland. In addition to the planned uprooting of hedges, it is also necessary to take into account the fact that the disappearance of elms in hedges, as a result of Dutch elm disease, has contributed to the absence in the findings of certain hedges, whose width of less than 3 metres/ 10 feet excludes them from statistical computations. New hedge planting currently being encouraged by the authorities cannot yet be listed, because the width does not generally exceed 3 m/ 10 ft.

The absolute values of the two statistical series are too different for it to be possible to go beyond a qualitative commentary dealing with areas posing specific estimation problems (transposition of a linear hedge value to area, problem with assessing the borderline between forest and heathland and maquis and garrigue scrubland for investigators who are not foresters, etc.). At best it may be a likelihood that the old 1991 statistical series effectively underestimated these types of plant formations. Bearing in mind the ecological interest of these different types of tree formations, it is not possible to ignore them, and show an interest solely in increased forested areas.

1.4 A positive profit and loss balance for forested areas

origin and allocation of forested areas	annual average forested area		
	gains	losses	balance
water and wetlands	1 700 ha/yr	2 500 ha/yr	-800 ha/yr
rocks	2 000 ha/yr	1 100 ha/yr	+900 ha/yr
farmland	29 700 ha/yr	33 200 ha/yr	-3 500 ha/yr
heathland and wildlands	46 800 ha/yr	28 100 ha/yr	+ 18 700 ha/yr
non-productive : roads, structures, etc.	4 900 ha/yr	10 100 ha/yr	-5 200 ha/yr
total	**85 100 ha/yr**	**75 000 ha/yr**	**+10 100 ha/yr**
% of total in France	0,15%	0,14%	0,02%

(Source: growth models for forested areas from 1982 to 1990, published in the SCEES annual forest statistics directories as part of the SCEES/Teruti surveys, old series).

Commentary: the findings of the SCEES/Teruti survey show a positive annual average balance of 10,000 hectares/ 25,000 acres of forested area gains, incorporating the negative growth of areas covered with scattered trees (which the IFN does not do). Bearing in mind the underestimation of the old SCEES/Teruti series, this figure might be thought to be a probable underestimate. In effect, the National Forest Inventory shows, between two listings made about ten years apart, a positive average balance of some 40,000 hectares/ 100,000 acres per annum. This discrepancy may perhaps be explained by an overestimation of the losses accumulated each year of areas which are, in fact, attached to forests. Furthermore, the Teruti statistical series unfortunately do not permit any specification of the trend of forest gains and losses between the 1970s and 1980s. At the very least, it is not on the basis of the Teruti survey (the only national land-use survey) that it is possible to accuse the poplar of being at the root of the decline in wetlands. Of the net negative balance for wetlands of 42,188 hectares/ 104,204 acres between 1982 and 1990, poplar plantations (categories 24-26) increased by 1103 ha/ 2724 acres (2.6% of the net debit for wetlands) at the expense of wetlands, while restoring to them a larger area, estimated at 1617 ha/ 3994 acres.

Bearing in mind the problems of definition and investigator competence in making a fine assessment of regenerating areas, inferences drawn from headings can sometimes be disputed, as is the case for certain cuts in the course of natural regeneration (sometimes counted as abandoned land or wildland) or man-made regeneration (sometimes counted as farmland when the ground is ploughed), as well as

for areas recently burnt (sometimes counted as heathland). In addition, forested area growth balances relate to the statistical error of the survey, taking into account the small areas in question, and the use of these figures requires extreme caution. Generally speaking, forested area losses in the 1980s seem, to some extent, to have been confined to certain regions which are either very forested (Aquitaine, Provence-Alpes-Côte d'Azur) or not very forested at all (Brittany).

1.5 The place of the forest and tree-covered areas in land-use in 1993

type of land-use	area in 1993 (in thousands of ha)	proportion of metropolitan land
woodland, forests and poplar plantations	14 810	27,0
heathland, groves and thickets maquis, garrigues hedges and scattered trees	3 598	6,5
total forested area	**18 408**	**33,5**
farmland in use	29 895	54,5
water and wetlands	940	1,7
land with outcrops (rocks, sand)	890	1,6
grassland, wildlands, roads and tracks	1 711	3,1
man-made areas (roads, carparks)	2 346	4,3
land with structures	729	1,3
total of metropolitan land	**54 919**	**100**

(Source: SCEES/Teruti 1993, Agreste nº 56)

Commentary: forests and sundry other areas with trees (apart from orchards and trees in towns and cities) represent more than 18,000,000 hectares/ 45,000,000 acres, i.e. one third of the area of metropolitan France.

1.6 The origin of French forests

	estimated area (in millions of ha)	% of total current metropolitan forested area
areas already containing high forest of native species, 200 years ago	1,0	7,0
areas with coppices and mixed coppice/ high forest, 200 years ago	7,0	49,3
high forest planted during the last 200 years	4,5	31,7
high forest originating from natural afafforestation on formely non-forested land, over the last 200 years	1,7	12,0

(Source: estimate by the Ministry of Agriculture and Fisheries)

Note: areas with coppices and coppice stands or mixtures of coppices and high forest, or areas converted to high forest, in the Daubrée Statistics (1908-1913), corrected to factor in the *départements* of Alsace-Lorraine then annexed by Germany, reflect an old method of silviculture, and their establishment on the whole predates the French Revolution. The area of high forests of native species already formed at least two centuries ago is deduced from the difference with the total forested area in the early 19th century, taking into account any variations in the national land area. High forests planted during the past two centuries are estimated on the basis of statistics for major known afforestation and reforestation programmes, with a multiplier of 1.2 to include isolated operations, carried out by forest owners without help from the State. High forests originating from natural afforestation on land previously not forested are deduced from the difference with the total current metropolitan forested area.

Commentary: only one half of the present forested area of France has been forested for more than two centuries. At least 80% of French forests show the clear effects of human activity, either by being turned into coppices or mixtures of coppice and high forest, or by being original plantations put in over the past two centuries. The remaining 20%, however, are not altogether "natural" areas, because the silviculture practised in most of these areas has encouraged some species at the expense of others. As is the case in the European countries, except in certain regions of the Nordic states and a small number of eastern European countries, the French forest is predominantly one that has been farmed for a long time, which is quite different from northern and tropical forests.

1.7 The structure of loggable inventoried forest stands

	1984 (ha)	% of area	1994 (ha)	% of area	1994/ 1984 %
regular high forest except for poplar plantations	5 712 479	42,4	6 021 429	43,9	+5,4
regular high forest: poplar plantations	258 300	1,9	282 000	2,1	+9,2
irregular high forest	586 843	4,3	707 199	5,2	+20,5
coppice	2 474 324	18,4	2 257 179	16,4	-8,8
mixture of hardwood high forest/ coppice	3 846 618	28,6	3 579 427	26,0	-6,9
mixture of softwood high forest/ coppice	513 611	3,8	740 088	5,4	+44,1
clear cut areas (awaiting regeneration or undergoing clearance)	80 617 (1)	0,6	136 654	1,0	+69,5
total	**13 472 792**	**100**	**13 723 976**	**100**	**+1,7**

(Source: IFN, apart from poplar plantations, just for loggable inventoried forests, based on stand structures; SCEES/Teruti for poplar stands; (1) area very probably underestimated in the fifty odd *départements* for which, in 1984, the IFN did not have two sets of aerial photographs corresponding to two successive inventory cycles and providing a definite reference to the situation ten years earlier; consequently, the variation from 1984 to 1994 is very probably overestimated; see inventory definitions and methods in the appendix).

Commentary: over the past two centuries, considerable efforts have been made to develop silviculture based on regular high forest. The high forest area has almost doubled in relation to the estimates of the Daubrée Statistics of 1908-1913 (apart from the *départements* of Alsace-Lorraine) in which it only represented 32% of the forested area. The past decade has seen the proportion of simple coppices and coppice/ high forest mixtures continue to fall from 51.7% to 48.9%. The data show the extent of stands used as simple coppices or coppice/ high forest mixtures, which is an original French feature when compared with countries using the Germanic silvicultural tradition and the Nordic states. This is why caution is called for in international comparisons involving hectare-based volumes. It is worth noting the rapid development of conversion to irregular high forest, which now accounts for 5.3% of loggable inventoried forests. The area put to high forest has increased by 2,500,000 hectares/ 6,250,000 acres in the last 80 years, mainly over the past 50 years, because of afforestation programmes assisted by the National Forest Fund (FFN), and natural growth rates.

What is more, the category of clear cut areas, pending regeneration (for more than five years) or in the process of being cleared, represents a datum that is complicated to analyse. In particular, it must be linked both to annual averages of areas undergoing man-made regeneration and part of forest losses (more than made up for by the gains), without overlooking, for hardwood species, the natural new growth rates which do not yet fulfil the criteria needed to be counted as in regeneration. According to the IFN, the 1984 area is very probably underestimated. In addition to this perhaps basic bias, the increase recorded in ten years can probably, and at least to a large degree, be related to the increase of softwood areas (logged on average at a younger age than hardwoods), especially with the onset of final cuts in large softwood plantations in the late 19th century and very early years of the 20th, without altogether excluding the possibility of certain premature clear cuts. In ten years, the rise in the construction and industrial timber harvest has been 20-25%. Taking into account the age-based structure of stands, the growth of the clear cut area probably points more to the rise of harvestable areas than to any change in silvicultural practices.

1.8 Biogeographical and physical characteristics

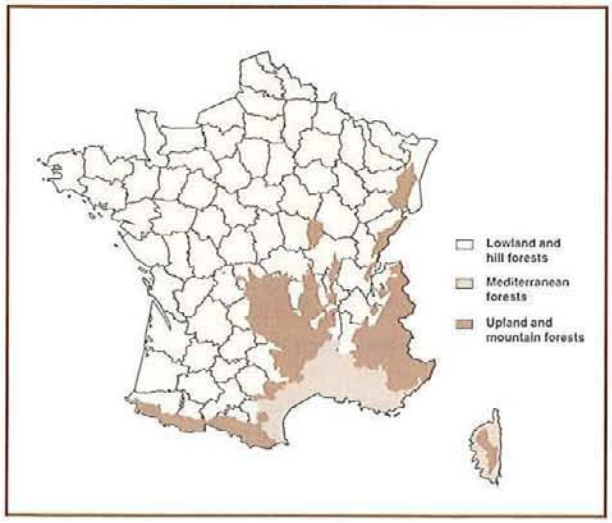
Lowland and hill forests, mountain forests, Mediterranean forests

	1984 (ha)	% of total area in 1984	1994 (ha)	% of total area in 1994	% 1994/ 1984
lowland and hill forests	8 671 509	63,6	8 751 652	61,7	+0,3
upland and mountain forests	3 893 153	28,5	4 205 048	29,6	+4,4
Mediterranean forests	1 073 846	7,9	1 233 032	8,7	+2,8

Distribution by gradient

0-15% gradient	8 063 622	60,0
16-30% gradient	2 108 335	15,7
31-70% gradient	2 927 926	21,8
> 71% gradient	341 941	2,5

(Source: IFN, apart from poplar plantations, just for loggable inventoried forests; lowland and hill forests, mountain forests, and Mediterranean forests are formed by a series of small forested areas, in the IFN sense, corresponding to the boundaries appearing in the Atlas des Forêts de France, edited by J.Gadant, published by de Monza Editions, p. 39)



Distribution by altitude

Forest		
range of altitudes (m)	area (ha)	percentage %
0-250	4 253 300	43,36
250-500	2 303 578	23,48
500-750	1 361 970	13,89
750-1 000	886 801	9,04
1 000-1 500	823 507	8,40
over 1 500	179 574	1,83
total	**9 808 730**	**100**
Other wooded areas		
range of altitudes (m)	area (ha)	percentage %
0-250	219 005	16,12
250-500	390 640	28,76
500-750	269 114	19,81
750-1 000	190 696	14,04
1 000-1 500	177 319	13,05
over 1 500	111 789	8,23
total	**1 358 563**	**100**

(Source: IFN, 1994, for forests and other wooded and forested areas (wooded garrigue and maquis, and sparse afforestations) of 59 other *départements* covering a total of 11.2 million hectares/ 27.7 million acres of forests and other forested areas, based on its Geographical Information System (SIG/GIS); the restrictions peculiar to the GIS mean that there may be nothing necessarily identical between the areas inventoried and the areas mapped, units of less than 4 ha/ 10 acres remaining unmapped).

Commentary: lowland and hill forests, which represent more than 60% of the area inventoried, have expanded very little over the past 10 years. Most of the growth of the forested area involves the Mediterranean region and mountain areas. Contrary to what is generally said, the forest in the Mediterranean region is thus expanding, even if maquis and garrigue scrublands are tending to decrease, at differing speeds depending on the area. A little less than one quarter of France's forests is situated on steeply sloping terrain. The forest plays an important part in the protection of mountain catchment basins.

In considering the 59 *départements* incorporated in the IFN's Geographical Information System, representing 72% of the nation's forested area, it should be noted that two-thirds of the forests taken into account are low altitude forests. The other forested areas are distributed more or less equally by altitude, bearing in mind the proportion of maquis and garrigue between 25-500 metres, and sparse afforestation at altitude. The forests situated higher than 750 metres, where there are a certain number of specific climatic limitations, are markedly underestimated, because of the absence of the *départements* in the northern Alps and the Vosges range; they occur in the Pyrenees, the Massif Central, the Jura and the southern Alps.

Distribution of areas for the 24 top forest species

(see table opposite)

Commentary: although hardwoods are in regression (more markedly in percentage terms than in total area, because of the expansion of mainly softwood forested areas) following afforestation and reforestation programmes, they are predominant over more than 63% of the forested area. At the end of the first complete cycle of the National Forest Inventory, in 1978, hardwood species were predominant in 66% of the inventoried area. According to the Forest Statistics of 1878, hardwood stands occupied 65% of the forested area, softwood stands 14.9%, mixed hardwood and softwood stands 17.6%, and empty areas 2.5%. By dividing into two the areas of mixed hardwood and softwood stands, the percentage of hardwood species in 1878 would have been about 76% (excluding empty areas),

	1984		1994		area
	area (ha)	% of total area	area (ha)	% of total area	1994/ 1984 %
pedunculate oak	2 449 331	18,53	2 421 945	18,04	-1,1
sessile oak	1 711 471	12,95	1 776 834	13,23	3,8
maritime pine	1 391 369	10,53	1 377 181	10,26	-1,0
beech	1 243 694	9,41	1 256 527	9,36	1,0
Scots pine	1 130 646	8,55	1 154 063	8,59	2,1
pubescent oak	886 837	6,71	855 466	6,37	-3,5
common spruce	691 971	5,24	744 268	5,54	7,6
silver fir	533 285	4,03	553 951	4,13	3,9
chestnut	529 414	4,01	484 285	3,61	-8,5
holm oak	341 075	2,58	342 595	2,55	0,4
ash	252 935	1,91	308 228	2,30	21,9
hornbeam	215 489	1,63	197 265	1,47	-8,5
birch	209 961	1,59	162 959	1,21	-22,4
Douglas fir	196 402	1,49	295 012	2,20	50,2
Aleppo pine	191 545	1,45	235 534	1,75	23,0
Austrian pine	171 744	1,30	188 900	1,41	10,0
false acacia	141 407	1,07	133 898	1,00	-5,3
large alders	105 268	0,80	85 657	0,64	-18,6
European larch	90 906	0,69	94 241	0,70	3,7
Corsican pine	77 577	0,59	109 125	0,81	40,7
aspen	66 497	0,50	60 279	0,45	-9,4
cork oak	60 008	0,45	64 634	0,48	7,7
willow	56 351	0,43	51 677	0,38	-8,3
pitch pine	56 582	0,43	55 987	0,42	-1,1
total hardwoods	**8 575 748**	**64,88**	**8 479 758**	**63,15**	**-1,1**
total softwoods	**4 641 689**	**35,12**	**4 948 335**	**36,85**	**6,6**

(Source: IFN, apart from poplar plantations, just for loggable inventoried forests, for areas where the species is regarded as predominant)

valuable hardwoods (1)	28 767	0,22%	32 495	0,24%	13%
valuable hardwoods (2)	322 765	2,44%	390 438	2,91%	21%

(Source: IFN, apart from poplar plantations, just for loggable inventoried forests, for areas where the species is regarded as predominant; valuable hardwoods (1): wild cherry, fruit trees and walnut; valuable hardwoods (2) ash, lime and maple, involving a double count with the area put to ash mentioned in the list of the 24 top forest species).

poplars and poplar plantations (1)	-	-	248 784	-	-
poplar plantations (2)	229 000	1,73%	261 100	1,94%	14,0%

(Source: (1) IFN, by adding in the poplar plantations and poplars counted in the inventoried loggable forested areas (thus already taken into account in the previous table); (2) Teruti old 1991 series (headings 24 and 25).

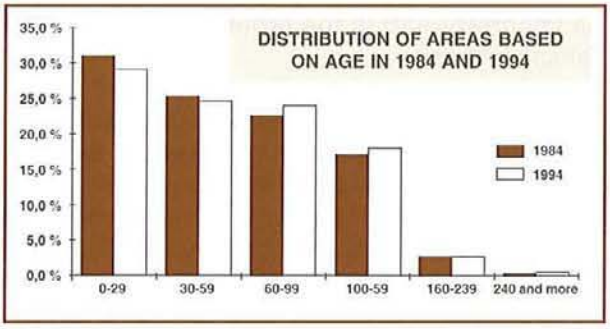
Bearing in mind traditional calculation methods (areas where the species in question is predominant) and the mixed nature of French stands over more than 70% of the inventoried forest, the table of forested areas for principal species very clearly underestimates the area in which secondary species are effectively present. France is a land of oak trees, the different species of which cover virtually 41% of the metropolitan forested area. Valuable hardwood species represent more than 3% of the forested area. The French forest is very diversified, with 136 species or groups of species represented (76 hardwood and 60 softwood: cf. the list in the appendix), and 89 species or groups of species sufficiently well represented for the National Forest Inventory to include them. To this must be added the areas covered by the 10 best represented species, exceeding 80% of the metropolitan forested area. To go higher than a 95% figure for the metropolitan forested area it is necessary to add in the areas covered by the 21 best represented species or groups of species. In 1878, it was necessary to add in the areas covered by the 8 species best represented to exceed an 80% figure for the metropolitan forested area (the individualization of species and groups of species did not permit giving the number of species to exceed the 95% mark of the metropolitan forested area).

In a century, in relation to the 11 principal forest species accounting for 84% of the 1878 forested area, the areas in question have progressed more or less spectacularly for the following species: sessile oak, pedunculate oak, Scots pine, maritime pine, common spruce and Aleppo pine. They have remained more or less stable for the holm oak. They have regressed quite sharply for the following species: hornbeam, beech, fir and larch. If we stick to the developments of the last 10 years, the salient factors are the following. The pedunculate oak is regressing slightly when compared with the sessile oak, which is often better adapted to the ecological conditions best represented in lowland and hilly regions. The two species progressing most of all, while remaining together at 3% of the total metropolitan forested area, are the Douglas fir and the Corsican pine, both greatly helped by the afforestation and reforestation policy of the past 50 years, with a view to obtaining certain woods whose quality is absent in the timber industry. The species undergoing the sharpest regression in percentage terms are birch and large alder, where the quality of stands often leaves something to be desired, and whose wood is currently not very remunerative for the tree-farmer. Nevertheless, the most conspicuous reductions in area involve the hornbeam and the chestnut, resulting in particular from the decrease of areas with coppices and coppice/ high forest mixtures.

1.9 The age of forest stands managed as regular high forest

	1984		1994	
years	(ha)	(%)	(ha)	(%)
0-29	1 775 937	31,1	1 756 139	29,2
30-59	1 454 401	25,5	1 498 969	24,9
60-99	1 296 379	22,7	1 460 033	24,2
100-159	988 381	17,3	1 103 792	18,3
160-239	174 900	3,1	184 774	3,1
more than 240	11 883	0,2	17 722	0,3

(Source: IFN, just for loggable inventoried forests, based on the age measurement by class of 5 or 10 years in regular stands with trees all of the same age, and by age estimate by classes of 30-50 years in regular stands with trees not all of the same age).



