Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE

MINISTÈRE
DE L'AGRICULTURE
ET DE LA PÊCHE

Indicators for the sustainable management of French forests

2005 Edition

Foreword

This is the third enhanced and updated edition of the report Indicators for the Sustainable Management of French Forests.

It pools the data and knowledge of managers, ecologists, researchers, statisticians, administrators and other stakeholders who are all striving to ensure that French forests will remain sustainable as a source of renewable resources, from economic, ecological, landscape and society perspectives.

Portraying forests with figures is a delicate operation – as clearly shown by the range of assessment criteria and monitoring indicators considered in this report.

The forest is rich, living and sustainable.

The present document was designed to provide a solid reflection of this environment.

I am certain that it will serve as a very useful instrument for enhancing awareness on our forest area, which currently accounts for 30% of the total area of metropolitan France.

This work is ongoing and will now have to be supplemented by a section on forests in the French overseas departments and territories. The extent of these forest areas is already well established, but special tailored operations and new updated assessment methods will be necessary for their measurement and monitoring.

Everyone who was involved in drawing up this report is thanked for his/her contribution.

Alain MOULINIER

Director General for Forestry
and Rural Development

Production

Inventaire forestier national

Steering committee members: François Archangeli (MEDD), Jean-Marie Barbier (FNSPFS), Thierry Bélouard (IFN), Anne Boisroux-Jay (DGFAR), Marc Bonnet-Masimbert (INRA), Jean-Michel Carnus (INRA/IEFC), Alain Colinot (CNPPF), Georges Decaudin (SCEES), Michel Denis (Cemagref), François de Sars (DGFAR), Jean-Luc Flot (DSF), Jean-Marc Frémont (IFN), Michel Hermeline (DGFAR), Franck Jacobée (MEDD), Nicole Jensen (DGFAR), Véronique Joucla (DGFAR), Guy Landmann (GIP ECOFOR), Françoise Lavarde (DGFAR), Caroline Merle (DGFAR), Christine Mevel (DGFAR), Jean-Marie Michon (ONF), Murièle Millot (DGFAR), Philippe Monchaux (AFOCEL), Michel-Paul Morel (SCEES), Christophe Orazio (IEFC), Claire-Eliane Petit (MEDD), Jean-Luc Peyron (GIP ECOFOR), Lucile Rambaud (DGFAR), Francis Trocherie (IFEN), Michel Vallance (ONCFS), Pierre Verneret (FNB).

Editors: Erwin Ulrich – ONF (§ 2.1), Jean-Pierre Renaud – IFN (§ 2.2), Louis-Michel Nageleisen & Jean-Luc Flot – DSF (§ 2.3 & 2.4 p), Gérard Dumé – IFN (§ 3.5.1), Isabelle Bilger & Eric Collin – Cemagref (§ 4.6), Pierre Ferrand – MEDD (§ 4.9 p), Jean-Luc Peyron – GIP ECOFOR (§ 3.3 p & 6.10 p), Nabila Hamza – IFN (other § in chapters 1 to 6).

External reviewers: Alain Chaudron – DGFAR (§ 1.4 & 1.4.1), Jean-Luc Dupouey – INRA (chapters 1 to 4), Guillaume Gaborit – CITEPA (§ 1.4 & 1.4.1), Valérie Merckx – ONF (§ 1.4 & 1.4.1), Gérôme Pignard – DDAF 34 (chapters 1 to 3), Daniel Vallauri – WWF (chapters 1 to 4).

With the collaboration of: Sylvie Batifol (IFN), Luc Bodineau (ADEME), Stéphanie Brachet (ENGREF/ANB), Eric Bruno (IFN), Catherine Cluzeau (IFN), Antoine Colin (IFN), Bernard Courtois (DGFAR), Francis Despres (CNPPF), Alexis Ducloz (Coopérative France Miel), Marianne Duprez (IFN), Jean-Michel Gilbert (DGFAR), Anne-Marie Granet (ONF), Marie-Claire Guéro (IFN), Patrick Haffner (MNHN), Charles Huck (FSA of Bas-Rhin), Jean-Paul Larrat (MSA), David Leduc (ONCFS), Philippe Michaut (French Ministry of the Interior), Jocelyne Naudé (IFN), Alexandra Niedzwiedz (LEF/ENGREF), Christophe Panaïotis (ODARC), Josyane Roblet (DGFAR), Christine Saint-Andrieux (ONCFS).