Commentary: the distribution of forested areas based on quite broad age classes shows a relatively satisfactory balance, with the relatively large presence of young stands resulting from the active afforestation and reforestation policy of the last 50 years. Within the 0-29 year category, the slowing down of the pace of afforestation and reforestation over the past 20 years is already quite noticeable.. The average area put to regeneration every year, or used for plantations in forest expansion programmes during the 1980s, was about 60,000 hectares/ 150,000 acres, whereas it was about 90,000 hectares/ 225,000 acres in the 1970s. This situation can be explained to a large degree by the degradation of the economic context, and might well, in due course, pose problems caused by ageing stands. In some cases, excessive ageing could possibly call into question the sustainability of forest management, if the slowing down of the pace of regeneration carries on for several decades to come. In effect, in regular high forests, one of the forester's most important tasks consists in organizing the regeneration of stands, and monitoring the type of new stand. For example, without proper intervention, it is not uncommon to see a pure beech high forest follow on from mixed oak and beech high forest, bearing in mind the natural regeneration dynamic of both oak and beech trees.

1.10 Ownership structure

forest type	1984 %	1994 %	increase of area 1994/1984 - %
State-owned forests	10,2	10,2	+2,9
other public forests managed by the Office National des Forêts	16,0	16,1	+3,8
private or communal forests managed by their owners	73,8	73,7	+2,8
total	**100**	**100**	-

(Source: IFN, apart from poplar plantations, corresponding to loggable inventoried forests, non-inventoried and non-loggable forests and forests not inventoried for an unspecified reason).

Commentary: the metropolitan forest is very largely privately owned. Compared with the start of the 20th century (Daubrée Statistics already mentioned), the relative share of State-owned forest (which has, incidentally, increased in area) has slightly dropped (from 12.3% to 10.2%, as has that of other public forests (from 19.7% to 16.1%), which means that the considerable expansion of forested areas is essentially due to privately owned forests. This feature is one of the most original factors in western and southern Europe, particularly when compared with Canada and the tropical countries. In Europe, after Portugal, France is the country with the highest proportion of privately owned forests.

1.11 Breakdown of public forests based on unit size

State-owned forests

size (ha)	number	cumulative area (in ha)	% of total State-owned area	average area (in ha)
0-5	36	59	0,00	1,6
5-20	38	466	0,03	12,3
20-100	210	11 237	0,63	53,51
100-1 000	767	338 277	18,95	441,04
1 000-10 000	471	1 234 825	69,18	2 621,71
more than 10 000	14	199 991	11,20	14 285
total	**1 536**	**1 784 855**	**100**	**1 162**

Forests owned by local authorities

size (ha)	number	cumulative area (en ha)	% of total area of local authority forest	average area (in ha)
0-5	646	1 796	0,07	2,8
5-20	2 285	27 954	1,05	12,2
20-100	5 606	292 735	11,02	52,2
100-1 000	6 094	1 718 423	64,70	282
1 000-10 000	361	615 261	23,17	1 704,3
more than 10 000	0	0	0	0
total	**14 992**	**2 656 169**	**100**	**177**

(Source: ONF, 1994)

Commentary: more than two-thirds of the area of State-owned forests is made up of units from 1000 to 10,000 hectares /2500-25,000 acres, whereas a little less than two-thirds of forests belonging to local authorities is made up of units from 100 to 1000 hectares / 250-2500 acres. Very large public forests are quite rare, because only 14 State-owned forests cover more than 10,000 hectares/ 25,000 acres, the largest being the Orleans forest, with 36,644 hectares/ 90,510 acres.

In all, the Office National des Forêts manages slightly less than 16,000 different forest units, of which only 1536 are State-owned, although these represent 40% of the total area of forests governed by the Forest Regulations (in application of the Forest Code). This land situation as far as public forests are concerned poses no major problems for the implementation of sustainable management. The oldest management of a public French forest dates back to 1376 and was designed to permit a rational use of the timber without endangering a renewable resource, based nevertheless on a slightly more restrictive concept than modern sustainable management.

1.12 Breakdown of privately owned forests by size of units.

size (ha)	total area of each size category (in thousands of ha)	average area of property unit (ha)	% of total area of private forest	number of owners
0-1	773	0,3	8	2 360 000
1-4	1 689	2	17	911 000
4-10	1 499	6	15	254 000
10-25	1 464	15	15	100 000
25-50	966	34	10	28 000
50-100	939	68	10	14 000
more than 100	2 410	258	25	9 000
total or average	9 740	2,6	100	3 676 000

(Source: SCEES/ESSES 1976-1983, statistical survey of economic structures of silviculture).

Note: there are some 430,000 hectares /1,060,000 acres of public forest (communal and sectional) not governed by the Forest Regulations for a variety of reasons, and thus not managed by the ONF (Source: SCEES/ESSES 1976-1983; they are counted in this table as private forest.)

Commentary: 75% of French forests belong to 400,000 owners, with more than 4 ha/10 acres. Forest groupings and associations (including plenty of family associations), companies, and other legal entities and persons own 1,700,000 hectares/ 4,200,000 acres, with an average of 11 hectares/ 27 acres per unit of ownership. Financial

organizations have holdings accounting for a little less than 2% of the forested area, and timber industrialists own just a negligible percentage. So it is vital that the promotion of sustainable forest management be undertaken in a spirit of partnership, bringing together at least some 10,000 local authorities and a large number of private owners. If the State is factored in, the 11,000 forest-owning communes and the 51,000 owners of more than 25 hectares/ 60 acres all amount to some 62,000 decision-makers controlling 71.3% of the metropolitan forested area. This situation is thoroughly compatible with efficient and sustainable forest management, embracing economic and environmental concerns at national level.

The large number of private owners seems, a priori, to be a factor of diversity in management methods, thus encouraging biodiversity. A lot of small and very small owners in fact show a certain stability in their application of traditional management methods. France is the European country with the largest number of private forest owners, so the forest is part and parcel of the family heritage of a large number of households.

1.13 A relatively well-described forest, ecologically speaking

forested area covered by a station type catalogue	67%

(Source: Ministry of Agriculture and Fisheries, 1994).

Commentary: at the combined instigation of researchers and the forestry administration, from the late 1970s onward, two-thirds of France's forests are now covered by a catalogue of forest station types. This catalogue inventories and describes the ecological units of small natural areas, and describes the environment, based on its geology, soils, humus, and, most often of all, vegetation, while sometimes including the topography and bioclimate. Sustainable forest management is in fact, above all else, a type of management suited to a particular environment and a type of stand inherited from both nature and history. So it must perforce be based on a sound ecological diagnosis. Then, on this basis, it must incorporate the targets and restrictions of the forest manager. In areas covered by a catalogue of forest station types, forest managers also profit today, if they so wish, from a useful tool for implementing sustainable management that respects the ecological potential of the forest environment. The use of these station type catalogues still requires more promotional back-up.

1.14 Distribution of volumes based on stand structure

		volume (in thousands of cu. m.)	% of volume	volume per ha cu.m.	1994/ 1984 %
regular high forest	1984	908 842	55,4	159	+15,2
	1994	1 046 807	56,5	174	
irregular high forest	1984	86 368	5,3	147	+26,1
	1994	108 941	5,9	154	
simple coppice	1984	134 924	8,2	55	+1,7
	1994	137 186	7,4	61	
hardwood high forest/ coppice mixture	1984	459 843	28,1	120	+5,2
	1994	483 532	26,0	135	
softwood high forest/ coppice mixture	1984	49 254	3,0	96	+57,2
	1994	77 416	4,2	105	
total	**1984**	**1 639 231**	**100**	**124**	**+13,1**
	1994	**1 853 882**	**100**	**138**	

(Source: IFN, apart from poplar plantations, just for loggable inventoried forests, based on stem-with-bark volumes, stopped at a 7 cm/3 in. cut (solid wood)).

poplars and poplar plantations	1984	-	-	-	-
	1994	22 771	-	149	

(Source: IFN, based on stem-with-bark volumes, stopped at a 7 cm/3 in. cut (solid wood); it has not been possible to recreate the 1984 situation, and findings are not available for all the metropolitan area; poplar volumes only involve total poplar plantations and do not take into account poplars in inventoried forests.

Commentary: the increase in standing volumes between 1984 and 1994 is proportionately very significantly greater than the increase in the corresponding areas. This phenomenon has been noted in several major European countries with important forestry sectors. Without overlooking the positive influence on the growth of the more dynamic silvicultural practices being used today, some experts have put forward the hypothesis of a general rise in productivity in forest ecosystems, possibly linked with the growth in the level of carbon dioxide in the atmosphere and a certain increase in nitric deposits in forests (atmospheric pollution acting like a fertilizer below a certain threshold). French forests are currently in a standing timber capitalization phase, which is explained in part by the considerable afforestation and reforestation programme undertaken over the past 50 years. Even for stand types that are in regression, such as simple coppices and mixtures of hardwood high forest and coppices, the standing volume is still increasing, which is to some extent an indicator of under-logging (when compared with previous practices) and to some extent the evidence of an ageing phase prior to conversion to high forest, based on traditional techniques with no recourse to plantation.

The average volume per hectare is now 138 cu.m., rising by 11% in relation to 1984. In comparison, this average volume is 70 cu.m./ha in the Nordic countries, from 250-300 cu.m./ha in countries using the Germanic silvicultural tradition, and 88 cu.m./ha in the 12 EU states (before the admission of Austria, Finland and Sweden). The progressive increase of average volumes per hectare is normal and inevitable because of the relatively young age of a large section of high forests (currently about 150 cu.m./ha) and poses no problems for most species, provided that it is not accompanied, in certain fragile environments, by a destabilization phase associated with excessive ageing for the species, due to its history and the type of silviculture applied over the last century. The problem is quite different for coppices and coppice/high forest mixtures, for which it is altogether impossible to envisage high average volumes per hectare. In mountain areas, some stands theoretically converted to selection high forest undergo alarming ageing and also see their average volume per hectare increase, at the same time as there is an actual adjustment (absence of young wood and reduction of the proportion of medium-aged wood).

1.15 Biogeographical and physical characteristics

	volume (in thousands of cu.m.)	1984 (per ha)	volume (in thousands of cu.m.)	1994 (per ha)
lowland and hill forests	1 042 961	123	1 170 623	138
mountain forests	553 116	148	629 784	162
Mediterranean forests	43 154	41	53 476	50
0 -15% gradient	-	-	1 105 367	137
16 - 30% gradient	-	-	290 514	138
31 - 70% gradient	-	-	404 614	138
> 71% gradient	-	-	53 383	156

(Source: IFN, apart from poplar plantations, just for loggable inventoried forests, based on stem-with-bark volumes, stopped at a 7cm /3 in cut (solid wood)).

Commentary: it is mountain forests that are characterized by the highest volume per hectare, due to greater ageing and certain logging problems to do with gradient and access. This situation is also partly explained by the increase in the proportion of softwood stands in mountain areas, which are usually characterized by a higher volume per hectare. In France, nevertheless, as in most other mountainous countries in Europe, experts at times, after the lapse of a few decades, have qualms about the increase of the risk of instability of certain old stands with poor access, and a relatively high volume per hectare, in zones where the ecological role of the forest is crucial for protecting dwellings, soil, water and infrastructures. Forests in the Mediterranean region are characterized by a very low volume per hectare, even if, as everywhere else, there is a certain increase in the standing volume.

1.16 Distribution of volumes for the 24 top forest species

(see table on following page)

Commentary: with the exception of Mediterranean species, volumes per hectare are relatively high. The Douglas fir represents a special case, which is explained by the extent of the plantations introduced over the past 30 years, and thus by the relatively young age of Douglas fir stands. The scale of standing volumes of silver fir can probably be explained by the conditions peculiar to mountain forests, and by the technical and economic problems of logging, even though a certain effort has been made to rejuvenate fir plantations, as is shown by a slight lowering of the standing volume. The most spectacular volume increase in a 10-year period has to do with Douglas fir stands. The growth of volumes per hectare between 1984 and 1994 attests, at national level, to the work done by forest managers, and the absence of any kind of irresponsible logging.

Together with thinking to do with the definition of a coherent biodiversity protection policy, one of the major concerns about the implementation of a sustainable management system for French forest stands involves the risk of on-going under-logging. This is why sustainable forest management calls for an efficient timber industry and a high level of timber consumption per head of population. This is quite compatible with forest management that respects environmental concerns, bearing in mind the important role played by the forest in maintaining ecological balances at local, regional, and world levels.

	1984 Volume in thousands of cu.m.				1994				1994/1984
	total standing volume	% of total volume	volume per ha of the species in stands where it is predominant	volume per ha of all species in stands where the species is predominant	total standing volume	% of total volume	volume per ha of the species in stands where it is predominant	volume per ha of all species in stands where the species is predominant	% variation of total standing volume
pedunculate oak	231 918	14,1	80,6	122,1	248 437	13,4	87,9	136,9	+7,1
beech	206 593	12,6	126,2	178,9	223 038	12,0	131,5	187,1	+8,0
sessile oak	182 628	11,1	93,2	130,0	218 796	11,8	107,6	151,0	+19,8
maritime pine	160 923	9,8	111,4	122,0	185 907	10,0	130,4	142,5	+15,5
silver fir	145 295	8,9	232,8	286,8	147 473	8,0	225,6	284,0	+1,5
Scots pine	130 953	8,0	98,5	122,3	137 719	7,4	101,4	129,7	+5,2
common spruce	117 034	7,1	136,4	173,4	137 710	7,4	152,4	192,0	+17,7
chestnut	80 870	4,9	80,3	105,0	89 823	4,8	89,1	115,7	+11,1
hornbeam	54 531	3,3	48,7	99,4	67 458	3,6	56,9	111,4	+23,7
pubescent oak	38 044	2,3	36,9	43,0	46 059	2,5	45,8	53,6	+21,1
ash	36 892	2,3	66,7	132,0	45 609	2,5	75,5	143,9	+23,6
birch	38 052	2,3	45,3	75,7	39 094	2,1	46,7	79,0	+2,7
Douglas fir	11 308	0,7	44,6	58,5	27 977	1,5	81,8	97,2	+147,4
Austrian pine	20 003	1,2	103,1	118,0	23 410	1,3	109,7	128,4	+17,0
aspen	20 100	1,2	60,5	106,7	22 052	1,2	65,3	121,6	+9,7
false acacia	15 249	0,9	58,7	84,0	17 780	1,0	71,2	94,3	+16,6
large alders	17 020	1,0	88,7	120,6	17 225	0,9	98,8	132,4	+1,2
European larch	14 992	0,9	131,4	152,9	15 292	0,8	128,1	153,6	+2,0
Corsican pine	10 081	0,9	118,31	131,3	15 259	0,8	124,2	143,6	+51,4
holm oak	8 430	0,5	19,8	25,6	11 690	0,6	26,3	31,3	+38,7
Aleppo pine	8 089	0,5	38,9	45,4	10 964	0,6	44,0	53,6	+35,5
willow	6 350	0,4	26,8	45,8	7 050	0,4	34,5	53,6	+11,0
pitch pine	5 926	0,4	90,7	104,3	6 498	0,4	98,4	109,7	+9,6
oak	2 888	0,2	40,4	47,7	3 588	0,2	47,6	54,0	+24,3
other hard hardwood species	50 449	3,1	41,6	88,9	53 407	2,9	39,6	95,0	+5,9
other soft hardwood species	17 681	1,1	50,5	87,8	19 976	1,1	60,0	103,8	+13,0
other white softwoods	3 023	0,2	29,2	41,8	8 952	0,5	79,4	101,2	+196,2
other red softwoods	3 909	0,2	77,6	97,6	5 639	0,3%	77,3	100,1	+44,3
total hardwoods	**1 007 694**	**61,5**	**110**	**114,4**	**1 131 081**	**61,0**	**124,2**	**128,7**	**+12,2**
total softwoods	**631 537**	**38,5**	**128**	**141,7**	**722 801**	**39,0**	**138,3**	**154**	**+14,5**
total	**1 639 231**	**100**	**124**	**124**	**1 853 882**	**100**	**138**	**138**	**+13,1**
valuable hardwoods (1)	15 708	1,0	28,6	64,0	19 655	1,1	34,9	75,0	+25,1
valuable hardwoods (2)	65 337	4,0	73,3	127,7	79 266	4,3	81,6	138,7	+21,3

(Source: IFN, apart from poplar plantations, just for loggable inventoried forests, based on stem-with-bark volumes, stopped at a 7 cm/3 in. cut (solid wood); the volumes per hectare are calculated by the IFN by referring the volumes to the areas in question, just for areas where the species is predominant; valuable hardwoods (1): wild cherry, fruit tress and walnut; valuable hardwoods (2) ash, lime and maple, involving a double count with the area put to ash mentioned in the list of the 24 top forest species)

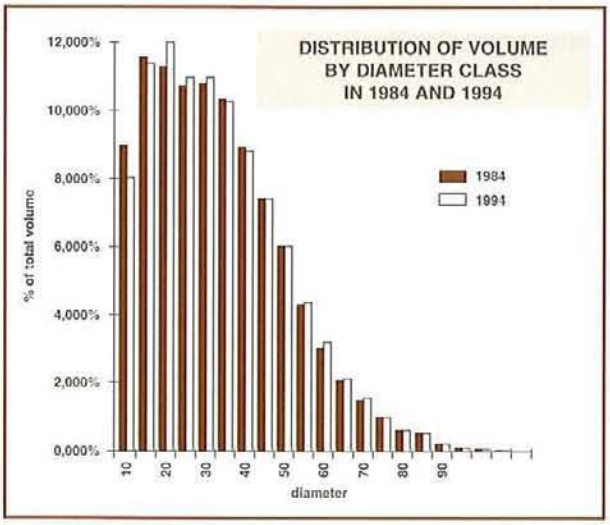
poplar plantations	-	-	-	-	22 771	-	-	149	

(Source: IFN, based on stem-with-bark volumes, stopped at a 7 cm/3 in. cut (solid wood); it is is not possible to recreate the 1984 situation, and the findings are not available for the whole of metropolitan France; volumes per hectare are thus calculated by the IFN by relating volumes to areas, just for areas where the species is predominant).

1.17 Distribution of classes by diameter

class of diameter	1984 (in thousands of cu.m.)	(%)	1994 (in thousands of cu.m.)	(%)
10-25 cm	698 578	42,64	787 541	42,48
30-55 cm	789 589	48,19	893 636	48,20
60-85 cm	136 615	8,34	158 333	8,54
90-115 cm	11 553	0,71	11 396	0,61
120 cm and more	2 095	0,13	2 940	0,16

(Source: IFN, apart from poplar plantations, just for loggable inventoried forests, the diameter classes being counted in multiples of 5 cm / 2 in; trees with a diameter of less than 7.5 cm/ 3 in at a height of 130 cm/50 in are not measured)



Commentary: the distribution of diameter classes is relatively evenly balanced, more or less stable betwen 1984 and 1994, and characteristic of a forest at full production capacity. Over the past decade, the slowing-down of afforestation and reforestation operations (already noticeable in the early 1970s) has nevertheless resulted in a drop of the proportion of small diameter trees. This can also be explained by the increasing use of hardwood species (whose initial growth is slower) in forested and reforested areas. Trees with a diameter greater than 120 cm/48 in. (and up to a diameter of 235 cm/ 92 in.) represent 2.94 million cu.m. Timber extraction carried out by logging seems to be quite evenly distributed among the different diameter classes, which is one of the parameters to be taken into account, in order to assess the sustainability of harvest planning.

1.18 Storage of carbon in the wooded stratum and forest ground

	1980	1990	1993	1993/1980
annual carbon emissions (in thousands of tons)	137 180	103 100	101 450	- 26 %
annual carbon emissions (in tons per inhabitant)	2,54	1,82	1,76	-30%

(Source: Ministry of the Environment—CITEPA)

(in thousands of tons of carbon)	aerial biomass of trees	underground biomass of trees	carbon in forest ground	total carbon stored in forests
stock 1984	483 000	68 080	390 000	941 000
stock 1994	545 950	76 920	450 000	1 073 000
current annual capitalization coming from 71.6% removal rate	8 165	1 160	5 820 (dead mass)	15 145

(Source: IFN, just for loggable inventoried forests, using, for the calculation of the biomass in each of the compartments: timber, bark, other aerial biomass, and underground biomass, the calculation coefficients for hardwood and softwood species of the EEC-UN document "Forest Resources of the EEC Region (Europe, USSR, and North America)", 1986, (page 152), one ton of biomass being equivalent to 0.45 tons of carbon; and using for carbon stocks in the soil the multiplier 0.81 based on the aerial biomass, drawn up by Waring and Schlesinger in 1985 for the temperate belt).