Technical coordination: Nabila Hamza (IFN)

DGFAR coordination: Nicole Jensen

English translation: David Manley

Graphic design: Francine Le Chevalier (DGFAR-MAG In-house communications)

Layout: Jocelyne Naudé (IFN)

Preface

The United Nations Conference on the Environment and Development (UNCED, Rio de Janeiro, 1992) outlined the main principles for sustainable development. The Pan-European Forest Process (or so-called Helsinki Process) was launched as a follow-up to the Second Ministerial Conference on the Protection of Forests in Europe (Helsinki, 1993) with the aim of applying UNCED principles to European forests. The Third Conference (Lisbon, 1998) defined criteria and indicators for sustainable forest management in Europe that the signatory countries are committed to update and enhance on a regular basis. This commitment was confirmed in the Fourth Conference (Vienna, 2003), which also recommended that the criteria and indicators be integrated in national forest programmes.

France has been publishing *Indicators for the Sustainable Management of French Forests* every 5 years since 1995 to review the progress. This is the third edition. It consists of 35 quantitative indicators that were adopted at the Vienna Conference in 2003 and which are classified under the six sustainable management criteria delineated at the Helsinki Conference. Twenty-one supplementary indicators were added to this list to account for distinct features of French forests–some of these are new indicators. For clarity, the so-called Vienna indicators are presented separately from those specific to the French forest setting. Moreover, special effort was made to comply with the methodological recommendations of the Vienna Conference. Two major climatic events have had a serious impact on metropolitan French forests since the previous edition, i.e. the severe storms of late December 1999 and the drought-heat wave of 2003. An in-depth analysis of the impacts of these events is presented under Criterion 2 (Maintenance of forest ecosystem health and vitality).

It is still too early to analyse the qualitative indicators for sustainable forest management–they are designed to assess progress in institutional, legal, economic, financial and informational domains between the Vienna Conference (2003) and the next Conference to be held in Warsaw in 2008. Once this analysis is undertaken, it will be summarised in the national report to be presented at the Conference in 2007. This will provide an opportunity to outline the French Loi d'Orientation sur la Forêt (LOF), passed in July 2001, which established the legal framework for sustainable forest management in France. Moreover, development of a national forest programme has been under way since 2004, in collaboration with all stakeholders of the forest-wood-paper sector, and it should be completed in the near future. This programme will include a national forest biodiversity action plan.

Within the current pan-European setting, the present document is focused only on metropolitan French forests, as in the 1995 and 2000 editions. A separate publication should be devoted to French forests in the overseas departments and territories, considering their specific character and substantial size, i.e. covering a total area of 9.1 million ha in nine department-regions and communities. It could be based on the conclusions of the next Livre blanc sur la forêt tropicale, which will be included in the French national forest programme.

The Direction générale de la forêt et des affaires rurales (DGFAR) of the French Ministry of Agriculture and Fisheries assigned the Inventaire forestier national (IFN) with the task of producing this document. It was coordinated by a steering committee of members from organisations and institutions in the forest-wood-paper sector, and it benefitted from the contributions and suggestions of various other stakeholders in this sector and relevant associations (cf. attached list).

Cautionary note

- The indicator headings outlined in the 2003 Vienna Conference were copied word for word, but the data presented in the tables do not always fully mesh with the topics.

- The indicators for the Vienna Conference have two figures, while those specific to French forests have three. These latter indicators were attached to the most relevant Vienna Conference topics. Appendix 1 provides a list and origins of the sustainable forest management (SFM) indicators.

- The Inventaire forestier national (IFN) data presented in this document for the years 1989, 1994, 1999 and 2004 are those available on 1st January of the year. Given the frequency of the inventories undertaken in each department (12 years on average), they correspond to the mean years 1981, 1986, 1991 and 1996, respectively. The impact of the storms of December 1999 was thus only partially taken into account in the 2004 IFN data. Appendix 3 provides a list of departments and IFN survey dates corresponding to the four reference years.
Some distribution criteria (structure, species, etc.) could not be determined in all the forest formations due to an absence of field inventories or for technical reasons. An "unspecified" line was thus added to ensure consistency. However, data from the Teruti survey of the Service central des enquêtes et études statistiques (SCEES) mentioned are expressed in real years, i.e. 1993, 1998 and 2003. This data source is thus used in Indicator 1.1 (Forest area).
The definition and methods used by IFN and SCEES (Teruti) are summarised in Appendix 2, and a summary of the IFN and Teruti areas is presented in Appendix 4.
IFN modified its inventory method in November 2004, so it is now based on systematic annual sampling, which should facilitate updating of the indicators.

- In the tables, figures and maps, the grouping categories for basic data are always defined while including the lower limit but excluding the upper limit. Annual variation rates are calculated on a compound interest basis. Finally, results expressed in euros for a given year correspond to constant euros.