Commentary: the forest is a most important site of carbon storage—the most important of all the earth's ecosystems. In France, the carbon stock in the biomass of forest trees is equal to 6 years of French carbon emissions in the form of carbon dioxide. The evaluation of the carbon stocks in the ground will be improved in the near future by the findings of the soil analyses of the soil inventory drawn up of sites in the European network (16 km x 16 km/ 10 x 10 miles), in 1993 and 1994. If the large carbon stock in forest ground is taken into account, the total carbon stock in the French forest corresponds to 10-11 years of emissions, which is a lot. Every year, the stock increases by at least 15,000,000 tons of carbon, and thus helps to neutralize about 15% of French carbon dioxide emissions. All calculations to do with the lessening of the impact of the rise in the greenhouse effect must take the forest into account, the forest being the only carbon stock that man's activities can increase, while creating a source of national wealth and jobs.

But the forest's contribution to the prevention of the increased greenhouse effect is not limited to the

forest carbon stock. It is important to take into account the carbon stored in used timber, outside the forest, as well as fossil fuel savings resulting from the burning of a renewable fuel, the carbon emitted from which is made up for by storage in the forest biomass, and thus does not contribute to enriching the atmosphere with carbon hitherto kept outside the biogeochemical cycles.

long-term storage in construction timber (in thousands of tons of carbon)	60-100 000
annual fossil fuel savings (in thousands of tons of carbon)	5 800

(Source: Industrial Timber Strategy Group (1988) and CTBA (1992), in millions of tons of carbon, based on the breakdown of production flows in 1988 and an estimate of the average life of each product category; fossil fuel savings estimated based on an evaluation of timber consumption for energy uses, made by G.A. Morin and P. Laufer (RFF XLIV-3-1992) for roundwood, industrial wood waste and wood product recycling, presupposing combustion in very good conditions and a coefficient of 0.73 tons of carbon per ton of petroleum).

Commentary: the carbon stock in construction timber is definitely underestimated, because the calculation of the average current life of each wood product category overlooks very long term storage in certain old buildings. In this calculation, the timber used in building (with an average life of between 30 and 50 years) represents about 80% of the total stock, the remainder being more or less made up of furniture. Other uses only make a very marginal contribution to long term carbon storage. Carbon stocks in the form of construction timber in France thus seem lower than those declared by Germany (340 million tons), probably because of a lesser use of timber in construction, as compared with Germany. Furthermore, on the basis of an annual consumption of 9 million tons of paper and cardboard and an average life of 8 years for cellulose (taking recycling into account), the quantity of carbon present on an on-going basis in paper and cardboard might be estimated at about 25 million tons.

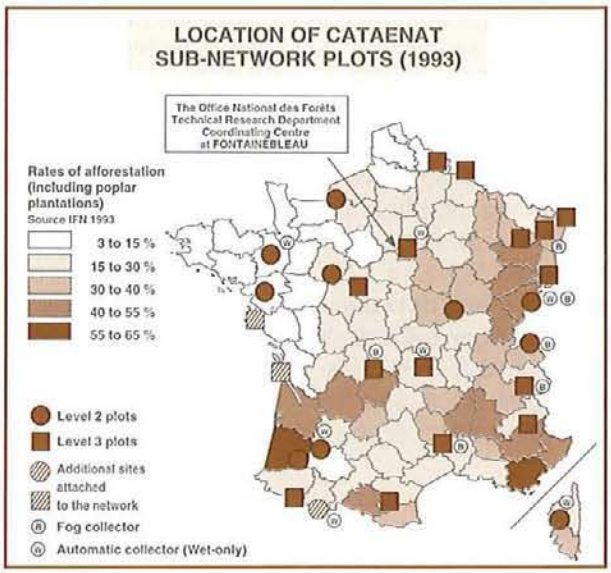
The energy contribution of wood seems quite significant at national level, compared with annual French consumption of 75 million tons-petroleum-equivalent resulting from petroleum products, when wood combustion technologies are efficient from the point of view of releasing greenhouse gases other than carbon dioxide.

2. THE HEALTH AND VITALITY OF THE FOREST ECOSYSTEM

2.1 Estimate of deposits under forest cover in the Cataenat sub-network for 1993 (first year the network was operational)

Plot code	protons (H+) eq/ha or g/ha	chloride (Cl) kg/ha	sulphate (S-SO4) kg/ha	nitrate (N-NO3) kg/ha	ammonium (N-NH4) kg/ha	total nitrogen N-NO3 and N-NH4	sodium (Na) kg/ha	potassium (K) kg/ha	magnesium (Mg) kg/ha	calcium (Ca) kg/ha	iron (Fe) g/ha	aluminium (Al) g/ha	manganese (Mn) g/ha	precipitation mm/yr
CHP40	18,6	46,3	11,8	3,1	2,3	5,4	22,5	38,9	5,1	12,7	3,4	110,1	233,4	750
CHP59	107,1	28,9	16,5	3,1	9,5	12,6	14,4	34,8	4,4	12,2	52,1	141,7	1308,2	739
CHS35	13,1	35,6	8,9	3,1	7,5	10,6	16,6	22,7	3	5,7	17,1	93,3	1754,1	539
CHS41	18,4	29,1	9	2,9	3,3	6,2	7,9	31	2,5	11,5	140	124,1	2523,2	458
CPS77	24,5	22,4	9,9	2,3	7,1	9,4	6,5	27,7	2,6	15,9	134,7	126,2	3623,5	531
DOU71	207,3	21,2	10,8	8,5	4,3	12,8	12,6	12,8	2,5	7,4	0	179,8	602,7	1175
EPC08	429,8	36,6	30,9	13,2	10,5	23,7	19,1	37,2	2,7	32,6	96,7	447,7	2615,8	1026
EPC63	34,6	13,2	8,1	4,3	3,5	7,8	5,8	14,1	2,6	8,7	35,6	208,6	512	511
EPC74	145,8	7,3	9,4	5,4	3,7	9,1	2,5	15,3	1,2	11,6	43,7	167,1	247,5	892
EPC87	49,4	26,6	9,1	5,4	3	8,4	12,7	33,3	2,9	6,8	0	247,9	287	868
HET30	145	34,4	18,5	8,7	5,2	13,9	18,2	21,5	3,3	23,3	44,3	403,8	695,6	2018
HET54a	68,3	9,2	8,6	5,4	3,9	9,3	3,7	18,7	1	6,2	8,4	80,4	711,3	602
HET64	92,5	20,3	12,1	5,8	5,2	11	9,7	12,4	2,3	11,6	2,3	116,3	416	824
PL20	35,8	106,1	13,9	4,4	0,5	4,9	63,4	14	10,8	29,6	23,3	745	507	948
PM17	39,8	104,8	9,9	3,8	2,6	6,4	61,2	11,5	9,3	11,9	4	108,1	159,9	518
PM40c	47,9	33,9	9,2	2,1	2	4,1	17,5	18	4,9	10,1	10,6	215,9	82,8	742
PM72	33,1	26,4	9	6,4	9,1	15,5	14,5	12	2,6	6,4	10,9	167,4	347,9	604
PM85	14,1	256,2	19,3	7	5,1	12,1	139,9	14,5	20,2	18,4	67	75,4	95,5	473
PS44	39,9	84,4	11,9	3,5	8	11,5	45,1	19,9	6,6	7,1	39,8	262,3	243,2	508
PS67a	236,8	13,2	14,6	8,4	8,2	16,6	5,1	18,9	1,9	11,2	57,4	520,9	1694,9	481
PS76	965,4	92	46,3	3,8	4,5	8,3	50,8	30,6	7,4	19,5	116,5	717,8	2882,5	679
SP05	3,8	5,8	6,2	0,3	0,2	0,5	1,8	21,3	2,2	13,1	49,5	155,4	74,3	499
SP11	79,8	20,1	16,9	6,8	4,5	11,3	10,2	28,7	3,1	18,8	59,3	290,2	341,3	743
SP25	97	12,8	12,3	7,7	4,4	12,1	6,1	16,5	2,1	15	39,5	279,2	401	1208
SP38	67,3	5,3	8,3	0,9	0,8	1,7	1,5	15,9	1	8,1	0	147,6	923,3	858
SP57	174,7	13,3	12,2	4,3	3,2	7,5	5,5	19,7	0,8	7,3	10,3	271,6	3174	672
SP68	117,9	9,4	8,5	5,8	3,2	9	4,6	15	1,4	7,5	3	170,2	284,2	540
average	123	41	13	5	5	10	21	21	4	13	40	243	990	756
median	67	26	11	4	4	9	13	19	3	12	36	170	507	679
min	3,8	5,3	6,2	0,3	0,2	0,5	1,5	11,5	0,8	5,7	0	75,4	74,3	458
max	965,4	256,2	46,3	13,2	10,5	23,7	139,9	38,9	20,2	32,6	140	745	3623,5	2018

(Source: ONF, managing the RENECOFOR network and the Cataenat sub-network; the sites are identified by their main species (CHS for sessile oak, CHP for pedunculate oak, HET for beech, EPC for spruce, PS for Scots pine, PM for maritime pine, PL for Corsican pine, DOU for Douglas fir, and SP for silver fir), then by the *département* where they are established).



Note: because this is the first year of measurements in these 27 forest sites, caution should be exercised in interpreting the figures gathered. It would actually be preferable to work with averages over several years. Even if the network is of no statistical use for the representativeness of the pollution climate in forests, it nevertheless gives certain pointers. The priority given to softwood stands for the establishment of this Cataenat sub-network can probably only increase the significance of deposits under cover. Moreover, the legitimacy of an average of 27 sites is extremely dubious, even if eloquent. This is why it is desirable to also take into account the median, that is, the value in relation to which one half of the sites have their values higher and the other half lower.

Commentary: As is clearly shown by the super-imposition of the Cataenat sub-network and the map showing the afforestation rate by *département*, the data per site cannot be easily used for making extrapolations. What is more, the interpretation of the deposits measured must take into account the fact that certain atmospheric additives, particularly calcium, magnesium and nitrogen, act like fertilizers, when they stay below a certain threshold, which varies with the type of ecosystem. This in turn involves a risk of destabilization in the way the forest ecosystem functions.

a) Proton deposits (which measure atmospheric pollution acidity) are situated between 3.8 and 965 g/ha/year, with an average of around 120 g/ha/year and a median markedly lower, of about 70 g/ha/year. Only two sites (PS76 and EPC08) receive major additions, likely to directly involve an acidification effect.

b) Sulphur deposits are situated between 6 and 46 kg/ha/year, with an average of around 13 kg/ha/year and a comparable median of 11 kg/ha/year. Only two sites (PS76 and EPC08) receive high levels of sulphur, likely to cause problems for the forest ecosystem, even of this addition may be made up for to some extent by calcium additions in the case of site EPC08. In Germany, for the period 1982-1986, deposits were between 9.4 and 58.6 kg/ha/year in beech woods, and between 21.4 and 155.1 kg/ha/year in spruce woods.

c) Total nitrogen deposits are situated between 0.5 and 23.7 kg/ha/year, with an average of about 10 kg/ha/year, and a comparable median of 9 kg/ha/year.
Only three sites (EPC08, PS67a and PM72) receive high amounts, likely to cause problems in the forest ecosystem. Six sites (CHP59, CHS35, PM72, PS44, PM85 and CPS77) nevertheless receive higher amounts of ammonium in the forest than in open land, doubtless because of the proximity of intensive ruminant livestock farming, producing significant dry deposits on foliage. In Germany, for the period 1982-1986, deposits were between 2.7 and 17.3 kg/ha/year of ammonia nitrogen, and between 4.0 and 13.7 kg/ha/year of nitric nitrogen beneath beech woods, and between 5.8 and 35.8 kg/ha/year of ammonia nitrogen and between 21.4 and 155.1 kg/ha/year of nitric nitrogen under spruce woods.

d) Deposits of sodium and chloride, when high, essentially reveal a maritime influence, subjecting trees to extremely saline conditions.

e) Aluminium deposits are situated between 75 and 750 g/ha/year, with an average of about 250 g/ha/year and a lower median of 170 g/ha/year. Only two sites (PS67a and PS76) receive high amounts, because of the proximity of very polluting industrial activities in a radius of a few dozen miles.

In all, four sites (PS76, EPC08, PS67a and PM72) out of 27 receive deposits under cover, certain aspects of which are such as to interfere, potentially, with the sound operation of the forest ecosystem. In these four sites, it should be noted that two are established in not very forested regions (PS76 and PM72), while site PS76 is even situated in the immediate vicinity of the large conurbation round Rouen and its very polluting industries. The southern half of metropolitan France does not seem to have any noticeable problem with atmospheric pollution in forests.

Generally speaking, French forestry experts consider that atmospheric pollution is one of the destabilizing factors in the way certain fragile forest ecosystems function, essentially in mountains at medium altitude, on poor, acid ground, covering a few tens of thousands of hectares.

2.1.1 Reduction of polluting atmospheric emissions

	1980	1990	1993	1993/1980
SO2	3 348	1 198	1 015	- 70 %
NOx	1 653	1 466	1 404	- 15 %

(Source: Ministry of the Environment—CITEPA)

Commentary: the 1980s were marked by a conspicuous reduction in the main atmospheric pollutants of industrial origin, especially as a result of the application of the provisions of the International Agreement on Trans-boundary Air Pollution, signed in Geneva in 1979. It thus seems justifiable to allow for a reduction in the adverse effects of atmospheric pollution in forests.

Nevertheless, a more rigorous approach presupposes taking into account, for each type of environment, its capacity to absorb the upheavals resulting from the deposit of atmospheric pollutants; this is the aim of the various theorizing about and mapping of the critical loads for each of the pollutants, in which most European countries are involved. This is a very complex task, however, and one that calls for a sound knowledge of the way forest ecosystems work.

2.2 Development of leaf loss over the past five years

Hardwoods - All of France

Number of trees observed

	Sessile oak	Pedunculate oak	Holm oak	Pubescent oak	Beech	Maples	Birches	Hornbeam	Chestnut	Ash	Poplars	Wild cherry	Other hardwoords	All hardwoods
1989	1 140	1 231	353	749	943	150	290	293	494	278	287	117	475	6 801
1990	1 141	1 264	353	747	946	153	290	296	491	277	272	119	492	6 841
1991	1 144	1 242	353	748	956	154	282	300	491	277	246	118	489	6 801
1992	1 138	1 213	351	731	958	157	274	292	493	274	240	118	465	6 705
1993	1 146	1 173	352	720	957	161	247	275	516	268	239	116	461	6 632
1994	1 156	1 273	367	731	1039	163	252	280	548	304	238	130	481	6 962

% of trees with more than 25 % leaf loss

1989	1,1	3,9	5,6	7,9	2,3	0,7	7,9	3,1	5,0	3,3	14,2	16,3	7,1	4,8
1990	2,4	6	6,3	8,6	3,8	3,3	22,1	15,2	7,7	3,3	15,1	27,7	13	7,7
1991	5,9	6,1	5,7	7	3,8	3,2	10,3	10	7,1	5,1	19,6	28,8	10,9	7,4
1992	8,6	9	5,7	5,4	4,4	4,5	10,2	13	10	2,9	14,2	33,9	10,7	8,5
1993	11,1	10,5	8	6	2,9	2,5	9,7	9,1	6,5	1,9	11,4	32,8	10,5	8,4
1994	5,5	13,9	10,9	12,7	2,7	3,1	6	5,3	7	3,3	13,4	18,5	10,3	8,4
Average 1989-92	4,5	6,3	5,8	7,2	3,6	2,9	12,6	10,3	7,5	3,7	15,8	26,7	10,4	7,1
Average 1991-94	7,8	9,9	7,6	7,8	3,5	3,3	9,1	9,4	7,7	3,3	14,7	28,5	10,6	8,2

% of trees with 11-25 % leaf loss

1989	10,0	16,5	30,9	16,8	10,9	6,7	15,5	9,2	10,9	10,8	10,8	19,7	15,4	13,9
1990	13,4	22,8	29,5	22,9	13,4	8,5	18,6	16,9	10,8	13,4	16,5	19,3	7,7	16,9
1991	17,5	21,2	28,3	25,4	12,3	13,6	19,1	17,3	10	15,2	6,5	20,3	12,5	17,5
1992	18,9	24,2	25,1	22,7	15,2	10,2	20,1	9,2	8,9	13,5	10,8	25,4	13,3	18,0
1993	25,6	27,4	20,7	25,4	11	10,6	20,2	9,8	7,6	7,8	9,2	24,1	10,4	18,5
1994	26,6	28,8	33,2	30,5	13,7	15,3	15,1	11,1	4	10,2	10,1	26,9	13,5	20,6
Average 1989-92	15,0	21,2	28,5	22,0	13,0	9,8	18,3	13,2	10,2	13,2	11,2	21,2	12,2	16,6
Average 1991-94	22,2	25,4	26,8	26,0	13,1	12,4	18,6	11,9	7,6	11,7	9,2	24,2	12,4	18,7

% of dry trees

1989	0,0	0,1	0	0	0	0	0	0	0,4	0	0	0	0,2	0,1
1990	0,1	0	0	0,1	0	0,7	2,1	0	1,2	0	0	0	1	0,3
1991	0,0	0,1	0,6	0,1	0	0	1,1	0	0,2	0	4,1	0	1,2	0,4
1992	0,1	0,3	0	0,1	0	0	2,2	0,3	0,2	0	2,9	0,8	0,4	0,4
1993	0,0	0,1	0,3	0	0	0	0,8	0	0,2	0,4	1,7	0	0,7	0,2
1994	0,0	0,2	0	0	0	0	0,4	0,7	0,4	0	0,4	0	1	0,2
Average 1989-92	0,1	0,1	0,2	0,1	0,0	0,2	1,4	0,1	0,5	0,0	1,8	0,2	0,7	0,3
Average 1991-94	0,0	0,2	0,2	0,1	0,0	0,0	1,1	0,3	0,3	0,1	2,3	0,2	0,8	0,3

% of trees with abnormal coloration

1989	7,0	9,1	14,2	14,6	12,5	8,7	37,2	11,9	24,0	5,4	37,3	24,8	18,1	14,4
1990	4,9	15	8,5	8,7	16,5	15	35,5	36,1	19,1	5,4	17,3	26,1	15,4	14,5
1991	4,5	10,1	12,2	14	14,6	22,1	32,3	30,3	10,8	5,4	36,6	34,7	20,2	14,4
1992	5,4	8,7	11,7	8,2	15,5	25,5	27,4	27,4	25,6	7	19,6	30,4	17	13,7
1993	10,8	16	16,2	15,8	9,9	18	17,4	34,9	27,3	4,1	14,6	43,1	20	16,2
1994	3,5	17,1	13,4	8,5	6	11,7	6,7	2,5	9,1	2	8	28,5	13,3	9,4
Average 1989-92	5,5	10,7	11,7	11,4	14,8	17,8	33,1	26,4	19,9	5,8	27,7	29,0	17,7	14,3
Average 1991-94	6,1	13,0	13,4	11,6	11,5	19,3	21,0	23,8	18,2	4,6	19,7	34,2	17,6	13,4

Softwoods - All of France

Number of trees observed

	Spruce	Fir	Scots pine	Maritime pine	Black pines	Aleppo pine	Douglas fir	Larch	Other softwoods	all softwoods	all species
1989	502	473	752	853	202	106	242	141	108	3 379	10 180
1990	500	460	759	926	203	106	243	142	100	3 439	10 280
1991	499	459	758	944	203	106	243	142	100	3 454	10 255
1992	486	479	758	902	204	106	243	136	94	3 408	10 113
1993	486	504	760	956	202	106	243	136	95	3 488	10 120
1994	588	521	792	949	249	106	243	139	123	3 710	10 672