Contents

Criterion 1

Maintenance and appropriate enhancement of forest resources and their contribution to global carbon cycles

INDICATOR 1.1

Area of forest and other wooded land, classified by forest type and by availability for wood supply

Landuse	1993		1998		2003		1993-2003
	x1,000 ha	%	x1,000 ha	%	x1,000 ha	%	Annual variation annuel
Forest (incl. poplar plantations)	**14,811**	**27.0%**	**15,220**	**27.7%**	**15.408**	**28.1%**	**0.4%**
Broadleaved	9,466	63.9%	9,715	63.8%	9.852	63.9%	0.4%
Conifers	4,052	27.4%	4,122	27.1%	4.090	26.5%	0.1%
Mixed	1,292	8.7%	1,384	9.1%	1.466	9.5%	1.3%
Other wooded land	**1,935**	**3.5%**	**1,825**	**3.3%**	**1.743**	**3.2%**	**-1.0%**
Thicked, hedges and scattered trees	**1,664**	**3.0%**	**1,563**	**2.8%**	**1.517**	**2.8%**	**-0.9%**
Total Wooded lands and other lands with tree cover	**18,410**	**33.5%**	**18,608**	**33.9%**	**18,668**	**34.0%**	**0.1%**
Others	36,509	66.5%	36,311	66.1%	36,251	66.0%	-0.1%
Total	**54,919**	**100.0%**	**54,919**	**100.0%**	**54,919**	**100.0%**	**0.0%**

(Source: SCEES/Teruti 1993, 1998 and 2003; forests excluding poplar plantations correspond to codes 18-21, poplar plantations to codes 24 and 25; FAO's other wooded land category corresponds to heathland-maquis-garrigues in the Teruti survey, code 70 ; thickets, hedges and scattered trees correspond to codes 22, 72, 23 and 26)

Commentary: the forest area in France has expanded to the current level of 15.4 million ha, i.e. 28.1% of the total area. The increase noted from 1993 to 1998 continued thereafter, but at a slower pace, decreasing from 82,000 to 38,000 ha per year. This downturn is mainly due to a decline in the afforestation of heath, fallow and farm lands. It is also associated with the decrease in agricultural abandonment and in subsidies that were provided to promote farmland afforestation within the framework of post-storm forest rehabilitation programmes (cf. § 1.1.1). Afforestation rates have been greatest in some of the least forested regions (Bretagne, Pays-de-la-Loire), as well as in the Mediterranean region, where the forest cover is already above 30% (Maps 1 and 2).

The percentage of broadleaved stands has remained steady (64%), whereas mixed stands have been increasing regularly. The conifer forest area seems to have levelled off at about 4.1 million ha.

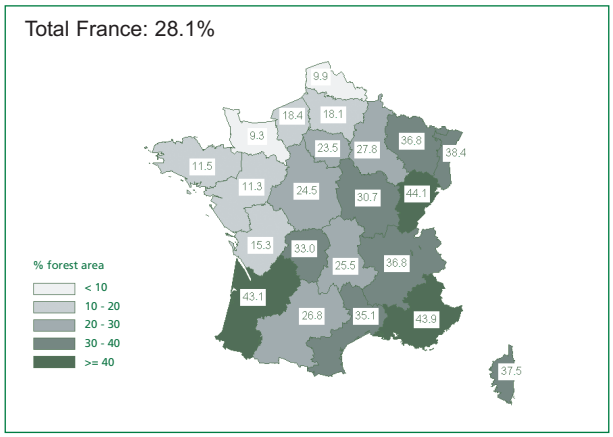
France ranks 3rd amongst the 25 EU countries in terms of forest area, surpassed only by Sweden (27.1 million ha) and Finland (21.9 million ha).

In France, the FAO classification "other wooded lands" corresponds to the "heathland-maquis-garrigue" category in the Teruti survey conducted by the French Service central des enquêtes et études statistiques (SCEES) and to most of the same Inventaire forestier national (IFN) categories. Contrary to its forest inventory data, IFN has not recorded any dendrometric data relevant to other wooded lands. These formations account for only 3.2% of the forest area in France, and they regressed at a rate of 16,000 ha per year between 1998 and 2003, as compared to 22,000 ha per year during the 5 preceding years. This is clearly in line with the preceding trend, i.e. heathland afforestation was already under way, but at a slower pace, along with a shift from heathland to farmland.

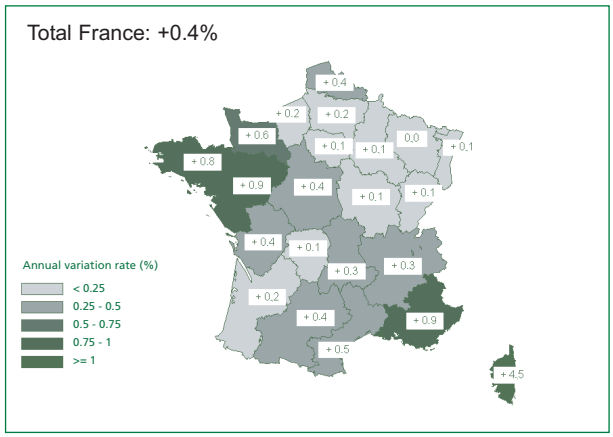
Areas with thickets and scattered trees also decreased from 1998 to 2003, but to a lesser extent than during the previous period. However, the overall trend shows an increase in afforestation in these lands, which has increased the forest area (cf. § 1.1.1).