% of trees with more than 25 % leaf loss

1989	2,4	12,7	8,4	5,3	4,0	26,4	7,0	2,1	7,5	7,3	5,6
1990	1,6	13,1	7,6	6,2	3,4	17	4,5	1,4	5	6,6	7,3
1991	1,6	13,5	9,2	6,5	5,4	10,3	1,6	0	5	6,7	7,1
1992	2,1	13,5	10,2	6,3	8,3	10,4	1,2	0	5,3	7,1	8
1993	1,8	12,7	10,1	8,9	10,9	11,3	0,8	3,7	9,5	8,2	8,3
1994	1,6	8,9	12,0	7,6	7,6	19,8	8,6	7,2	8,9	8,2	8,4
Average 1989-92	1,9	13,2	8,9	6,1	5,3	16,0	3,6	0,9	5,7	6,9	7,0
Average 1991-94	1,8	12,2	10,4	7,3	8,1	13,0	3,1	2,7	7,2	7,6	8,0

% of trees with 11-25 % leaf loss

1989	9,2	22,8	25,9	13,8	15,8	30,2	7,4	18,4	11,1	17,4	15,1
1990	8,6	21,1	24,4	11,1	15,3	41,5	14	10,6	6	16,2	16,7
1991	8,8	20,3	23,4	7	15,8	37,7	10,3	12	5	14,4	16,5
1992	8,6	19,8	22,7	7,4	14,2	34	7,8	25	6,4	14,7	16,9
1993	10,9	19,2	22,1	6	13,9	33	8,6	16,9	4,2	13,9	16,9
1994	7,5	19,8	21,8	15,9	16,9	36,8	11,1	25,2	0,8	16,6	19,2
Average 1989-92	8,8	21,0	24,1	9,8	15,3	35,9	9,9	16,5	7,1	15,7	16,3
Average 1991-94	9,0	19,8	22,5	9,1	15,2	35,4	9,5	19,8	4,1	14,9	17,4

% of dry trees

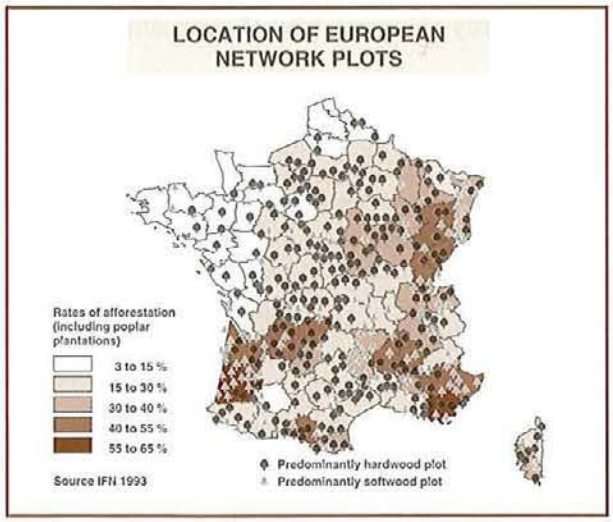
1989	0	0	0,5	0	0	0	0	0	0	0,1	0,1
1990	0	0,2	0	0,8	0	0	0	0	0	0,2	0,3
1991	0	0,2	0,1	1,2	0	0,9	0,4	0	0	0,4	0,4
1992	0	0,2	0,4	0	0	0	0	0	0	0,1	0,3
1993	0	0,4	0,5	0	0	0	0	0	0	0,2	0,2
1994	0,0	0,0	0,4	0,2	0,0	0,0	0,8	0,0	0,0	0,2	0,2
Average 1989-92	0,0	0,2	0,3	0,5	0,0	0,2	0,1	0,0	0,0	0,2	0,3
Average 1991-94	0,0	0,2	0,4	0,4	0,0	0,2	0,3	0,0	0,0	0,2	0,3

% of trees with abnormal coloration

1989	3,8	14,6	31,8	7,3	8,4	48,1	10,3	14,2	8,3	15,1	14,7
1990	3	14,3	28,9	9,3	22,2	11,3	6,2	2,8	9	13,7	14,2
1991	2,4	19,4	38,1	15,7	25,1	2,8	9,9	7,7	15	18,6	15,8
1992	1,9	12,3	23	3,4	13,2	0	19,3	12,5	12,7	11	12,8
1993	2,7	10,5	27,2	16,5	16,8	4,7	28	13,2	14,7	16,3	16,3
1994	1,9	17,1	19,7	9,8	9,2	11,3	18,1	4,3	8,1	12,0	10,3
Average 1989-92	2,8	15,2	30,5	8,9	17,2	15,6	11,4	9,3	11,3	14,6	14,4
Average 1991-94	2,2	14,8	27,0	11,4	16,1	4,7	18,8	9,4	12,6	14,5	13,8

(Source: European network, made up in France of about 550 sites of 20 trees, arranged in a systematic grid (16 km x 16 km), observed once a year by a team of two pre-trained observers operating in accordance with the community protocol described and annotated in a French handbook)

Commentary: over the period 1989-1994, about 92% of trees in the French part of the European network were in the category of healthy trees, with zero or slight foliage shortfall, despite a major drought that lasted 3-5 years, depending on the region. In all probability, the slight process of foliage degradation, observed over these past 6 years, can be largely explained by climatic conditions. The fastest degradation occurs with pedunculate oaks, while other hardwood species particularly vulnerable to water supply conditions, like poplar, hornbeam and birch, showed impoverished foliage from the onset of the dry period, in 1989 and 1990 in particular. The situation with fir and spruce, which had so alarmed European public opinion in the very early 1980s, has been stable since 1985-87.



2.3 Significant damage caused by biotic and abiotic agents

2.3.1 Damage caused by pests and diseases.

forested area requiring rehabilitation after damage from pests and diseases	2 500 ha/year
forested area where significant growth losses can be attributed to pests and diseases without calling into question the future of stands	150 000 ha/year 50 000 ha/year

(Source: expert estimate by the Forest Health Department at the Ministry of Agriculture and Fisheries, based on crop-protection measures of the past decade; the areas concerned usually vary from one year to the next. It is very rare that a major problem persists in the same spot for more than three years).

Commentary: the damage caused by pests varies a great deal from year to year in the same decade. It depends, in effect, essentially on the actual dynamics of these insect populations, in interaction with climatic conditions (droughts, storms, etc.). Death rates are essentially due to the combination of severe and repeated leaf-loss (defoliation) and a drought lasting several years in a row, to population explosions of bark beetles, as well as to crop-protection accidents occurring in very young plantations and seedlings. Growth losses at stand level may be attributed to severe defoliation, to spruce fomes, to scattered death rates in a stand due to attacks by insects living beneath the bark, to the action of root rot fungi, etc..

Insects and fungi are normally observable in the functioning of forest ecosystems. Growth losses that they may bring about at stand level are often part of the normal risk that a tree-farmer has to accept. The most serious problems stem from the fact that certain types of such damage can call into question the manager's basic choices, or create a situation which he does not have the wherewithal to cope with. In many instances, the most significant damage stems from attacks from pests and diseases on stands already weakened by climatic conditions and meteorological phenomena and events. Some forest species, like pedunculate oak, ash and silver fir, are characterized by natural dynamic regeneration, which at times allows them to colonize environments which are not perfectly suited to them; a series of climatic stresses may then trigger decay processes, accompanied by opportunist pests, thus doing away with this species in all or part of the area where it does not have a real place.

2.3.2 Areas of forest and other wooded areas destroyed by fire

	forest	other wooded areas	total
1976	52 752 ha	35 592 ha	88 344 ha
1977	11 360 ha	35 341 ha	46 701 ha
1978	2589 ha	17286 ha	19875 ha
1979	35 867 ha	23 860 ha	59 727 ha
1980	8 703 ha	13 473 ha	22 176 ha
1981	13 283 ha	14 428 ha	27 711 ha
1982	30 954 ha	24 191 ha	55 145 ha
1983	30 312 ha	23 417 ha	53 729 ha
1984	14 723 ha	12480 ha	27 203 ha
1985	26 328 ha	31 040 ha	57 368 ha
1986	27 021 ha	24 808 ha	51 860 ha
1987	8 376 ha	5 733 ha	14 109 ha
1988	1 909 ha	4 793 ha	6 702 ha
1989	44 242 ha	31 324 ha	75 566 ha
1990	56 485 ha	16 140 ha	72 625 ha
1991	6 524 ha	3 605 ha	10 129 ha
1992	(9 134 ha)	(7 473 ha)	16 607 ha
1993	(9 412 ha)	(7 701 ha)	17 113 ha
average 1976 - 1984	22 283 ha	22 230 ha	44 512 ha
% of total metropolitan area	0,16 %	1,0 %	0,27
average 1985 - 1993	19 347 ha	(21 724 ha)	41 071 ha
% of total metropolitan area	0,14%	1,1%	0,25%
average 1976- 1993	(21 665 ha)	(18 483 ha)	40 148 ha

(Source: Ministry of Agriculture and Fisheries, Ministry of the Interior and Land Management, based on the Prometheus files for the Mediterranean region and statements by the DRAF and DDAF for other regions; the figures in brackets are based on the hypothesis that 55% (average for the years 1976-1990) of the burnt area in 1992 and 1993 is forest).

Commentary: Forest fires, in the strict definition of the term, have a relatively low incidence at the level of the metropolitan forested area, even if there are marked variations from year to year. Nevertheless, their concentration at more than 80% in the Mediterranean region creates a tricky problem in this zone, where about 1% of the forest stand area, strictly speaking, is damaged on average every year. In reality, the problem is focused in an even smaller area, because the probability of destructive fire is far from equal in the 2.2 million forested hectares of southeast France (extended Mediterranean vegetation zone). Even if, in a certain way, fire is part of the way certain types of forest ecosystems in this region function, the rapid succession of fires in the same place (especially when the rate of return is less than 30-50 years) is such as to encourage erosion and a degradation process in plant formations, culminating in maquis or garrigue scrubland. On steep slopes, fires may be disastrous because of renewed erosion. It should be noted that environments associated with forests are even more often destroyed by fire, with burnt areas reaching or exceeding, on an annual average, 10% of the category of other wooded areas in southeast France. So forest management promoting the formation and upkeep of forest proper contributes to the sustainability of these forest environments.

2.3.3 Volume harvested in areas affected by storms.

	1965-1974	1975-1984	1985-1994
volumes in public forest	3 M cu.m.	3,6 M cu.m.	9,7 M cu.m.
volumes in private forest	0,7 M cu.m.	12 M cu.m.	6,5 M cu.m.
total volume	3,7 M cu.m.	15,6 M cu.m.	16,2 M cu.m.
% of standing volume	0,23 %	0,95 %	0,87 %
% of the production of the corresponding decade	-	2,58 %	2,16 %
average volume per ha of metropolitan forest per annum	0,026 cu.m./ha/yr	0,111 cu.m./ha/yr	0,114 cu.m./ha/yr
area-equivalent of average annual volumes destroyed	about 2 500 ha	about 9 800 ha	about 9 300 ha

(Source: ONF and Ministry of Agriculture and Fisheries, just for exceptional deadwood and windfalls, thus not taking into account deadwood volumes regularly harvested in mountains at the end of winter; for private forests, most of these figures come from M. Doll's thesis " Disastrous Meteorological Events in Forests", 1988; the area-equivalent of the volumes destroyed per annum is calculated from the average volume per hectare of regular high forests, the type of stand most often affected by deadwood; this estimate does not claim to give the total area affected by storms, but it meets the needs of the international questionnaire distributed by Finland and Portugal.

Note: the figures for public forests are thoroughly reliable, because they stem from inventories made prior to the sale of deadwood. In private forests, the estimates tend to be made jointly by private forest administrations and organizations, always higher than the sales actually recorded; the amounts seem, nevertheless, to reflect the overall situation.

Commentary: from 1982 on, France has experienced a series of exceptionally violent major storms, causing large quantities of windfalls (Massif Central, 1982; North-east, 1984; Brittany, 1987; northern half of France, 1990). Even if these disastrous meteorological events cause locally huge problems for logging, for marketing organization (they are likely to upset the markets for certain species for several years) and for the rehabilitation of damaged and destroyed stands, their global impact at the level of French forests overall is still very low. This situation can probably be associated with a sensible and dynamic silvicultural system, which, in a relative sense, protects France from the forest-related catastrophes which have struck the very dense stands of Central Europe, without it always being easy to weigh up the effects of the weather and the responsibility of a given type of silviculture.

2.3.4 Proportion of regenerations protected from serious damage by big game.

	1993
total area declared as undergoing regeneration	327 000 ha
area protected from big game	38 538 ha (40 to 45 000 ha ?)
% of regeneration protected from big game	about 12 % (12 to 14 % ?)

(Source: 1993 survey of the Ministry of Agriculture and Fisheries and the Ministry of the Environment published in Information Bulletin DERF/SDEF/DNP/SDCFF/No.94 no.3013 of 14 April 1994; bearing in mind the evaluation method used, it is certainly possible to consider a scale of 40-45,000 hectares protected at any given moment, but with a period of protection differing between deterrents and other protection methods, half of these areas being in forests governed by the Forest Regulations, which, however, represents only 30% of areas regenerated each year).

Commentary: according to the survey organized jointly by the Ministry of the Environment and the Ministry of Agriculture and Fisheries, which makes no statistical claims, about 12% of regenerations receive special protection to avoid excessive damage caused by big game. The most threatened species are hardwood. Protection of regenerations from big game cost at least 16 million francs in 1991 and 1992, with State subsidies covering only 40% of this cost. Nevertheless, it is not easy to assess the national cost of regeneration protection. A lot of regeneration units are not entitled to State aid and their protection must be self-financed by the product of felling. Experts generally reckon that protection against roe-deer may double the price of plantations, and protection against red deer may quadruple it.

Without totally excluding the responsibility of unsuitable silvicultural methods in certain zones, it is worth noting that this problem concerns regenerations of irregular stands as much as regular

stands. In cleared high forests, the abnormal absence of natural regeneration is often only noticed by foresters. When the situation lasts for several decades, management sustainability is seriously compromised, as is already the case in many parts of Switzerland, Austria and Germany. However, the role of large herbivorous mammals in the upkeep of open environments and clearings, which favours a certain biodiversity, must not be overlooked.

Furthermore, the scale of protective measures does not prevent all damage, both because damage affects non-protected areas, and because certain measures are less than perfect. In the protected area inventory, private forests only account for 50% whereas they represent almost 70% of areas in regeneration. It seems unlikely that this situation can be explained solely by plantations of species of little interest for big game. It is thus reasonable to think that a significant proportion of non-protected regenerations in private forests is confronted by problems of game damage.

2.4 Development of mineral fertility of soils

A soil inventory over a systematic 16 km x 16 km/ 10 x 10 mile grid was carried out over all the forested area of the EU countries in 1993 and 1994. The findings are being analyzed and will not be available until late 1995.

3. A FOREST PRODUCING GOODS AND SERVICES

3.1 A timber harvest lower than production

	1984	1994	1994/1984
net current production	cu.m./yr 58 249 207	cu.m./yr 72 758 452	% +25
	cu.m./ha/year 4,41	cu.m./ha/year 5,42	% +23
extraction	cu.m. 45 107 000	cu.m. 52 064 000	% +15
rate of extraction	% 69,1	% 71,6	% +2,5

(Source: IFN, just for loggable inventoried forests, except poplar plantations; present net production being the sum of the current growth of recordable trees (diameter at 1.30 m/50 in. greater than 7.5 cm/3 in.), recruitment (a technical term describing the incorporation of the growth of non-recordable trees) and growth in the form of felled trees, after deducting the death rate; the value calculated is the annual average over a 5-year period before the inventory is drawn up; the 1994 extraction is, in effect, the extraction value estimated by the IFN in a 1994 survey; "Estimate of timber extractions in French forests, a forestry approach to home consumption"; in fact, the 1994 extraction corresponds to an average annual value corresponding to the periods separating the last 2 cycles available by *département* in 1994; the 1984 extraction was calculated by estimating the fuelwood harvest as stable and by applying to the actually marketed volume of construction timber and trade timber between 1984 and 1994, the same multiplier as for the marketed harvest of construction timber and trade timber between 1982 and 1992; to calculate the extraction rate, it is necessary to re-incorporate in the EAB survey the volume of bark (for softwood species) and logging losses generally estimated at 10% of the volume).

Note: because of a very cautious application of the production evaluation method, the 1984 findings have been underestimated on average by 12%. Production increases between 1984 and 1994 are thus between 12% and 15%. The extraction rate is the ratio between the volume extracted and the net current production, this latter being current production less the declared natural death rate; the extraction rate for 1984 has been corrected to take into account a 12% underestimation.

poplars and poplar plantations	1994
total IFN production on 199 916 ha	1 578 000 cu.m.
IFN production per ha	7,16 cu.m./an
Teruti extrapolated total IFN production	2 233 000 cu.m.
extraction (just for logs)	2 857 212 cu.m.
rate of extraction	128%

(Source: IFN for the production for poplars in inventoried loggable forests and for poplar plantations, and EAB (just for logs) for extraction; pro rata IFN extrapolated estimates of areas of poplar plantations in the old 1991 Teruti series: 282,800 ha; the biological production of poplars and poplar plantations does not take into account the biological production of aspen (a forest species very close to poplars), estimated at 1,273,112 cu. m./year in 1994).

Commentary: the productivity of French forests is rising sharply, which can be specifically explained by the scale of afforestation and reforestation carried out over the past 50 years, and thus by the significance of young age classes in full growth. The Daubrée Statistics, published in 1912, reported a total annual production of 23,503,711 cu. m., corresponding to a production of 2.38 cu. m./ha/year. The current extraction rate shows that there is no risk of over-logging. The harvest has increased significantly in 10 years but proportionately far less than growth. Together with concerns about the implementation of a coherent forest biodiversity protection policy, the continuity of sustainable management in the present silvicultural context calls specifically for a continued programme of timber mobilization and for increasing the harvest, at least in certain types of stands and certain areas.

By comparison, the extraction rate currently stands at 70% in the Nordic countries, 67% in the Eastern European countries, and 69% in the 12 EU States (before the admission of Austria, Finland and Sweden). The European continent is not, as a whole, threatened by over-logging. According to the 1994 statistics of the UN Economic Commission for Europe, only 5 European countries (Albania, Cyprus, Greece, Portugal and the former Yugoslavia) currently harvest all the net annual growth (and even more for three of these).

Note: a 100% extraction rate is a value which, as part of the sustained yield theory for a timber harvest, should be the aim in a balanced and managed forest, when the top priority management goal is timber production. But in this framework, this 100% value might sometimes be exceeded without the continued existence of the forest being threatened. Specifically, this would be the case when there is an imbalance in favour of mature stands, where the harvestable volume is significant and current production falling. Furthermore, in a regularly regenerated forest, the extraction rate is, very generally speaking, lower than 100% because account is made of the diameters of young stems when they exceed 7.5 cm/3 in., a diameter for which there are no profitable outlets.

There is a specific problem for poplars, where plantations comply with a cyclical logic akin to that of certain agricultural products. For this species, but without factoring in the production of alignments (probably about 230,000 cu. m./year), the extraction is currently markedly higher than production since it already stands at 128% of the latter, without taking into account trade timber (undoubtedly reduced, admittedly). Marked aging of French poplar plantations does exist, as does an imbalance favouring mature stands, where the harvestable volume is significant and current production falling. It is also certain that part of the aspen harvest in forests is marketed as poplar which definitely relativizes the statistical value of the extraction rate calculated just on the basis of poplar plantations.

Recycling

	1983	1993
rate of cellulose fibre recycling	33,2%	36%
% of old recycled paper in the manufacture of pulp	39%	47,4%

(Source: Copacel)

Commentary: Throughout the last 10 years there has been a programme to increase the recycling rate of cellulose fibres now standing at 36%, based in particular on the separate collection of old paper and cardboard. Considerable investments have been made to increase the pulp capacity of old paper. The level attained now stands at 47.4%. Despite this significant progress, France is still relatively inadequate in terms of its "harvest" of old paper and cardboard, when compared worldwide. From this viewpoint, France currently offers an interesting situation, likely to attract new investments. The growth of old paper recycling responds more to a waste management logic than to forest protection logic, in a country like France where the timber harvest does not endanger a renewable resource.

Accessibility of forests

logging category	area (ha)	area %	volume (thousands cu.m.)	volume %
		1984		
easy	9 129 249	66,4	1 149 209	70,1
average	3 024 253	22,0	367 009	22,4
difficult	1 067 422	7,8	123 014	7,5
not loggable	534 498	3,8	unknown	-
total	**13 755 422**	**100**	**1 639 232**	**100**
		1994		
easy	9 422 077	67,1	1 325 869	71,5
average	3 103 772	22,1	418 845	22,6
difficult	916 127	6,5	109 168	5,9
not loggable	607 558	4,3	unknown	-
total	**14 049 534**	**100**	**1 853 882**	**100**

(Source: IFN, apart from non-inventoried and unspecified forests; easy logging means specifically a haulage distance of less than 500 m).

Commentary: two-thirds of France's forests are easy to log. During the decade that elapsed between the two inventories, major efforts were made to improve access to almost 370,000 hectares/ 914,000 acres, in order to simplify management. Volumes with easy or average access exceed 94% of the total standing volume. The introduction of forest roads and tracks into the countryside is attracting more attention than was the case until just recently.

3.2 Forests managed on the basis of a management plan

	1974	1984	1994
	managed State-owned forests		
ha	1 184 453	1 421 039	1 764 206
%	71,0	82,3	89,8
	other managed public forests run by the ONF		
ha	1 316 400	1 650 772	1 801 062
%	54,4	66,1	71,0
	managed private forests of more than 25 ha in a single plot		
ha	94 917	2 345 897	2 479 773
%	2,8	71,2	74,0
	total managed metropolitan forests		
ha	**2 595 770**	**5 417 708**	**6 045 504**
%	-	**38,7**	**42,5**

(Source: ONF for State-owned forests and other public forests managed by the Office National des Forêts, based on the link between areas with a development plan in force and areas entered in the SER file, without taking into account logging regulations for coppices and coppices with standards; ANCRPF for private forests of more than 25 ha; the percentage of all managed metropolitan forests in 1984 and 1994 is calculated on the basis of areas in the 1981 and 1991 Teruti old series).

Commentary: obviously enough, the quality of forest management is not necessarily conditioned by the formalization of a management plan approved by professional or administrative agencies. Although small forests are not recorded in any precise listing, many of them are governed by logging regulations. Nevertheless, for forest estates of a certain size, the preparation of a management plan offers an occasion to make a complete report of the environmental conditions, to formulate technical and economic guidelines for the owner, and to forecast a calendar of operations required. It is reckoned not to be necessary to draw up a management plan for areas of less than 10 hectares in a single plot, because the management improvement attendant thereupon would not be made up for by the bureaucratic complexity of the procedure. Between 10 and 25 hectares, in a single plot, a management plan is an option left up to the owner.

It must be emphasized that a great deal of work has been accomplished in the last 20 years to increase the area covered by approved management plans by more than 3.5 million hectares. Although much effort has been invested in public forests, the major part of the effort has involved private forests of more than 25 hectares in a single plot. Counting areas of coppices and coppices with standards covered by logging regulations in public forests, the rate of development now stands at 82.6% in forests managed by the Office National des Forêts; it is not possible to achieve a 100% figure because of the management percentage currently being studied, after the validity of the previous management plan has expired.

areas covered by an approved management plan or by an approved regional forest guideline, in %	92,7%

(Source: Ministry of Agriculture and Fisheries, 1994).

Commentary: almost all France's forested area is covered by a planning document adapted to its specific conditions, or by a regional guideline document which then provides the manager, who so desires, with a general framework for his silvicultural thinking and activities. Management plans must take into account approved regional forestry guidelines. These guidelines are worked out by regional forest and forest product committees, where all the partners concerned are represented, including nature protection associations. The Ministry of Agriculture and Fisheries, responsible for forest policy, has decided to inject new life into this regional system of thinking, coordination, and negotiation, in such a way as to develop clear and easily interpreted guidelines and activities implemented to promote the economic, ecological and social roles of the forest.

3.3 Forest product harvests

1) Timber

in thousands of cu.m. and in millions of F 1992 value

	1982	1992	1992/1982
volume of construction timber	17 756	21 494	+ 21%
volume of trade timber marketed	8 418	10 631	+ 26%
volume of fuelwood (marketed or domestically consumed)	14 000 ?	14 511	-
value of timber after logging (except home consumption)	?	10 488	-

(Source: SCEES/EAB and survey on the value of timber after logging; the volume of fuelwood (marketed or consumed at home) and construction timber,consumed at home, is estimated by deduction involving the total extraction (calculated by the IFN in a 1994 study: "Estimate of timber extraction in French forests, a forestry approach to home consumption") and the known cumulative volume of construction timber and trade timber; it has been hypothesized that this volume underwent virtually no change between 1982 and 1992; the fuelwood volume marketed in 1992 was 2.737 million cu. m.).

Commentary: the harvest of marketed timber has risen sharply over the last decade. The value of timber felled and hauled exceeds 10 billion francs, if home consumption is excluded, and probably amounts to 12.5 billion francs if the value of home consumption (11.8 million cu. m. in 1992) is incorporated at an overall price of 164 F/cu. m. (average value of fuelwood marketed after logging in 1992). It must also be noted that a not inconsiderable proportion of fuelwood harvested comes from wooded areas that are not strictly forested (hedges, thickets, spinneys). Based on the project carried out by the research centre for natural resources in the Ecole des Mines (Engineering College) in Paris in 1982, and on the estimate of fuelwood consumption made by the IFN, the total consumption of wood in France (after allowing for imports and exports) was around 59 million cu. m. RE (roundwood equivalent) in the early 1980s, in other words an average consumption of slightly more than one cubic metre per inhabitant per annum.

2) Hunting

	State-owned forests	other public forests	private forests	all forests	average income per ha
leasing of forested land for hunting (year 1993)	165MF	272MF	135MF	572MF	40F/ha
value of venison				452 MF	32F/ha
total				**1 022 MF**	**72 F/ha**
cost of damage caused by big game to agriculture alone, not including damage to forest regeneration			94,9 MF		

(Source: ONF accounts for State-owned forests; for other public forests, pro rata extrapolation of areas based on revenues of State-owned forests; estimate for private forests based on areas leased for hunting (ESSES survey, 1976 - 1983) and on a national average rate of 100 F per hectare assessed on the basis of a DRAF survey; ONC for hunting tables concerning red deer, roe-deer and wild boar (1993 - 1994 season); the value of the venison being calculated on the basis of the animal's average weight (17 kg for roe-deer, 80 kg for red deer and 40 kg for wild boar) and the wholesale price at Rungis (average for the last 3 months in 1993); damage by big forest game to agriculture being estimated by the ONC based on compensation paid out for 1993).

Commentary: the share of hunting in the returns from State-owned forests is increasing sharply: 3.2% in 1973, 9.5% in 1983 and 13.2% in 1993. In 20 years, the product of hunting in State-owned forests has increased by a factor of 2.3 in constant francs. The situation is very different in private forests, where just 13% of forested areas appear to be leased for hunting, which means that when the owner does not profit from hunting, he is far from invariably benefiting from an additional revenue compensating him for the limitations stemming from a sometimes significant expense incurred by big game. In one decade, from 1983 to 1993, the extraction of large animals by hunting increased by a factor of 2 for red deer, and by 2.5 for roe-deer and wild boar, thus showing the considerable increase of hoofed wild animals throughout France. In all, hunting in forests now represents a sum of about 1 billion francs, of which

less than 15% effectively benefits private forest owners. But to establish the net profit for society, it would be necessary to deduct the value of the damage caused by big game to the forests themselves (this value is not known because it is tricky to estimate), and, more broadly, to adjacent farmlands (slightly less than 100 million francs).

3) The forest mushroom harvest

	truffles	boletus and other forest mushrooms
average annual volume		
1971 - 1980		7900 t
1981 - 1988	60 t	8200 t
average annual volume marketed as is		
1981 - 1988		2280 t
average annual volume marketed with a view to industrial processing		
1981 - 1988		1450 t
estimate of the value of the total harvest		
	130 MF (?)	400 MF (from 260 to 870 MF)

(Source: annual survey of the SCEES on volumes and "Forest Mushrooms" section of the National Federation of Mushroom Producers; using a basic unit value of 50 F for 1 kg of boletus and other forest mushrooms, and for the average quantity harvested in the period 1981 - 1988; the volumes are very probably markedly underestimated and the unit value fluctuates a lot depending on the market and the season (Rungis 1994: from 33 F/kg for large lots to 200F/kg for small lots; Bordeaux 1994: from 45F/kg for large lots to 110F/kg for small lots)).

Commentary: bearing in mind a clear underestimation of volumes, the value of the annual harvest of edible forest mushrooms may reasonably be estimated, on average, at about 600 million francs; in good years, it may doubtless easily exceed 1 billion francs. In fact, the harvest varies a great deal from year to year: 13,500 t in 1975, 2,650 t in 1978. Less than half this harvest is marketed, the rest being consumed domestically. In the great majority of cases, the forest owner does not profit from the production of his own forest, the harvest being dominated by unauthorized professional and occasional mushroom gatherers. This is a harvest activity which benefits society more than the forest owner, who must nevertheless assume the major part of the cost of the sustainable management of a forest producing a large range of harvestable products.

4) Other products harvested in forests or forest-associated formations, and remuneration of different services

nature	production t/year	value MF
lichens for perfumery and cosmetics	2 000	
butcher's broom foliage	200	2,4
butcher's broom roots	150 à 200	2 à 3
rockrose foliage	800	6,4
bilberries for cosmetics and pharmacy	1 000	15
pine residue for distillation of essential oils	40 000 cu.m.	OF
honey from fir	600	20 à 30
cork	4 000	7,2
pine resin	2 550	8,7
decorative foliage	unknown	unknown
other sundry revenues just for State-owned forests	-	50
total of other products harvested in forests and services remunerated	-	110 à 120

(Source: ONIPAM) Interprofessional National Office of Perfume, Aromatic and Medicinal Plants; Association of Beekeepers of Lorraine; values for 1989; ONF, value for 1993; Ministry of Agriculture and Fisheries for cork and pine resin in 1992).

Commentary: there are lots of small outlets for various harvestable forest products. In its sector of expertise, the ONIPAM nevertheless estimates that most of them are on the decline. This is also the case with cork and pine resin. For some years now, honey production from fir has collapsed, without any convincing explanation having been found for this phenomenon. It should also be noted that most of these varied products bring no profit to the forest owner, because the harvest is generally gathered without authorization or the payment of a fee.

4. BIODIVERSITY

4.1 Proportion of mixed stands

	1 species	2 species	3 species	4 species and more
area in 1984	3 992 300ha	3 884 084ha	2 814 513ha	2 445 458ha
% of total metropolitan area in 1984	30,39%	29,57%	21,43%	18,62%
area in 1994	3 847 735ha	3 840 762ha	2 948 723ha	2 668 102ha
% of total metropolitan area in 1994	28,92%	28,87%	22,16%	20,05%

(Source: IFN, just for loggable inventoried forests, based on the number of species observed within a radius of 25 m, each representing IFN field sites).

(volume in thousands of cu.m.)	volume per ha of the species in stands where it is predominant in 1984 (in cu.m./ha)	volume per ha of all species in stands where the species is predominant in 1984 (in cu.m./ha)	percentage of purity in volume for the main species in 1984	volume per ha of the species in stands where it is predominant in 1994 (in cu.m./ha)	volume per ha of all species in stands where the species is predominant in 1994 (in cu.m./ha)	percentage of purity in volume for the main species in 1994
pedunculate oak	80,6	122,1	66%	87,9	136,9	64%
beech	126,2	178,9	71%	131,5	187,1	70%
sessile oak	93,2	130,0	72%	107,6	151,0	71%
maritime fir	111,4	122,0	91%	130,4	142,5	92%
silver fir	232,8	286,8	81%	225,6	284,0	79%
Scots pine	98,5	122,3	81%	101,4	129,7	78%
common spruce	136,4	173,4	79%	152,4	192,0	79%
chestnut	80,3	105,0	76%	89,1	115,7	77%
hornbeam	48,7	99,4	49%	56,9	111,4	51%
pubescent oak	36,9	43,0	86%	45,8	53,6	85%
ash	66,7	132,0	51%	75,5	143,9	52%
birch	45,3	75,7	60%	46,7	79,0	59%
Douglas fir	44,6	58,5	76%	81,8	97,2	84%
Austrian pine	103,1	118,0	87%	109,7	128,4	85%
aspen	60,5	106,7	57%	65,3	121,6	54%
false acacia	58,7	84,0	70%	71,2	94,3	76%
large alders	88,7	120,6	74%	98,8	132,4	75%
European larch	131,4	152,9	86%	128,1	153,6	83%
Corsican pine	118,3	131,3	90%	124,2	143,6	86%
holm oak	19,8	25,6	77%	26,3	31,3	84%
Aleppo pine	38,9	45,4	86%	44,0	53,6	82%
willow	26,8	45,8	59%	34,5	53,6	64%
pitch pine	90,7	104,3	87%	98,4	109,7	90%
cork oak	40,4	47,7	85%	47,6	54,0	88%
valuable hardwoods(1)	28,6	64,0	45%	34,9	75,0	46%
valuable hardwoods(2)	73,3	127,7	57%	81,6	138,7	59%

(Source: IFN, except for poplar plantations, just for exploitable inventoried forests, for the top 24 species by area, based on stem-with-back volumes, stocked at a 7 cm cut (solid wood); the volumes per hectare are calculated by the IFN by relating volumes to areas, just for areas where the species is predominant).

Commentary: more than 70% of the area of French forests consists of mixed stands. During the last 10 years, monospecific stands have slightly dwindled, whereas mixtures, with 3 species or more, have significantly increased. Stands with 4 species or more now represent one-fifth of metropolitan forested areas, which is a particularly exceptional situation in western Europe. This situation seems to have been relatively stable for a century, because the 1878 Forest Statistics

estimated the percentage of mixed stands at 70.4%, pure stands at 27.1% and empty areas in forests at 2.5%.

The mixture of species noted falls within the silvicultural guidelines recommended by the french school of silviculture for the past 150 some years. It is based on the priority given to one or two major gregarious species, accompanied by secondary species and/or an under-storey. This is why the area where the predominant species covers less than 75% of the forest cover stands at just 30.5%. But this situation varies a great deal from species to species, as is shown by the table where the percentage of specific purity is close to the percentage of the volume of the predominant species in the total stand volume. It is generally around 70% for major gregarious hardwood species (oaks, beech, etc.). 85-90% for pines and 50-60% for main secondary species.

4.2 Natural forests and semi-natural old forests

natural metropolitan forests

public forests	about 7 000 ha
private forests	about 23 000 ha
total	**about 30 000 ha**

(Source: ONF and IFN 1994 value; natural forests are assessed by the presence of a high forest from time immemorial, consisting exclusively of local native species, and free of human activity for at least 50 years; the value for private forests is estimated by applying the same ratio between natural forests and non-loggable forests in 1984 (estimated by the IFN) as for public forests, which possibly slightly overestimates the area of private natural forests, because of lower representation in mountain regions where most natural forests are concentrated).

semi-natural old metropolitan forests

public forests	about 700 000 ha
private forests	about 800 000 ha
total	**about 1 500 000 ha**

(Source: estimate by the Ministry of Agriculture and Fisheries; semi-natural old forests are estimated by the presence of a high forest consisting exclusively of native species, not coming from plantations, established as forests for at least 80 years; the total area has been estimated by the difference between the total high forest area in the Daubrée Statistics (1908-1913) and the high forests planted during the 19th century (known planting programmes, with a multiplier of 1.2); the breakdown between public and private forests is made based on 2/3 of the high forests existing for more than 2 centuries in public forests (with a slight addition to take into account the natural afforestation of the many empty areas recorded in stands in the 19th century) and the balance to private forests).

semi-natural-looking forested formations	2 738 854 ha

(Source: IFN, 1994, just for inventoried forests, by selecting stands with the following conditions: a high forest structure, the elimination of man-made afforestation and reforestation, the presence of at least 2 forest species in 20-are IFN sites, and the predominant species that is locally indigenous).

Commentary: French metropolitan forests have been markedly shaped by man throughout the past 10 centuries. This legacy can be seen in the extent of coppices and coppice/high forest mixtures. Only 6 million hectares are high forest, a typical treatment of natural and semi-natural forests. The doubling of the forested area in the last 2 centuries explains the relatively young age of areas occupied by high forests: only a quarter of them may be regarded as semi-natural old forests. Logically enough, this proportion is significantly higher in public forests, as inheritors of the ancient royal forests. Semi-natural forest formations occupy 2.7 million hectares, i.e. 45% of the total area currently put to high forest and almost 80% of high forest areas existing for more than 80 years.

4.3 Area of very old regular stands forming specific habitats

species	age limit (1)	area in 1994 (en ha)	percentage of national land in high forest
pedunculate oak	180 yr	14 851	2,545%
sessile oak	240 yr	895	0,205%
pubescent oak	150 yr	5 198	3,618%
holm oak	200 yr	722	6,163%
cork oak	120 yr	4 163	7,229%
beech	180 yr	35 915	5,192%
chestnut	150 yr	17 229	14,992%
ash	120 yr	3 496	3,616%
alder	70 yr	1 850	17,676%
aspen	70 yr	1 059	11,598%
birch	50 yr	11 073	51,804%
lowland fir	160 yr	31	0,084%
lowland spruce	160 yr	243	0,145%
mountain fir	200 yr	12 378	3,795%
mountain spruce	200 yr	9 359	2,349%
maritime pine	140 yr	814	0,074%
Scots pine	200 yr	1 533	0,190%
Corsican pine	200 yr	2 116	2,251%
pitch pine	150 yr	7 383	14,55
European larch	200 yr	8 655	10,371%
total of 18 species	-	**138 963**	**2,654%**

(1) age limit greatly exceeding the admissible age for the rotation of the species in question

(Source: IFN, based on just regular high forests, the estimate of the age on the basis of which the stands in question significantly exceed the admissible age for the rotation of the species in question having been made with the collaboration of the ONF and the INRA; the age in question may be regarded in a first approximation as a probable age for the appearance of phenomena of physiological over-maturity or senescence in average conditions).

Commentary: for 18 species representing almost 5.2 million hectares of regular high forests (about 87% of the total high forest area and 38% of the

metropolitan forested area), about 2.7% of the area occupied by stands have an average age significantly exceeding the admissible age for the rotation of the species concerned. It is quite normal that this rate is very low for lowland spruces, because plantations of this type have only been developed for the past 50 odd years. These types of stand have a phase of over-maturity, or even senescence, and contain specific habitats for certain animal and plant species which ordinary silviculture is not reckoned to encourage. For at least 87% of regular high forest (this does not affect similar calculations for other species), forest management practised in France is thus far from doing away with these habitats which are typical of natural stands.

4.4 Volume of dead wood in forests

1984	11 592 152 cu.m.	0,88 cu.m/ha
1994	20 757 663 cu.m.	1,55 cu.m/ha

(Source: IFN for just inventoried forests, except for poplar plantations, just for standing timber that has been dead for at least 5 years since the field visit of the inventory team).

Commentary: even in forests cultivated over a long period, more than 1% of the volume of inventoried wood is wood that has been dead for at least 5 years, thus offering a habitat for certain saproxylophagous insects, saproxylic fungi and insectivorous birds. To this effect, in its instructions about biodiversity considerations in forest planning and management, the ONF recommends that senescent trees and dead trees be kept as they are. The volume of 1.55 cu. m./ha is definitely underestimated because the IFN does not take into account standing timber that has been dead for more than 5 years, or timber on the ground. The increase in dead wood volumes in forests has to do, on the one hand with the increased cost of labour, which now prohibits extracting all dead wood, as it dies, as was the practice in the 19th century, and, on the other hand, with the series of major storms and periods of extreme drought occurring since the mid-1970s.