Wooded lands and "other lands with tree cover" currently account for 18.7 million ha, or 34% of metropolitan France.

Finally, a comparison with the last two IFN inventories shows that planned afforestation accounted for just 16% of newly forested areas on average during the 1984-96 period, while a rate of 13% was recorded for a more recent period (1992-2002) in the Teruti survey conducted by SCEES. This indicates that the expansion of French forests has mainly been due to natural afforestation of heathland and fallows.



Map 1: Percentage forest area by administrative region in 2003 (source: SCEES/Teruti)



Map 2: Annual variation rate in forest area by administrative region from 1993 to 2003 (source: SCEES/Teruti)

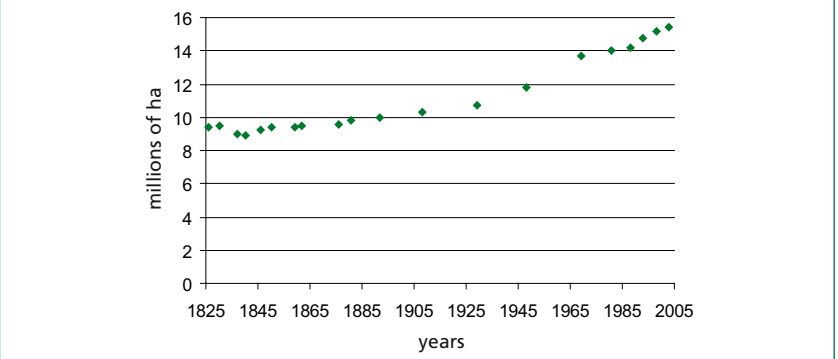


Figure 1: Variations in forest area over the last 2 centuries (source: Cinotti, based on a multi-source compilation for the pre-1980 period; SCEES/Teruti for the post-1980 period)

⇨*Note : even though the direction of the trend is beyond doubt, the different values plotted on the graph should be considered with caution since, until 1960, they are based on estimates from varied sources, often drawn from the land register. This register is above all a fiscal instrument that often underestimates forest areas. From certain surveys, it can be estimated that in slack periods of afforestation the land register's underestimate is usually around 20%, but that in periods of intense afforestation the underestimate may be as much as 50% for some localities. The land register figures have nevertheless become much more reliable in recent years. From the 1960s, new statistical methods using aerial photography (Teruti survey of the Service central des enquêtes et études statistiques (SCEES) of the French Ministry of Agriculture, and the permanent inventory of forest resources conducted by the Inventaire forestier national (IFN), have improved the assessment of forest areas.*

Box 1: Variations in forest area over the last 2 centuries

The area of land under forest has increased markedly since the early 19th century–it seems to have virtually expanded by two-thirds in nearly 2 centuries.
This situation, which is common to most European countries, is especially the upshot of higher agricultural yields and the reduced need for land for food production in the 19th and 20th centuries. It has also led to planned and natural reforestation of marginal land that had been cleared and cultivated as a result of population pressure. This has simplified erosion and flood control initiatives within the framework of national policies. The growth of forest areas is a very positive trend, since public opinion, the scientific community and legislators are unanimous in acknowledging the great economic, ecological and social value of forests. This sharp rise in forest coverage over 2 centuries should, however, not detract from the fact that land is still being cleared as a result of urban growth and infrastructural development, particularly around large built-up areas, and that some very unique forest environments, such as alluvial forests, are dwindling because of major projects undertaken to modify the course of large rivers.

Forest stands available for wood supply (including poplar plantations)

Forest type	1993		1998		2003		1993-2003
	x1,000 ha	% available /total	x1,000 ha	% available /total	x1,000 ha	% available /total	Annual variation rate
Broadleaved	9,062	95.7%	9,272	95.4%	9,344	94.8%	0.3%
Conifers	3,875	95.6%	3,929	95.3%	3,874	94.7%	0.0%
Mixed	1,236	95.6%	1,319	95.3%	1,388	94.7%	1.2%
Total	**14,172**	**95.7%**	**14,520**	**95.4%**	**14,605**	**94.8%**	**0.3%**

(Source : SCEES/Teruti 1993, 1998 and 2003 and IFN 1994, 1999 and 2004 to estimate the share available for wood supply represented by production forest stands that can be accessed for wood supply, including non-inventoried stands and poplar plantations).

Commentary: IFN considers that forest stands available for wood supply include all production forests that can be accessed for wood supply, along with poplar plantations. This is currently estimated to represent 95% of the total wooded area, or 14.6 million ha. This percentage applies equally to broad-leaved, conifer and mixed forests. It decreases slightly over time because the forest area not available for wood supply is expanding at a faster pace than production forests (2.6% versus 0.3% per year).

INDICATOR 1.1.1
Forest area gains and losses

Commentary: the transition matrix obtained in the Teruti survey conducted by the Service central des enquêtes et études statistiques (SCEES) enables a detailed analysis of the different patterns leading to the observed expansion of forest area. This matrix covers the 1997-2003 period, which overlaps the periods discussed in § 1.1, thus explaining the slight differences in the data presented.
Over the 1997-2003 period, the forest area increased by +40,200 ha per year on average as the result of two contrasting trends–a gain in forest area of 84,700 ha per year and a loss of 44 500 ha per year.

Origin and allocation of forested area	Changes in forested area from 1997 to 2003 (ha/year)		
	Forested area gains	Forested area losses	Balance
water and wetlands	1,100	-1,100	0
soil with outcropping parent rock	2,900	-1,200	1,700
farmland in use	23,300	-12,200	11,100
thickets and scattered trees	13,600	-7,300	6,300
hedges	1,300	-1,500	-200
hathland-maquis-garrigues and fallows	38,800	-13,500	25,300
grassland, trails and ornamental gardens	1,200	-2,000	-800
man-made areas +/- structures, prohibited areas	2,600	-5,800	-3,200
total	**84,700**	**-44,500**	**40,200**
% of total in France	0.15%	-0.08%	0.07%

(Source : SCEES/Teruti, see transition matrix for 1997/2003 in appendix ; forested area encompasses woodlands and forests (18 to 21) and poplar plantations (24, 25))

These gains in forest coverage concerned heathland and fallows (46%), farmland (28%) and thickets and scattered trees (18%). Forest losses also concerned these three categories, but the balance is largely in favour of forests (estimated at +42,700 ha/year). The main negative category is man-made areas–infrastructures and urban areas–with an estimated balance of – 3,200 ha per year.

An in-depth analysis of the 1997-2003 transition matrix sheds greater light on these trends (cf. Appendix 11):

➢ the variations in heathland and fallows are in line with typical transitions that occur in periods ofagricultural abandonment: farmland ⇨ fallows ⇨ heathland ⇨ forest. The result of these transitions is that farmlands turn into heathlands and fallow lands at a rate of +10,900 ha/year and heathlands and fallows are transformed into forest at +25,300 ha/year. The rates estimated for the 1993-98 period are +26,600 and +47,600 ha/year, respectively, thus confirming the hypothesed correlation between diminishing agricultural abandonment and forest expansion.

➢ there is a positive shift from thickets and scattered trees to forest (+6 300 ha/year), which is due to two contrasting trends–thickets gradually become denser and expand to more than 50 ares, i.e. the threshold of the forest classification, at a rate of 13,600 ha/year, while forests are fragmenting into thickets at a rate of 7,300 ha/year.

➢ the situation differs markedly for hedges as the balance relative to forests is virtually null. Hedges have increased by +800 ha/year but this is offset by substantial reverse trends. The increase mainly involves thickets and scattered trees, which is hard to explain and possibly related to a confusion in the definition. The loss of hedges is mainly to the benefit of agriculture (–900 ha/year), but this rate is better than that estimated for the 1993-98 period (–3,200 ha/year).

INDICATOR 1.1.2
Forest area by biogeographical area and elevation class

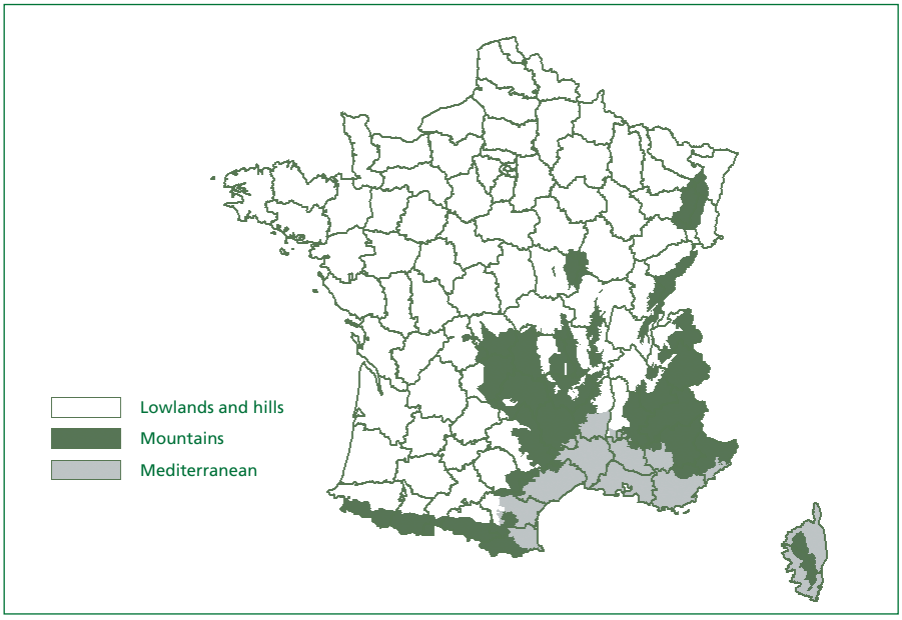
Forests (including poplar plantations)