4.5 Native species and introduced species

	trees occurring in forests			
	native species	acclimatized species	tropical species	total
number of hardwood species	57	3	16	**76**
number of hardwood species	57	10	12	**79**
number of softwood species	16	5	29	**50**
total	**73**	**15**	**41**	**129**
proportion of national land covered in 1984	95,01%	4,99%		**100%**
proportion of national land covered in 1994	94,03%	5,97%		**100%**

(Source: M. Rameau (ENGREF) for the list of species (or groups of species in the case of cultivated poplars and eucalyptus) of trees found in forests (see list in appendix); IFN for the calculation of the proportion of the national land area covered by native species; an acclimatized species is a species which was introduced enough decades ago to have demonstrated unequivocally, over more than a generation, its proper adaptation to the environmental and climatic conditions prevailing in France, and which can reproduce naturally in forests without a helping hand from man: see list in appendix; the definition of native species has been made at national level, and not by minor forested regions).

Commentary: in European forests taken as a whole, French forests are exceptionally diversified, due to the number of species it is possible to find in them. This is explained by the variety of types of physical environments and climates encountered, and by the type of management practised for several centuries. Hardwood species predominate in both number and area. The significance of the number of acclimatized and tropical species occurring in forests should not obscure the fact that native species represent 94% of the metropolitan forested area. It should not be forgotten that the presence of certain species, nowadays regarded as local, only dates back a few centuries, as is the case with the chestnut in the Paris Basin and Alsace.

4.6 Endangered and vulnerable species found in forests

	species strictly or very often present in the forest environment	species growing in a quite balanced way in forests and in open environments (or also requiring very specific environments: e.g bats)	species occasionally present in forest environments but usually observed in open environments	total no. of species likely to be observed in forests	total no. of species observed throughout the national territory
vascular plants outside the Mediterranean region					
number of species	327	423	225	975	more than 3 000
number of endangered or vulnerable species	10	14	5	29	-
% of endangered or vulnerable species	3,1%	3,3%	2,2%	3,0%	-
mammals					
number of species	6	26	?	32	105
number of endangered or vulnerable species	2	9 (bats)	?	11	-
% of endangered or vulnerable species	33%	35%	?	34%	-
birds					
number of species	20	33	?	53	270
number of endangered or vulnerable species	8	0	?	8	-
% of endangered or vulnerable species	40%	0%	?	15%	-

(Source: Ministry of the Environment and National Museum of Natural History, 1994; this indicator poses major methodological problems involving the definition of what a forest species is, species of birds associated with young stands and regenerating plots, or clearly ubiquitous species, being specifically omitted; the lists of references used are, for birds: the inventory of endangered fauna in France (MNHM, WWF, Nathan, 1994) and "Birds in Europe, Their Conservation Status (Birdlife, 1994)", for vascular plants and mammals: the Red Book of Endangered Species and the Habitats Directive; see the list of endangered and vulnerable species in the appendix).

Commentary: major methodological problems weigh upon the reliability of these indicators, rendering their interpretation difficult. In effect, many species have a home range consisting of a patchwork of biotopes which are not all forested. For example, the list has considered the black stork to be a forest species, because it effectively nests in forests, but feeds in wetlands; does its endangered species status have to do with forest evolution or the diminution of wetlands? In addition, it must be borne in mind that the drop in numbers of certain migratory species may be attributed as much to negative impacts in the wintering zone as to negative impacts in French forest management. The survival of bats found in forests does not depend solely on forest conservation, but also on the protection of caves and buildings housing certain species. Furthermore, the major portion of the populations of species found in forests is made up of arthropods, lower plants (lichens and bryophytes) and micro-organisms, for which precise data are not available.

These lists include just one rare forest species: the service tree of Fontainebleau. The list of species strictly or very often present in the forest environment, and which are endangered or vulnerable appears in the appendix; the list of mammals nevertheless also includes species with mixed behaviour occurring in a more or less balanced pattern in forests and open environments. This list, drawn up by the Fauna and Flora Secretariat of the National Museum of Natural History at the request of the Ministry of the Environment, does not claim to present an exhaustive listing of all the species regarded as vulnerable by the Inventory of Endangered Fauna in France, such as for example the hazel grouse and the capercaillie, or species requiring monitoring, such as for example the European badger, the marten and the wild cat.

Whatever the case may be, the refinement of a coherent national and regional protection policy for endangered and vulnerable species is crucial. For many species whose life is not spent solely in forests, such a policy calls specifically for an overall understanding of land management, although we cannot expect to solve these problems simply by measures concerning just forest management. The debate about the protection of the bear has clearly shown this.

4.7 Forests in strictly protected forest reserves and special reserves

	strictly protected forest/ reserves	reserves with a special management system	total
national parks	650 ha	98 150 ha	98 800 ha
protected forests	0	3 783 ha	3 783 ha
bio-reserves in metropolitan public forests	639 ha	13 223 ha	13 862 ha
metropolitan nature reserves	12 474 ha	23 477 ha	35 951 ha
metropolitan coastal conservancy	0	about 6 800 ha	about 6 800 ha
national hunting and wildlife reserves	0	about 15 000 ha	about 15 000 ha
total metropolitan	**13 763 ha**	**about 160 000 ha**	**about 175 000 ha**

(Source: Ministry of the Environment, Ministry of Agriculture and Fisheries and ONF, situation in 1994; this total does not include the majority of protected forests whose main target is the protection of the physical environment).

Commentary: slightly more than 1% of the metropolitan forest is governed by various statutory protection measures, helping to steer their management, as a priority, towards biodiversity protection at species and ecosystem level. Needless to say, the regional situation of all types of forest ecosystems remains to be checked, to establish a rational strategy for protecting rare, threatened and representative ecosystems. This project is currently being undertaken as part of the application of the Community "Habitats" Directive and of the establishment of the Natura 2000 Community network.

In addition, the ONF is currently working on the design of a network of strictly protected forest reserves covering a wide range of forest ecosystems. Advances in this respect should thus be chalked up over the next few years.
In the French context, it nevertheless seems preferable to encourage a consideration of biodiversity in ordinary forest management rather than to try and reach the very high ratios of strictly protected forest reserves proposed or observed in countries where silviculture is, on the whole, less respectful of the natural environment, furthermore, population density and the structure of land ownership would make it hard to establish very large strictly protected forest reserves comparable to those which have been created in Canada, the United States, Finland, Sweden and Norway, in conditions which bear absolutely no comparison.

4.8 A very accommodating forest for deer

average density of red deer in 1993	0.35 head per 100 ha
average density of roe-deer in 1993	5.98 head per 100 ha
total density of deer in roe-deer equivalent	7.4 head per 100 ha

(Source: Ministry of the Environment and ONC, based on a method of population estimation relying on hunting plans; for the recapitulatory indicator 1 red deer is reckoned to be the equivalent of 4 roe-deer).

Commentary: during the last decade, the red deer population seems to have increased by about 50% and the roe-deer population seems to have multiplied by a factor of more than 3.
This spectacular growth over the past decade is itself in addition and complementary to a considerable growth in deer populations since 1963. It can be partly explained by the geographical spread of roe-deer populations in hitherto little colonized regions (mountains, the Mediterranean environment, central and western France). French forests thus seem to be a particularly accommodating environment for this type of large mammal, whose populations can only be controlled by hunting.

These populations have not stopped increasing between 1975 and 1993, but hunting plans have multiplied by a factor of 2.6 for red deer and 4.4 for roe-deer. The current situation is worrying the powers-that-be, especially because of damage by game, attracting complaints from certain tree-farming forest owners, and which may considerably exceed the damage normally acceptable by these large mammals. A 30% rise in shooting authorizations was granted, by way of hunting plans, between 1990 and 1992.

4.9 Conservation of genetic forest resources

	hardwoods	softwoods	total
listed or monitored stands (number)	706	1 204	1 910
listed or monitored stands (area)	26 387 ha	44 544 ha	70931 ha
number of genetic units inventoried and conserved in collection	about 20 000	about 32 000	about 52 000
special conservation programme for genetic forest resources	3 966 ha	2 916 ha	6 882 ha for 2 species

(Source: Ministry of Agriculture and Fisheries, CEMAGREF, INRA and ONF, 1992 data for listed and monitored stands; 1994 data for the special conservation programme for genetic forest resources).

Commentary: to monitor the quality of seeds and seedlings used in artificial regenerations, France recommends the use of seeds from listed forest stands, selected by their general appearance. To avoid poor genetic adaptation of plantations to environmental conditions, the French system operates by regions of origin for each of the major reforestation species. These regions of origin are made up of an area or group of areas sharing the same ecological conditions, containing a certain number of stands with similar phenotypical characteristics. These number 22 for silver fir (for 124 listed stands), 20 for beech (for 180 listed stands), and 15 for the sessile oak (for 130 listed stands). The number of listed stands per region of origin helps to avoid too great a reduction of genetic variability. In a given afforestation zone, there is a list of recommended regions of origin, designed to minimize the risk of harmful genetic pollution.

The lesser significance of listed stands of hardwood species is explained by a lower demand for seeds for plantations and by a desire to favour natural regeneration. The monitoring of genetic resources and their improvement has, historically, been a priority issue for softwood afforestation and reforestation programmes, aimed at increasing the available resource for qualities of wood of which there is a shortage in France. Collections of genetic units, concerning some 70 species, are well developed in France, thus playing an important part in the conservation of "ex situ" genetic resources; their scope, furthermore poses a problem regarding the on-going financing of their upkeep. For most non-ligneous forest plant species, a plan to protect genetic variability usually involves the establishment of reserves equipped with appropriate management specifications.

Because of the active involvement of INRA and CEMAGREF forest researchers, France has played a major role in the development of a genetic forest resource conservation policy affecting the whole European continent, by way of Resolution S2 of the Strasbourg Conference. The network of "in situ" genetic reserves, which has only been in operation since 1991, already includes beech and silver fir, i.e., species covering a little more than 13.5% of the forested area; in the near future it will include the black poplar, the sessile oak, the pedunculate oak, spruce and a few other species. An "ex situ" conservation programme is under way for the wild cherry and the elm, which represent 0.3% of the forested area. Certain ecotypes (or sub-species) need greater protection, especially when endangered by a risk of genetic pollution; this is the case with the Pyrenean pine, whose area of plantation in France is additionally threatened by forest fires. Knowledge about infra-specific variability is still incomplete, and currently represents an obstacle for the assessment of the phenomenon of genetic pollution.

4.10 Natural regeneration and man-made regeneration in regular high forest

	State-owned forests (ha)	Forests owned by local authorities (ha)	Private forests (ha)	total (ha)
average annual areas				
natural regeneration	4 750	4 850	7 200	16 800
rman-made regeneration	4 050	4 650	22 700	31 400
extension of forested area	0	0	12 300	12 300
total	**8 800**	**9 500**	**42 200**	**60 500**
proportion in all regenerations and plantations forming extensions of forested areas				
	27,8 %	51,9 %	20,3 %	100 %
proportion of areas treated as high forest for more than 80 years				
	52 %	48 %	-	100%

(Source: areas annually put to regeneration, apart from poplar plantations, estimated for the average of the last 10 years based on IFN data for the 3 ownership categories; the breakdown between natural regeneration and man-made regeneration is made for public forests on a pro rata basis regarding ONF works programmes for the period 1981-1994; the area of man-made regenerations in private forests is estimated, after deducting seedlings bought by the ONF and exports, on the basis of the number of seedlings planted in 1988-1989 in private forests, and on an average plantation density of 2,200 seedlings/ha for hardwoods and 1,320 seedlings/ha for conifers, and a replanting rate of 10%; the forest extension area results from statistics of the Ministry of Agriculture and Fisheries (FFN-average 1982-1992 and State budget-average 1988-1992); the area of natural regenerations in private forests is estimated by difference, without taking into account seedlings sometimes required to complete the natural regeneration, thus resulting in a probably slight underestimation in area of natural regenerations in private forests; the area of plantation subsidized by the FFN and the State budget to improve impoverished high forests is estimated jointly, by experts, by the Ministry of Agriculture and Fisheries and the Ministry of the Environment, at 7,000 ha out of the 35,000 ha annually subsidized on average during the period in question, the rest of the area being made up of coppices or coppice/high forest mixtures, old farmland and wildlands).

Commentary: about one-third of the forested areas annually put to regeneration (outside forested area extension) corresponds to natural regeneration (strict or assisted). The area of about 16,800 hectares concerned by natural regeneration must nevertheless not be added to the current 6 million hectares of high forest. In effect, the high forest

area has considerably grown over the past 50 years and the new high forests have not yet reached the age of regeneration.
It should rather be associated with the 3.5 million hectares treated as high forest for the past 80 years and more. By not taking into account the 28,000 hectares of afforestation and reforestation subsidized each year by the FFN and the State budget, which do not involve the improved production of a formerly existing degraded high forest (and thus do not replace an at times possible natural regeneration), high forests of an age fit for regeneration currently account for 16,800 ha of natural regeneration and 15,700 ha of plantation.

So natural regeneration probably represents a little more than half the regeneration programmes for high forests in France in a situation suited to regeneration. This suggests an average life (which foresters call rotation) of about 110 years for high forests.

Furthermore, this estimate of natural regeneration does not include irregular and cleared high forests where regeneration is natural and permanent, any more than areas of coppices and coppice/high forest mixtures, where regeneration does not involve plantation. These stands are better represented in private forests.

4.11 Principle operations artificializing the forest environment

	State-owned forests	Forests owned by local authorities	Private forests	total
		average annual areas		
drainage or ploughing operations	6 685ha	4 595ha	about 20 000 ha	**about 31 000 ha**
fertilization or additives	670ha	760ha	about 10 000 ha	**about 11 500 ha**
use of herbicides or phytocides	8 530ha	2 790ha	about 16 000 ha	**about 27 000 ha**
use of insecticides or fungicides	5 210ha	2 280ha	about 58 000 ha (1)	**about 65 000 ha**

(Source: ONF for State-owned forests (average for the years 1985 - 1993) and forests owned by local authorities (average for the years 1989 - 1993); DRAF survey in 1994 for private forests; (1) out of this total about one-third corresponds to palliative treatments aimed at reducing the risk of stinging among local people from the pine processionary caterpillar, and not at protecting the forest).

Commentary: ploughing before planting accounts for most of the ground operations carried out in French forests. In some cases, however, ground operations may precede a natural regeneration (for example hoeing).

Use of fertilization and additives is not widespread, except in the forests of the Landes. The use of herbicides and phytocides has grown over recent years, because of the rising cost of labour for manual clearing, and because of the drawbacks of certain heavy machinery used for mechanical upkeep. Recourse to these products involves some 27,000 hectares per annum; these operations are only repeated in the same place 2 or 3 times a century.

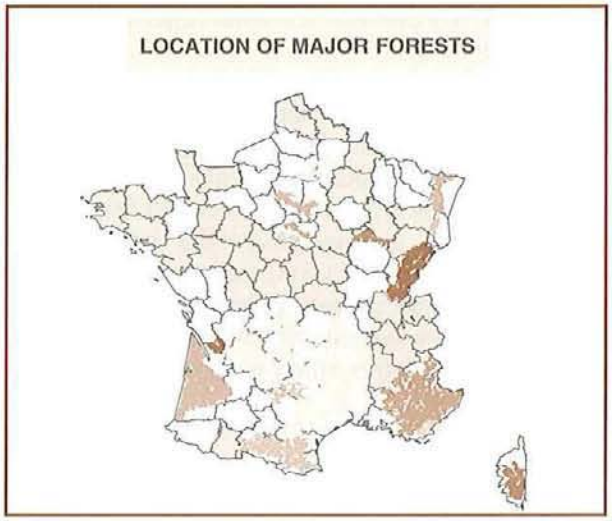
By a rational use of herbicides and phytocides for controlling brambles and especially grasses, they may sometimes permit recourse to a natural regeneration, which, without them, would be prohibitively expensive. As a result of the recommendations of a task force made up of scientists, forestry professionals and France Nature Environment, in 1993, the authorities defined a deontological framework for the use of chemical products in forests which also applies to insecticides and fungicides.

Almost all the areas concerned by insecticide (organic or chemical) and fungicide treatments correspond in fact to a fight against destructive insects. Two-thirds of the areas treated involve the processionary caterpillar in the Southwest and the Southeast; in these regions, half the treatments are not aimed at forest protection, but at preventing people from being stung by these caterpillars. The remainder of the areas are treated against the pine weevil at planting (localized application) and certain hardwood leaf-eating species (members of the Bombycidae (silkworm group), Geometridae and green leaf-roller...).

As with herbicides and phytocides, the products used have received the approval of the authorities, after examination of an ecotoxicological dossier and consultation with different scientific committees.

Under no circumstances must these areas be combined, because operations of ploughing, fertilization, chemical clearance and protection against certain biotic agents may involve the same areas of young plantations or natural regenerations. Furthermore, to date the use of genetically homogeneous seedlings (clones) in a plantation is essentially limited to the poplar and to a few experimental plantations with a small number of other species, intensively farmed.

4.12 Division of the forested area into basic units



class of area	number of units average	number of types	average area (ha)	average perimeter (km)	index of compact-ness of units
from 4 to 100 ha	32 484	1,18	20,54	2,864	0,56
from 100 to 1 000 ha	3 770	2,85	278,22	26,044	0,23
from 1 000 to 5 000 ha	407	5,12	2 064,51	156,504	0,10
from 5 000 to 10 000 ha	58	6,43	6 6696,59	446,702	0,06
from 10 000 to 50 000 ha	39	7,51	20 581,08	1 324,398	0,04
from 50 000 to 100 000 ha	6	9,00	66 742,91	5 090,455	0,02
more than 100 000 ha	10	9,50	700 237,04	45 069,654	0,01

(Source: IFN, 1994, for forests and other forested areas in 59 *départements* covering a total of 11.2 million ha of forests and other forested areas, based on its Geographical Information System (GIS); the limitations peculiar to the GIS mean that there is not necessarily a similarity between inventoried areas and mapped areas; perimeters are also dependent on the mapping, and then the digitilization method; a break of 200 m. does not interrupt the continuity of the forest unit and the movements of many forest species. National forest types are the high forest of just hardwoods, the high forest of just conifers, the mixed high forest, the mixture of high forest with hardwoods predominant and coppices, the mixture of high forests with conifers predominant and coppices, the simple coppice, parcelled forestations, random forestations, wooded garrigue and maquis, young reforestations and poplar plantations; the compactness index for forest units is calculated by relating the perimeter of a circle (a geometric figure with maximum compactness) with the same surface as the average of the units in question, to the average perimeter; units of less than 4 ha are not mapped).

Commentary: the division of the forested area is an important factor for evaluating the capacity of forested ranges to accommodate certain animals with very specific behavioural requirements. Some animal species, like the red deer and the bear, need plenty of peace and quiet and a refuge area deep within large forests, while other species, like the roe-deer and certain birds of prey seek out varied terrain and, at least in certain periods of their life cycle, favour clearings and small forested areas. Mutatis mutandis, this approach is also true for plant species. It has been estimated that a break of 200 m. would not interrupt the continuity of a forest unit. This option, which is open to criticism like any other option, tries to embrace the changeable behaviour of a certain number of animals and their movement between forest units linked by forest or sub-forest corridors. It does not help to directly identify very compact large forested ranges, offering major zones removed from forest perimeters and interference resulting from human activities other than silviculture.

The current situation reflects the land structure and a legacy of the history of the last few centuries. It is not within man's power to bring about swift changes in this situation, whatever his persuasions may be about the desirable configuration of forest units, to best fulfill the forest's economic, ecological and social functions. Where sustainable management is concerned, it is nevertheless interesting to monitor the development of the way French forests have thus been structured. In many cases, increasing parcelling may be accompanied by additional problems for the survival of viable populations of certain endangered and vulnerable animal and plant species, as well as for the organization of timber production. In other cases, the openning up of clearings of varying sizes in very compact units might be advantageous to certain species.