Biogeographical area	1989		1994		1999		2004		1994-2004
	x1,000 ha	%	x1,000 ha	%	x1,000 ha	%	x1,000 ha	%	Annual variation rate
Lowland and hill forests	8,924	63.1%	8,989	62.4%	9,152	62.0%	9,338	61.8%	0.4%
Mountain forests	4,040	28.6%	4,171	29.0%	4,274	29.0%	4,403	29.2%	0.5%
Mediterranean forests	1,175	8.3%	1,234	8.6%	1,327	9.0%	1,357	9.0%	1.0%
Total	**14,139**	**100.0%**	**14,394**	**100.0%**	**14,753**	**100.0%**	**15,098**	**100.0%**	**0.5%**

(Source : IFN, for all forests including poplar plantations; the three biogeographical areas together form a series of IFN forest regions corresponding to the boundaries featured in the Atlas des forêts de France - Published by de Monza - 1991, p. 39)

Commentary: the 1994-2004 Inventaire forestier national (IFN) data correspond to an average for the 1986-1996 period because national inventories are currently only conducted every 10-12 years. These data therefore cannot be directly compared to the Teruti 1993-2003 survey data of the Service central des enquêtes et études statistiques (SCEES) mentioned in § 1.1.1 (cf. cautionary note).

Lowland and hill forests still represent over 60% of French forests, although this proportion continues to fall slightly in favour of the other categories. Mediterranean forests have recorded the highest rate of increase (+1% per year), mainly owing to the natural afforestation of heathland and fallow land by Aleppo pine, pubescent oak and holm oak. Mountain forests are expanding at a fair rate (+0.5% per year)–their proportion is now close to 30% of the total area.



Map 3: Biogeographical areas in France (source: IFN)

Forests (including poplar plantations)

Commentary: two-thirds of French forests are lowland forests below 500 m elevation. Those located above 750 m represent over 20% of the total forest area, covering 3.3 million ha, and require management that is tailored to their specific climatic constraints. The percentage mapped forest area is increasing for all elevation classes, but at a higher pace at lower elevations, which is in line with the rate of increase of Mediterranean forests that are mainly located in lowland areas. The percentage mapped forest area is 57% within the 750-1,500 m elevation range.

Elevation range	1999			2004			1999-2004
	Mapped area		% mapped forest area	Mapped area		% mapped forest area	Annual variation rate of mapped area
	x1,000 ha	%		x1,000 ha	%		
0 - 250 m	6,456	41.2%	19.5%	6,630	41.4%	20.0%	0.5%
250 - 500 m	3,913	25.0%	35.5%	4,005	25.0%	36.3%	0.5%
500 - 750 m	2,024	12.9%	49.9%	2,069	12.9%	51.0%	0.4%
750 - 1,000 m	1,375	8.8%	52.3%	1,404	8.8%	53.4%	0.4%
1000 - 1,500 m	1,437	9.2%	59.6%	1,455	9.1%	60.4%	0.2%
above 1,500 m	454	2.9%	27.1%	459	2.9%	27.4%	0.2%
Total	**15,659**	**100.0%**	**28.5%**	**16,023**	**100.0%**	**29.2%**	**0.5%**

(Source : IFN 1999 and 2004, for all forests of over 4 ha (including poplar plantations) based on the IFN cartographic database and the IGN Alti database (50 m elevation intervals). The areas monitored are larger than those derived from statistical data, i.e. 14,753 Kha for 1999 and 15,098 Kha for 2004, because they are based on cartographic processing data - cf. Appendix 4).

INDICATOR 1.1.3
Forest area by IFN forest structure

Forest stands available for wood supply (including poplar plantations)

Forest structure (excluding poplar plantations)	1989		1994		1999		2004		1994-2004
	x1,000 ha	%	x1,000 ha	%	x1,000 ha	%	x1,000 ha	%	Annual variation rate
regular high forest	5,753	43.1%	6,021	44.8%	6,423	47.2%	6,768	49.0%	1.2%
irregular high forest	729	5.5%	707	5.3%	671	4.9%	639	4.6%	-1.0%
coppice	2,393	17.9%	2,258	16.8%	2,124	15.6%	2,098	15.2%	-0.7%
mixed coppice/broadleaved high forest	3 685	27.6%	3,581	26.6%	3,494	25.7%	3,437	24.9%	-0.4%
mixed coppice/conifer high forest	683	5.1%	741	5.5%	747	5.5%	764	5.5%	0.3%
temporarily unstocked*	93	0.7%	137	1.0%	139	1.0%	115	0.8%	-1.7%
Subtotal	**13,337**	**100%**	**13,444**	**100%**	**13,597**	**100%**	**13,821**	**100%**	**0.3%**
unspecified	0		127		270		270		7.8%
Total	**13,337**		**13,571**		**13,867**		**14,091**		**0.4%**

* clear cutting or accident less than 5 years previously

Poplar plantations : regular high forest	**202**	**202**	**207**	**220**	**0.9%**

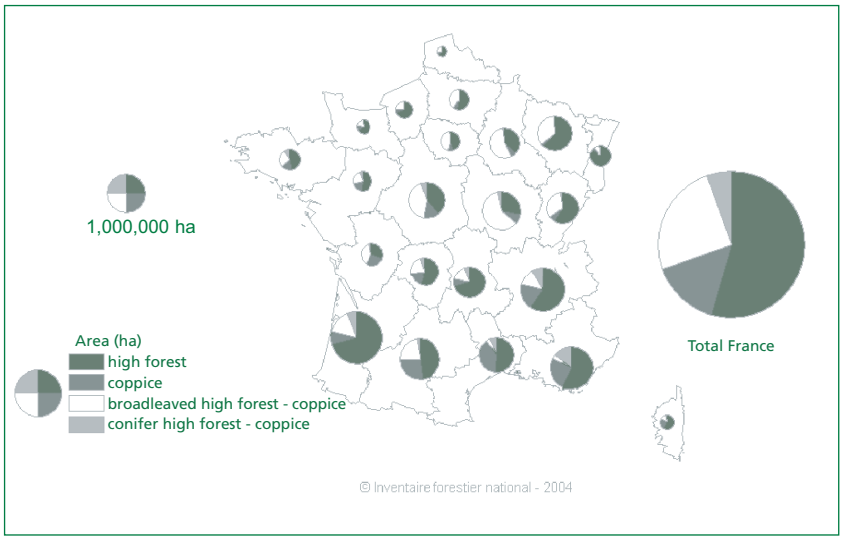
(Source : IFN, criterion established only for the inventoried forests available for wood supply and poplar plantations (landuse 5))

Commentary: silvicuture based on regular high forest has developed considerably in France over the past 2 centuries. High forest now represents 53% of the inventoried forest area compared with 32% in the estimates of the Daubrée statistics of 1908-1913 (excluding Alsace-Lorraine departments).

The increase in regular high forest noted 5 years ago is still under way, and mainly concerns broadleaved stands–it derives principally from the active or passive (by ageing) conversion of coppices and mixed coppice/high forest stands which are in sharp decline, and to a lesser extent from natural afforestation. This process is very clear in the eastern and northeastern regions (Alsace, Lorraine, Champagne-Ardenne, Franche-Comté and Rhône-Alpes) of France, as well as in Normandie and Pays de la Loire (cf. Appendix 11).
Coppices and mixed coppice/high forest stands still represent around 2/3 of broadleaved stands, which is a phenomenon specific to France, in contrast with countries following the German silviculture tradition and Scandinavian countries.

Areas classified as irregular high forest are also still declining. This trend mainly concerns the Rhône-Alpes, Auvergne and Limousin regions, where recent inventories have highlighted a clear reduction in irregular high forest to the benefit of regular high forest. When interpreting the low level attained by irregular high forest structures (4.6%), it should be kept in mind that the forest structure observed by IFN represents an objective recording of the state of the stand–essentially in terms of the vertical structure–and not a reflection of the work done by the owner. Aged or regularised selection high forests, particularly in the Jura and Pyrénées regions, are classified by IFN as regular high forest, even though current silviculture programmes are aimed at restoring selection.

The overall temporarily unstocked land area does not exceed 1% of the total inventoried forest area.
The increase in temporarily unstocked area resulting from the 1999 storms could only be partially taken into account since the survey data in the IFN database currently just covers 22 administrative departments (cf. list of survey dates and departments in Appendix 3). Paradoxically, a decrease in unstocked area is noted in the 2004 data because the area deforested by storms in Gironde and Landes was not taken into account. The 1994 and 1999 data integrate the damage inflicted by the frost of 1985 on maritime pine in these two departments, which sharply increased the unstocked area relative to the 1989 situation. IFN's new annual survey method should overcome this problem in future.