The findings from 59 *départements* help, in particular, to shed light on a large number of forest units. The development of compactness indices of these units, based on area categories, might suggest that apart from certain specific zones, the basic grid of French forests is formed by areas of less than 1,000 ha, connected by numerous and not particularly sizeable corridors, thus permitting the formation of much larger units. This hypothesis requires confirmation. Nevertheless, this impression of extreme division (which is an undeniable reality) must be qualified by the fact that the 32,500 forest units of less than 100 ha represent less than 6% of the forested area. Conversely, it is possible to identify 16 forest units of more than 50,000 ha, lending a marked structure to the forested areas of the 59 *départements*: the Massif Central (2,812,000 ha), formed mainly by an aggregate of 8 sub-units with different features, interconnected by fairly narrow forest and sub-forest corridors; the Southern Alps and the Provence Pre-Alps (1,338,000 ha); the Landes (1,070,000 ha); the Pyrenees and the Corbières (573,000 ha); the Jura (361,000 ha); central Corsica (259,000 ha); the Northern Vosges (226,000 ha); the Picardy ranges (130,000 ha); the green belt south of Paris (121,000 ha); the plateaus of Burgundy (111,000 ha); the Massif des Maures (86,000 ha); the forest of

Orleans (73,000 ha); the valleys of the Rouergue (72,000 ha); the Double in Saintonge region (60,000 ha); the Southern Vosges (56,000 ha); and Sologne (53,000 ha). Bearing in mind the *départements* not yet taken into account in the IFN's Geographical Information System, some of these large forest units are in reality even larger. Furthermore, it is quite possible that subsequent surveys might reveal continuities between some of these major units, like for example between the Vosges and the Jura.

4.13 Division of the forested area into large units of homogeneous forest vegetation

forests

class of area	number of units	total area (in ha)	average area (in ha)
from 4 to 10 ha	59 348	397 913	6,71
from 10 to 25 ha	59 532	953 819	16,02
from 25 to 50 ha	30 129	1 056 519	35,07
from 50 to 100 ha	16 856	1 168 738	69,34
from 100 to 500 ha	12 851	2 531 140	196,96
more than 500 ha	2 091	3 545 264	1 695,49
all areas	180 807	9 653 392	53,39

other wooded areas

class of area	number of units	total area (in ha)	average area (in ha)
from 4 to 10 ha	3 015	21 960	7,28
from 10 to 25 ha	6 842	113 815	16,64
from 25 to 50 ha	4 456	157 005	35,24
from 50 to 100 ha	2 781	193 032	69,41
from 100 to 500 ha	2 182	431 607	197,80
more than 500 ha	360	579 660	1 610,17
all areas	19 636	1 497 079	76,24

(Source: IFN, 1994, for forests and other forested areas in 59 *départements* covering a total of 11.2 million ha of forests and other forested areas, based on its Geographical Information System (GIS); the limitations peculiar to the GIS mean that there is not necessarily a similarity between inventoried areas and mapped areas, and the units are determined by photo-interpretation based on national forest types: the high forest of just hardwoods, the high forest of just conifers, the mixed high forest, the mixture of high forest with hardwoods predominant and coppices, the mixture of high forests with conifers predominant and coppices, the simple coppice, parcelled forestations, random forestations, wooded garrigue and maquis, newly reforested areas and poplar plantations; units of less than 4 ha are not mapped).

Commentary: the units determined by photo-interpretation (from 4 ha in a single plot) only refer to national types of forest vegetation, and not to the more numerous types which are identified in each *départemental* inventory. More than one-third of the total surface of the forests of the 59 *départements* consists of units of more than 500 ha (high forests of just hardwoods, high forests of just conifers, mixed high forests, mixture of high forest with hardwoods predominant and coppices, etc...), offering a habitat of a certain size for species with exacting territorial behavioural requirements. The parcelling of land is thus not systematically synonymous with ecological parcelling. This is also true for other forested areas which are sometimes of very great interest for biodiversity. Two-thirds of the forest units cover less than 25 ha, which guarantees a certain habitat diversity. The similarity of this distribution of units with the division of the land into large units gives some idea of the way French forests are spacially structured.

4.14 Forest peripheries

	size of forest				
	less than 25 ha	from 25 to 50 ha	from 50 to 100 ha	from 100 to 500 ha	more than 500 ha
interface with water	1,0%	0,9%	0,8 %	0,9%	0,7%
interface with wetlands	0,1%	0,1%	0,2%	0,1%	0,3%
interface with semi-natural environments	14,6%	14,9 %	17,6%	22,1%	32,2%
interface with farmlands	81,3%	81,7%	79,2%	74,7%	63,8%
interface with man-made environments	2,9%	2,4%	2,2%	2,2%	3,0%

(Source: IFEN-Corine, 1994, data drawn up from the cover corrected by Corine-Landcover Sud (Aquitaine, Midi-Pyrenees, Provence-Alpes-Côte d'Azur and Languedoc-Roussillon; the nature of the interface is expressed in % of the total linear structure for a given type of range; aquatic areas cover continental and maritime waters, while wetlands describe marshlands, peat bogs, salt-marshes, maritime marshes and intertidal zones; semi-natural environments correspond both to environments with shrubby and/or grassy vegetation (grassy areas, natural rangelands, heathland, scrub, ...) and to open areas (beaches, dunes, bare rock, glaciers); farmland includes arable land, productive rangelands, permanent crops and heterogeneous zones of agro-forestry type, and artificialized areas correspond to urban zones, industrial areas, mines and urban green open spaces).

Commentary: forest perimeters are often environments housing a wealth of species, offering a wide range of habitats in small areas. The two tables above have already shown the quantitative importance of these interfaces between forest units with different aspects, as well as between the forest and other types of land-use. But some of the interest of these marginal areas is closely linked with the nature of the environment with which the forest is in contact. It is easy to understand that the ecological interest of a marginal area is not the same if it involves contact between a forest and an alpine meadow, or between a forest and a residential estate. Based on a sub-set of the 59 *départements* considered in the two tables above, the IFEN has specified the nature of these interfaces

between the forest and other types of land-use. As is also the case for the IFN's Geographical Information Systems, the IFEN system still only covers part of the territory, thus not giving an overall view of the issue.
The above table, corresponding to 24 *départements*, underscores certain trends that are specially visible in the region in question. The smaller the areas, the more their interface with farming increases and the more their interface with semi-natural environments decreases.

Likewise, if large ranges of more than 500 ha are excepted, the interface with artificialized environments increases with the fragmentation of the forested area. The size of forest ranges thus seems to reveal and describe with accuracy a type of landscape association.

5. PROTECTIVE FUNCTIONS

5.1 Soil conditions

A soil inventory over a systematic 16 km x 16 km/ 10 mi. x 10 mi. grid was drawn up for all the forested area of the EU countries in 1993 and 1994. In particular, it includes a description of soil structures, as well as of the organic matter which plays an important part in the way soil functions. The findings are being analyzed and will not be available until late 1995.

5.2 Forest management prioritizing physical protection (soil and water)

	State-owned forests (ha)	public non-State-owned forests (ha)	total public forests (ha)
primary physical protection series	128 020	215 142	343 162
secondary physical protection series	112 723	401 269	513 992
total	**240 743**	**616 411**	**857 154**
including areas effectively playing a highly protective role	192 000	?	?

(Source: ONF figures at 01/01/94 for public forests; the estimate of areas with an effective and marked protective role come from a specific survey).

Commentary: about 350,000 hectares/865,000 acres of public forests are managed with a priority for protecting the physical environment. The policy for rehabilitating mountain areas, conducted by the State since 1860, has caused it to acquire the most degraded areas which it has reforested and developed to assume a protective role. These areas form the major part (190,000 ha/470,000 acres) of the 240,743 ha/594,635 acres of the State-owned protection series. The area of private land effectively forested within the perimeters of mountain area rehabilitation is very small. The particularly active phenomena that these State-owned series of mountain area rehabilitation affect are landslides and rock falls for 21% of the areas, avalanches for 14% of the areas and gullying for 65% of the areas. The public forest physical protection series also ensures the vital regulation of water systems.

Furthermore, with the methodological back-up of scientific advisors, the Office National des Forêts has programmes for almost 400 km/250 mi. of coastal dunes characterized by on-going marine and wind dynamics. The constant readaptation of the vegetation to morphological changes creates a fragile and unstable environment. Bearing in mind these features and the heavy tourism in these environments, management targets give priority to protection and public access. Major works are limited to the upkeep of the reshaping of the Atlantic dunes, the aim being to prevent them breaking up, which would be a national disaster.

5.3 Forest management taking into account the specific restrictions for water quality protection

protection perimeter of drinking water catchment and sources of marketed mineral water	about 800 000 ha

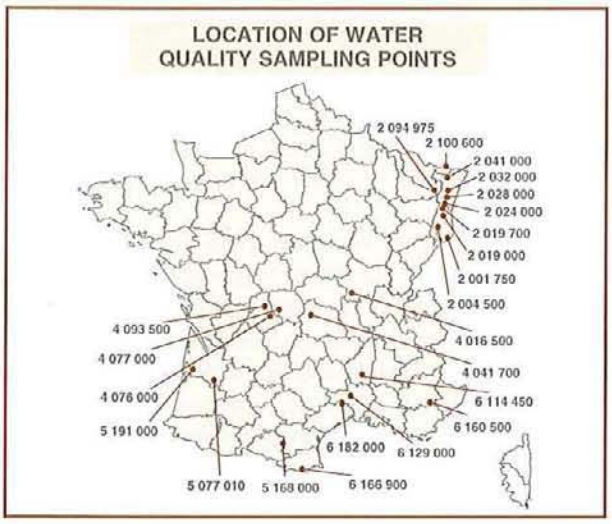
(Source: DRAF and DDAF estimate, 1994, with extrapolation of the extended protection perimeters of drinking water catchments on a pro rata basis with forested areas, for the missing regions (apart from Rhône-Alpes which represents an exception because of the extent of its mineral water source protection perimeters)).

Commentary: about 200,000 hectares/500,000 acres of forest are included in the protection perimeters of drinking water catchments, clearly delimited in the landscape and with specific entitlements. Furthermore, almost 600,000 hectares/1,500,000 acres of forest are situated within the protection perimeter of mineral water sources, and also play a certain role in water quality protection, without forest management here being subject to specific restrictions.

5.4 Water quality in forest catchment basins

see map on next page

Commentary: water quality at the outlet of large forest catchment basins is a parameter which merits considerable attention, bearing in mind the forest's protective role for water resources, in terms of quality and quantity alike. In Europe, nevertheless, major



catchment basins are very rare, where the forest covers most of the land and where silvicultural operations may be entirely responsible for the possible degradation of water quality. It is often extremely difficult to identify clearly the sources of dispersed pollution. The table shows certain quality parameters for all the sampling points situated in fairly densely forested catchment basins, where the IFN was able to calculate the afforestation rate. These figures only present an initial, extremely imperfect approach. In effect, almost all the initial sampling points have been set up by Water Boards near major sources of pollution, the prime objective being in fact to assess the pollution level of French water courses, and not at the outlet of large forested ranges where sources of pollution are a priori infrequent. So the data for 1981 are rare. Moreover, in order to be as independent as possible from annual effects, it would have been necessary to be able to compare the data over 2 three-year periods, set 10 years apart, for example 1981-83 with 1991-93, which has not been possible. Certain preliminary comments may nevertheless be made.

By using the reference of the grid of general quality description of the Ministry of the Environment (circular of November, 1971), it appears that the pH is never a problem. The situation is excellent where dissolved oxygen is concerned: all the points are, on average, in the highest quality category (1A), six points being relegated to the second quality category (1B), and one to the third (2), when their worst measurement is considered. Category 1B corresponds to good quality water; it can thus be said, for dissolved oxygen, that all the water is of good or very good quality. Degradation really starts as from category 2. For suspended matter, all the points are also in the highest category 1A on average, seven of them in category 2, one in class 2, one in class 3 and one unclassified, for their worst measurement. For electrical conductivity, all the points, except one, are also in the highest quality category 1A on average, three of them being relegated to 1B for their worst measurement. For nitrates, five points are in category 1A, 22 in category 1B and one in category 2 on average; by contrast, the worst values have ten points classified in 2 and one point in 3. It is worth noting that this worrying situation for nitrates concerns the northern half of France. For the organic oxygen, requirement, the situation is likewise less favourable than for the first four parameters: on average, only 13 points are classified in 1A, 12 in 1B, two in 2 and one in 3; with their worst measurement, only seven points remain in 1A and ten in 1B, while seven points are in category 2 and four in category 3. For the catchment basins taken into account, general water quality is thus good or even excellent for most parameters. A potential problem seems to emerge from nitrates and the organic oxygen requirement, in other words, parameters for which the link with silvicultural management is not straightforward.

Note: a specific inventory was drawn up in the Vosges in 1992, to pinpoint and map the critical loads of atmospheric pollutants; what emerges from this survey made by J.P. Party, A. Probst and E. Dambrine, is that the Vosges have about 7.5% of catchment basins with acidified surface water (pH lower than 5.6) and about 12% with potential risk of acidification (pH between 5.6 and 6.2). This acidification involves 15% of the catchment basins in the sandstone Vosges, 24% of the catchment basins inventoried on the Lorraine side of the Vosges shelf, and 2% of the catchment basins inventoried on the Alsace side of the Vosges shelf.

QUALITY OF WATER IN CERTAIN LARGE CATCHMENT BASINS

point of sampling	area of catchment basin (ha)	rate of afforest-ation %	year	pH			dissolved oxygen (in mg/l)			material in suspension (in mg/l)			conductivity at 20°C (µS/cm)			nitrates (mg/l)			organic oxygen requirement (DBO5) (mg/l)		
2001750	3 768	51	1991	7,8	8,0	8,4	8,0	10,4	13,1	1,0	13,3	37,0	477,0	530,0	616,0	8,2	12,6	23,0	2,0	3,3	6,0
2001500	9 047	73	1991	6,7	7,3	7,7	6,4	9,9	12,0	2,0	9,2	60,0	67,0	82,0	155,0	2,8	4,6	12,0	3,0	5,6	8,4
2019000	20 589	62	1991	6,7	7,1	8,1	8,0	10,6	12,9	1,0	5,3	13,0	71,0	121,0	177,0	2,8	5,5	7,2	1,6	3,9	5,8
2019700	11 840	52	1991	6,6	7,2	8,0	8,2	10,6	12,7	1,0	6,4	18,0	77,0	94,0	110,0	2,0	4,6	6,5	1,5	3,8	5,0
2024000	12 429	73	1981	7,0	7,2	7,6	6,9	9,8	12,0	3,0	19,3	136,0	128,0	202,0	320,0	5,1	8,4	11,5	2,0	4,8	7,0
			1991	7,0	7,3	7,8	6,7	9,1	12,9	2,0	9,3	45,0	156,0	355,0	641,0	6,0	8,9	14,0	0,4	4,0	11,3
2028000	4 164	85	1991	7,0	7,3	7,8	7,8	10,3	13,7	0,0	5,4	19,0	80,0	111,0	139,0	5,0	6,5	9,0	1,8	3,9	7,5
2031400			1991	6,9	7,3	7,6	6,7	10,5	13,4	1,0	6,9	42,0	90,0	119,0	140,0	4,0	5,2	8,0	1,1	4,1	6,5
2032000	43 292	71	1981	7,1	7,3	7,5	7,8	10,9	13,7	4,0	23,0	168,0	98,0	121,0	155,0	6,7	8,7	13,0	2,0	5,0	20,0
			1991	7,0	7,3	7,6	5,1	10,5	14,1	1,0	7,7	44,0	100,0	154,0	203,0	6,0	7,7	11,0	5,1	10,5	14,1
2041000	9 324	76	1991	7,1	7,3	7,5	7,9	10,5	14,6	3,0	6,3	14,0	102,0	126,0	294,0	2,0	4,3	4,4	1,2	2,3	3,8
2094975	3 990	93	1991	6,7	7,1	7,5	7,0	9,8	12,2	0,0	2,0	4,0	50,0	70,0	160,0	2,0	4,3	6,5	2,0	2,0	2,0
2100600	9 562	62	1991	6,3	7,1	7,4	6,7	8,7	11,0	2,0	10,0	20,0	100,0	113,0	125,0	5,0	8,4	13,3	2,0	2,9	6,0
4015300			1991	7,3	7,5	7,7	8,3	10,8	13,3	3,0	9,3	15,0	114,0	150,0	165,0	4,8	8,2	12,4	3,3	3,9	4,9
4016500	59 195	17	1991	7,5	7,7	7,8	8,7	10,8	13,5	6,0	15,3	23,0	150,0	204,0	272,0	2,9	3,9	5,1	2,5	3,0	3,4
4041700	47 548	19	1991	7,7	7,9	8,2	9,4	11,5	14,2	1,0	7,0	15,0	80,0	101,0	127,0	3,0	4,6	6,3	2,9	3,9	4,7
4076000	114 738	41	1991	6,8	7,1	7,4	7,6	9,3	11,4	4,0	12,5	28,0	54,0	67,0	98,0	3,1	4,2	5,0	2,5	3,67	4,7
4077000	54 217	45	1991	6,6	7,0	7,4	9,1	10,6	12,0	7,0	10,2	18,0	57,0	70,0	88,0	1,4	3,4	5,5	1,8	2,5	3,3
4093500	62 201	24	1991	7,0	7,5	8,1	8,1	9,8	11,7	10,0	17,6	30,0	141,0	213,0	298,0	5,2	7,6	8,4	1,6	3,2	4,4
5077010	77 691	76	1991	7,2	7,4	7,5	8,8	10,4	12,0	3,0	7,0	14,0	175,0	188,0	230,0	2,8	6,0	15,7	0,4	1,9	3,0
5168000			1991	7,7	7,9	8,4	7,9	10,4	12,1	1,0	8,0	20,0	145,0	195,0	265,0	2,6	6,7	15,9	2,0	6,6	21,0
5191000	203 993	72	1981	6,0	6,6	7,2	8,6	9,8	11,5	1,0	4,2	10,0	110,0	122,0	130,0	1,5	3,2	6,3	0,2	0,9	1,7
			1991	5,9	6,2	7,0	8,6	9,6	10,8	2,0	5,3	9,0	135,0	148,0	175,0	1,9	4,6	10,1	0,7	1,3	3,0
6114450	62 159	41	1991	7,8	8,1	8,5	10,4	11,4	14,0	5,0	5,8	8,0	130,0	219,0	325,0	1,3	1,9	2,7	1,0	1,8	2,6
6129000	54 962	63	1991	7,4	7,7	8,0	4,7	8,2	11,0	1,0	3,5	8,0	120,0	233,0	320,0	0,7	1,4	2,6	1,3	2,1	3,2
6160500	76 492	41	1991	7,3	7,8	8,2	9,7	10,4	11,2	3,0	4,8	9,0	302,0	398,0	570,0	0,5	0,7	0,8	1,7	2,0	2,6
6166900	1 808	41	1991	7,5	7,8	8,1	8,9	10,9	12,5	1,0	6,5	11,0	34,0	42,0	50,0	0,6	1,2	2,2	1,6	2,1	3,0
6182000	87 613	43	1981	7,9	8,1	8,5	9,6	11,2	12,7	1,0	3,1	5,0	240,0	269,0	315,0	0,0	1,7	3,3	1,0	2,6	3,9

minimum measured | average | maximum measured

*(Source : Ministry of the Environment and the six Water Boards, for sampling points situated in densely forested catchment basins; the selection of sampling points being limited by the capacity of the IFN to calculate afforestation rates based on its Geographical Information System and the digitization state of forest cover by *département*)

6. OTHER SOCIO-ECONOMIC FUNCTIONS

6.1 Public access capacity

average forest area per inhabitant (for metropolitan France)	0,25 ha

(Source: Teruti 1991 and RGP 1990).

Commentary: with 0.25 ha per inhabitant France is about average for Europe. If the average for the Nordic countries is 3.39 ha per inhabitant, and that for Eastern Europe 0.26 ha per inhabitant, that for the 12 EU member States (before the admission of Austria, Finland and Sweden) is 0.21 ha.

6.2 Popular forested areas around large cities

major conurbations	population	forested area accessible within a radius of 100 km/60 miles in ha(1)	per inhabitant
Paris	9 309 457	331 719	0,036 ha
Lyon	1 259 964	294 258	0,234 ha
Marseille	1 227 128	155 707	0,127 ha
Lille-Roubaix Tourcoing	957 506	41 345	0,043 ha
Nice	850 737	164 978	0,194 ha
Bordeaux	695 118	705 281	1,015 ha
Toulouse	649 305	169 232	0,261 ha
Lens-Béthune	584 973	46 214	0,079 ha
Saint-Etienne	512 325	319 283	0,623 ha
Nantes	495 230	56 542	0,114 ha
Toulon	436 962	160 476	0,367 ha
Grenoble	404 151	263 256	0,651 ha
Strasbourg	387 544	309 410	0,798 ha
Rouen	379 382	192 423	0,507 ha
Valenciennes	340 934	79 428	0,233 ha
Nancy	328 846	550 015	1,673 ha
Tours	281 728	235 372	0,839 ha
Clermont-Ferrand	254 222	267 073	1,051 ha
Le Havre	253 461	106 618	0,421 ha
Montpellier	247 759	83 046	0,335 ha
Rennes	244 167	86 829	0,356 ha
Orléans	242 715	323 037	1,331 ha
Dijon	229 954	493 416	2,146 ha
Mulhouse	223 352	413 520	1,851 ha
Angers	207 893	133 435	0,642 ha
Reims	206 159	288 367	1,399 ha
total	**18 413 605**	**5 754 487**	**0,313 ha**

(1) not counting bordering countries

(Source: IFEN, based on the 1990 RGP (urban areas belonging to urban unit categories in INSEE classes above 6) and the 1988 Communal Inventory, limited to areas recorded as tourist attractions (heading K) at the time of the Communal Inventory; the total population is 56,615,000 inhabitants).

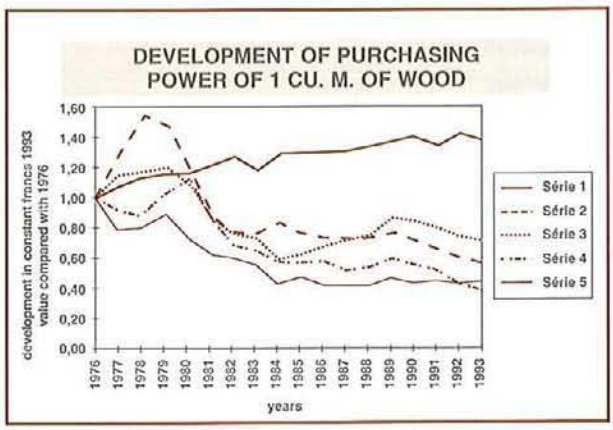
Commentary: each citizen in a conurbation of more than 200,000 inhabitants could theoretically set him- or herself on 0.313 hectares of forest within a radius of 100 km / 60 miles. This is a relatively high figure, explained by the scale of large urban areas in eastern France, which is more forested. It is worth noting that this ratio does not take into account accessible forested areas within a radius of 100 km, but adjudged not very attractive or popular for recreation, according to the 1988 Communal Survey. The worst situation affects the Parisian conurbation (0.036 ha/inhabitant) and Lille-Roubaix-Tourcoing (0.043 ha/inhabitant), the best being Dijon (2.15 ha/inhabitant) and Nancy (1.673 ha/inhabitant). The four largest conurbations are below the national average. France does not have statistics for the public use of forests, except for Fontainebleau forest which attracts almost 10 million visitors per annum.

zones specially earmarked for visitors in State-owned forests	18 088 ha
other State-owned forests with high tourist pressure	1 098 000 ha
zones specially earmarked for visitors in non-State-owned public forests	22 052 ha
other non-State-owned forests with high tourist pressure	600 000 ha
private forests marked by high tourist pressure	1 368 000 ha
total	**3 106 000 ha**
% of metropolitan forested area	21,8 %

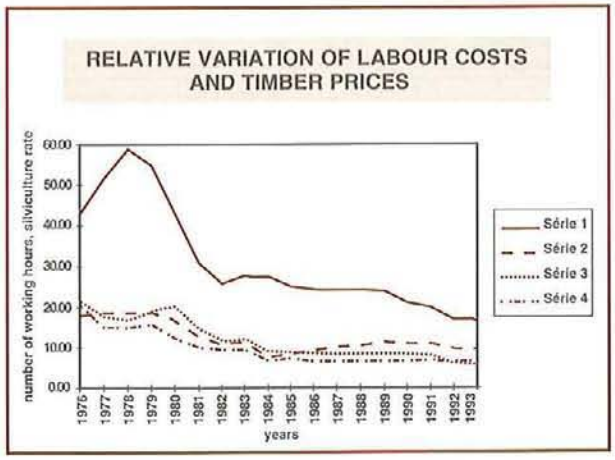
(Source: ONF for public forests (1994 situation), SCEES/ESSES 1976-1983 for private forests).

Commentary: Public use is an important factor for management in more than one-fifth of French forests. Accommodating the public is the chief concern of the forest manager on 40,000 hectares/ 100.000 acres specially equipped to this effect in public forests, essentially near large towns and cities and tourist resorts. Several points of view need considering. Private owners who do not close off their forest and tolerate public access to their property are offering society a free service, while putting up with damage caused by certain thoughtless tourists. In some forests around urban areas, over-use of certain zones is already posing ecological problems that are not easily solved.

6.7 Comparative development of timber prices and average salaries in silviculture



Source: ONF, hourly rates of forest workers for the "silviculture" profession (series 1); series of average ONF prices for oak with 50 plus diameter (series 2), beech of 40 plus diameter (series 3), Silver fir of 25 plus diameter (series 4); series of average Poitou Charente CRPF prices for poplar with 1-1.5 cu. m. volume (series 5); in constant francs (ONF current value schedule).



Source: ONF, hourly rates of forest workers for the "silviculture" profession; series of average ONF prices for oak with 50 plus diameter (series 1), beech of 40 plus diameter (series 2), Silver fir of 25 plus diameter (series 3); series of average Poitou Charente CRPF prices for poplar with 1-1.5 cu. m. volume (series 4); in constant francs (ONF current value schedule).

Commentary: without overlooking the productivity gains already made and possibly forthcoming, the most evident and immediate danger for the sustainable management of French forests lies in the comparative fluctuations in timber prices and labour costs vital for good quality silviculture.

This development shows up a gap which can no longer be made up for by productivity gains. The problem is heightened by the fact that small diameter standing timber prices of certain noble species, such as oak, have developed less unfavourably than prices for average and large diameter trees. This situation seems to run counter to certain wishes directed at foresters, aimed at increasing standing stocks and promoting a more punctilious form of management.

It must not be taken for granted that a change in silvicultural options would necessarily cause the problem to go away, because a more detailed, tree-by-tree management, based on models nowadays being recommended by certain parties, involves a greater use of skilled labour. Over and above the prospect of the forest being left to its own devices, more or less across the board, there cannot be any sustainable forest management without a sizeable market remunerating forest products and services.

At the present time, society is showing increasing interest in forests, but citizens do not seem prepared personally (outside of taxation mechanisms) to remunerate the forest manager to have access to the forest and its minor products—something which is accepted by other European and North American citizens. As of now, the timber harvest and its development by an efficient industry, stimulated by a major market, represent the most immediate challenge for sustainable French forest management.

7. INVENTORY DEFINITIONS AND METHODS

7.1 Definitions

7.1.1 Forests and small woods (clumps, groves): these include productive forests, protected forests and small forested or wooded areas, and meet the following conditions:

a) apparent cover of forest trees: at least 10% (or, when seedlings and young saplings are involved, at least 500 future shoots well distributed per hectare);

b) main function: timber production (current or potential) for productive forests and small forested areas, conservation and recreation for protected forests;

c) area and average crown width: at least 5 ares and 15 metres, except for productive forests, where the figures are 4 hectares and 25 metres.

7.1.2 Open poplar plantations:
these are man-made stands, of at least 5 ares with average crown width of at least 15 metres, made up solely or mainly of cultivated poplar clones, planted at regular intervals with a density of at least 100 saplings/ha (and a live tree density of at least 50/ha).

7.1.3 Heathland and wildlands:
this category includes heathland, wildlands, and empty, uncultivated land which is not regularly maintained for grazing. These areas may have scattered forest trees if their cover is less than 10% (or when seedlings and young saplings are involved, 500/ha).

7.1.4 Wooded hedges:
these are lines of forest tree species, with at least 3 recordable trees with an average density of at least 1 tree every 10 metres.

7.1.5 Scattered trees:
these are forest trees which are either isolated or scattered, or grouped in thickets with an area of less than 5 ares.

7.2 Inventory methods

7.2.1 The old series of figures from the SCEES/ Teruti survey is based on the annual observation of 554,708 points situated throughout metropolitan France. The nomenclature of the land-use categories amounts to 99 headings. The area of forests (including poplar plantations) corresponds to the sum of headings 18-21, and 24-25 (more than 10% of tree cover and a unit area of more than 0.5 ha). The area of other forested or wooded areas corresponds to heathland, maquis and garrigue (headings 70-71). The area of thickets and clumps corresponds to headings 22 and 26. The area of hedges corresponds to heading 72. The forest areas in the old series are very definitely underestimated, because the new sampling of 555,845 points, and the new set of aerial photographs introduced since 1991 show a much sharper progression of the forested area than that shown by the old sampling.

7.2.2 The National Forest Inventory (IFN) operates by interpreting aerial photographs, then by drawing by lots sampling points in the field based on the photo-interpretation procedure. On the ground, IFN teams measure a series of dendrometric parameters, and prepare a description of the environment based on plant and soil references. Each *département* is thus inventoried on average every 10 years. The IFN alone makes it possible to obtain reliable and accurate data on the specific composition of stands, the structure and types, accessibility, cover density, distribution of age and diameter classes, standing death rate, etc.. The national data correspond to the summary of the *départemental* data in the latest available inventory, which means that values measured in different years in the same inventory cycle, over ten years or so, are factored in. This is why the choice has been made to use the Teruti survey for the total forest areas. So it is quite normal that the breakdown of total forest areas by type, using perforce the IFN data, does not make it possible to find exactly the same values—and all the more so because the reference periods are not quite the same (1981-1991 for Teruti, 1984/1994 for the IFN).

8. LIST OF TREES OCCURRING IN FRENCH FORESTS

A tree is a ligneous plant with a single stem, bare at the base, thus consisting of a trunk and a crown, capable of attaining a height of more than 7 metres/ 23 feet in the adult state.

Note: this list has been drawn up with the help of Mr. Jean-Claude Rameau (ENGREF), based on two sources: the listings of the national Forest Inventory and the "French Forest Flora, an Illustrated Ecological Guide", published by Jean-Claude Rameau et al. It has been completed by the INRA and the AFOCEL. This choice means that no mention is made of a certain number of tropical species, usually present in small and somewhat experimental areas.

List of trees native to France occurring in forests

1.	*Abies alba*	Silver fir
2.	*Juniperus communis*	Common juniper
3.	*Juniperus oxycedrus*	Prickly juniper, cade
4.	*Juniperus thurifera*	Spanish juniper, savin
5.	*Larix decidua*	European larch
6.	*Picea abies*	Norway spruce
7.	*Pinus cembra*	Arolla pine
8.	*Pinus halepensis*	Aleppo pine
9.	*Pinus mugo*	Dwarf mountain pine
10.	*Pinus nigra laricio corsicana*	Corsican pine
11.	*Pinus nigra salzmannii*	Pyrenean pine
12.	*Pinus pinaster*	Maritime pine
13.	*Pinus pinea*	Stone or umbrella pine
14.	*Pinus sylvestris*	Scots pine
15.	*Pinus uncinata*	Mountain pine
16.	*Taxus baccata*	Yew
1.	*Acer campestre*	Field maple
2.	*Acer monspessulanum*	Montpellier maple
3.	*Acer opalus*	Italian maple
4.	*Acer platanoides*	Norway maple
5.	*Acer pseudoplatanus*	Sycamore
6.	*Alnus cordata*	Italian or Corsican alder
7.	*Alnus glutinosa*	Common alder
8.	*Alnus incana*	Grey alder
9.	*Betula pendula*	Silver birch
10.	*Betula pubescens*	Hairy birch
11.	*Carpinus betulus*	Hornbeam
12.	*Castanea sativa*	Sweet chestnut
13.	*Cornus mas*	Cornelian cherry
14.	*Crataegus monogyna*	Common hawthorn
15.	*Fagus sylvatica*	Beech
16.	*Fraxinus angustifolia*	Narrow-leaved ash
17.	*Fraxinus excelsior*	Common ash
18.	*Fraxinus ornus*	Manna or flowering ash
19.	*Ilex aquifolium*	Holly
20.	*Malus sylvestris*	Crab apple
21.	*Olea europaea*	Olive
22.	*Ostrya carpinifolia*	Hop-hornbeam
23.	*Populus alba*	White poplar, abele
24.	*Populus canescens*	Grey poplar
25.	*Populus nigra*	Black poplar
26.	*Populus tremula*	Aspen
27.	*Prunus avium*	Wild cherry, gean
28.	*Prunus padus*	Bird cherry
29.	*Pyrus amygdaliformis*	Almond-leaved pear
30.	*Pyrus pyraster*	Wild pear
31.	*Quercus cerris*	Turkey oak
32.	*Quercus ilex*	Holm oak
33.	*Quercus sessiliflora*	Sessile oak
34.	*Quercus pubescens*	Pubescent oak
35.	*Quercus pyrenaica*	Pyrenean oak
36.	*Quercus robur*	Common oak
37.	*Quercus suber*	Cork oak
38.	*Salix alba*	White willow
39.	*Salix caprea*	Sallow, goat willow
40.	*Salix daphnoides*	Violet willow
41.	*Salix fragilis*	Crack willow
42.	*Salix pentandra*	Bay-leaved willow
43.	*Salix viminalis*	Common osier
44.	*Sambucus nigra*	Elder
45.	*Sorbus aria*	Common whitebeam
46.	*Sorbus aucuparia*	Rowan, mountain ash
47.	*Sorbus domestica*	Service tree
48.	*Sorbus latifolia*	Service tree of Fontainebleau
49.	*Sorbus mougeoti*	Mougeot service tree
50.	*Sorbus torminalis*	Wild service tree
51.	*Tamarix gallica*	Tamarisk
52.	*Tilia argentea*	Silver-leaved lime
53.	*Tilia cordata*	Small-leaved lime
54.	*Tilia platyphyllos*	Broad-leaved lime
55.	*Ulmus glabra*	Wych elm
56.	*Ulmus laevis*	European white elm
57.	*Ulmus minor*	Lock elm

List of trees acclimatized to France and relatively well represented in forests

An acclimatized tree is a tree which 1) has been introduced enough decades ago to have shown unequivocally, over more than one generation, that it is well adpated to the environmental and climatic conditions that prevail in France, and which 2) can reproduce naturally in forests, without a helping hand from man.

1. *Abies nordmanniana*	Caucasian fir
2. *Cedrus atlantica*	Atlas cedar
3. *Cupressus sempervirens*	Italian or funeral cypress
4. *Pinus nigra nigra*	Austrian pine
5. *Pinus nigra laricio calabrica*	Calabrian pine
6. *Pseudotsuga menziesii*	Douglas fir

1. *Juglans regia*	Common walnut
2. *Quercus rubra*	Red oak
3. *Robinia pseudacacia*	False acacia

List of exotic trees sometimes found in forests

1. *Abies bornmulleriana*	Turkish fir
2. *Abies cephalonica*	Greek fir
3. *Abies cilicica*	Cilician fir
4. *Abies concolor*	Colorado fir
5. *Abies grandis*	Vancouver fir
6. *Abies numidica*	Numidian fir
7. *Abies pinsapo*	Spanish or hedgehog fir
8. *Abies procera*	Noble fir
9. *Acacia dealbata*	Silver wattle, mimosa
10. *Aesculus hippocastanum*	Horse-chestnut
11. *Calocedrus decurrens*	California incense cedar
12. *Cedrus brevifolia*	Cyprus cedar
13. *Cedrus deodara*	Deodar
14. *Cedrus libani*	Cedar of Lebanon
15. *Celtis australis*	Nettle tree
16. *Chamaecyparis lawsoniana*	Lawson cypress
17. *Cryptomeria japonica*	Japanese red cedar
18. *Cupressocyparis leylandii*	Leyland cypress
19. *Cupressus arizonica*	Arizona cypress
20. *Cupressus atlantica*	Atlas cypress
21. *Cupressus dupreziana*	Tassili cypress
22. *Cupressus macrocarpa*	Monterey cypress
23. *Larix eurolepis*	Dunkeld larch
24. *Larix kaempferi*	Japanese larch
25. *Metasequoia glyptostroboides*	*Dawn redwood*
26. *Picea sitchensis*	Sitka spruce
27. *Pinus brutia*	Calabrian pine
28. *Pinus contorta*	Lodgepole pine
29. *Pinus eldarica*	
30. *Pinus radiata*	Monterey pine
31. *Pinus rigida*	Northern pitch pine
32. *Pinus taeda*	Incense pine
33. *Pinus strobus*	Weymouth pine
34. *Sequoia sempervirens*	Redwood
35. *Sequoiadendron giganteum*	Big tree, wellingtonia, giant sequoia
36. *Taxodium distichum*	Swamp or bald cypress
37. *Thuja plicata*	Western red cedar
38. *Tsuga heterophylla*	Western hemlock

1. *Acer negundo*	Box-elder
2. *Ailanthus altissima*	Tree of heaven
3. *Eucalyptus sp.*	Eucalyptus
4. *Juglans nigra*	Black walnut
5. *Gleditschia triacanthos*	Honey-locust
6. *Laburnum anagyroïdes*	Laburnum
7. *Liquidambar styraciflua*	Liquidambar
8. *Liriodendron tulipifera*	Tulip tree
9. *Platanus hybrida*	London plane
10. *Platanus orientalis*	Oriental plane
11. *Populus deltoides*	Eastern cottonwood
12. *Populus trichocarpa*	Black cottonwood
13. *Prunus laurocerasus*	Cherry laurel
14. *Prunus lusitanica*	Portuguese laurel
15. *Prunus serotina*	Black cherry
16. *Quercus palustris*	Pin oak

9. LIST OF ENDANGERED AND VULNERABLE SPECIES

Endangered and vulnerable vascular forest plants:

Bellflower *(Campanula cervicaria)*
Lady's slipper *(Cypripedium calceolus)*
Shield fern *(Dryopteris cristata)*
Atlantic polystichum *(Dryopteris aemula)*
Narrow-lipped helleborine *(Epipactis leptochila)*
Spurred coralroot *(Epipogium aphyllum)*
Wood rush *(Luzula luzuloides subsp. tenacissima)*
Holly fern *(Polystichum braunii)*
Wintergreen *(Pyrola rotundifolia)*
Service tree of Fontainebleau *(Sorbus latifolia)*

Endangered forest mammals:

Brown bear *(Ursus arctos)*
Lynx *(Lynx lynx)*

Vulnerable forest mammals:

Great horseshoe bat *(Rhinolophus rhinolophus)*
Lesser horseshoe bat *(Rhinolophus hipposideros)*
Large mouse-eared bat *(Myotis myotis)*
Lesser mouse-eared bat *(Myotis blythi)*
Geoffrey's bat *(Myotis emarginatus)*
Bechstein's bat *(Myotis bechsteini)*
Noctule *(Nyctalus nyctalus)*
Lesser noctule *(Nyctalus leisleri)*
Western barbastelle *(Barbastella barbastellus)*

Rare and endangered forest birds:

Black stork *(Ciconia nigra)*
Booted eagle *(Hieraaetus pennatus)*
Pygmy owl *(Glaucidium passerinum)*
White-backed woodpecker *(Dendrocopos leucotos)*
Three-toed woodpecker *(Picoides tridactylus)*

Vulnerable forest birds:

Woodcock *(Scolopax rusticola)*
Redstart *(Phoenicuris phoenicurus)*
Corsican nuthatch *(Sitta whiteheadi)*

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This document based on deliberations regarding criteria and indicators for the sustainable management of northern and temperate forests made at the Montreal seminar (1993) and fleshed out at the Geneva Meeting (1994), which involved every country in the European continent. A criterion has to do with a major concern of forestry policy, and steers a series of decisions. An indicator helps to assess the tangible results of programmes undertaken. The publication of this list of criteria and indicators for sustainable management at national level represents the first collective endeavour by the European countries to give all citizens the means to verify, for themselves, the conformity of current forest characteristics and of developments chalked up over the past ten years in official discussions about the forestry policy of their own country and of the other countries in the European continent.

RÉPUBLIQUE FRANÇAISE
ministère de l'agriculture et de la pêche