Map 4: Forest area by administrative region and IFN forest structure (source: IFN, 2004)

INDICATOR 1.1.4
Forest area by main tree species

Forest stands available for wood supply (excluding poplar plantations)

Main tree species	1989		1994		1999		2004		1994-2004
	x1,000 ha	% of total area	x1,000 ha	% of total area	x1,000 ha	% of total area	x1,000 ha	% of total area	Annual variation annuel
pedunculate oak	2,382	17.9%	2,424	17.9%	2,333	16.9%	2,200	15.7%	ND
sessile oak	1,762	13.2%	1,777	13.2%	1,868	13.6%	1,835	13.1%	ND
undifferentiated oak*	0		0		0		148	1.1%	ND
maritime pine**	1,398	10.5%	1,383	10.2%	1,381	10.0%	1,365	9.8%	-0.1%
beech	1,231	9.2%	1,255	9.3%	1,291	9.4%	1,301	9.3%	0.4%
Scots pine	1,179	8.8%	1,154	8.5%	1,122	8.2%	1,127	8.0%	-0.2%
pubescent oak**	846	6.3%	860	6.4%	920	6.7%	981	7.0%	ND
common spruce	717	5.4%	744	5.5%	740	5.4%	718	5.1%	-0.4%
silver fir	544	4.1%	554	4.1%	566	4.1%	572	4.1%	0.3%
chestnut**	515	3.9%	488	3.6%	492	3.6%	496	3.5%	0.2%
holm oak**	367	2.8%	390	2.9%	432	3.1%	432	3.1%	1.0%
ash	271	2.0%	309	2.3%	359	2.6%	398	2.8%	2.6%
Douglas fir	231	1.7%	296	2.2%	332	2.4%	368	2.6%	2.2%
Aleppo pine	232	1.7%	236	1.7%	241	1.8%	254	1.8%	0.8%
hornbeam	202	1.5%	197	1.5%	198	1.4%	204	1.5%	0.3%
Austrian pine	183	1.4%	188	1.4%	179	1.3%	194	1.4%	0.3%
birch	199	1.5%	163	1.2%	156	1,1%	164	1.2%	0,0%
Corsican pine	92	0.7%	109	0.8%	133	1.0%	153	1.1%	3.4%
false acacia	136	1.0%	134	1.0%	131	0.9%	131	0.9%	-0.2%
larch	95	0.7%	94	0.7%	96	0.7%	109	0.8%	1.4%
large alder	94	0.7%	85	0.6%	82	0.6%	83	0.6%	-0.2%
cork oak**	72	0.5%	79	0.6%	79	0.6%	79	0.6%	0.1%
willow	57	0.4%	52	0.4%	61	0.4%	71	0.5%	3.1%
aspen	60	0.5%	60	0.4%	61	0.4%	63	0.5%	0.5%
large maple	27	0.2%	33	0.2%	38	0.3%	57	0.4%	5.8%
mountain pine	55	0.4%	56	0.4%	55	0.4%	56	0.4%	0.0%
other broadleaved species	264	2.0%	245	1.8%	268	1.9%	290	2.1%	1.7%
other conifer species	118	0.9%	139	1.0%	153	1.1%	148	1.1%	0.6%
total broadleaved**	**8,484**	**63.7%**	**8,552**	**63.3%**	**8,769**	**63.7%**	**8,935**	**63.8%**	**0.4%**
total conifers**	**4,845**	**36.3%**	**4,953**	**36.7%**	**4,999**	**36.3%**	**5,063**	**36.2%**	**0.2%**
subtotal**	**13,329**	**100.0%**	**13,505**	**100.0%**	**13,768**	**100.0%**	**13,998**	**100.0%**	**0.4%**
unspecified	8		66		99		93		
Total	**13,337**		**13,571**		**13,867**		**14,091**		**0.4%**

* pedunculate, sessile and pubescent oak

** including estimated area in different formations of the Mediterranean region not inventoried in 1994, 1999 and 2004

(Source : IFN, apart from poplar plantations, a criterion set only for forests available for wood supply where the tree species is regarded as predominant. The variation rate of the area under pedunculate, sessile and pubescent oak could not be calculated because these three oaks were aggregated in 2004 when doubt was raised as to the species determinations)

Commentary: French forests are very diversified, with 136 species represented, including 176 broadleaved and 60 conifer species. Amongst these, 65 species or groups of species are sufficiently represented for the Inventaire forestier national (IFN) to include them in its forest dendrometric surveys (cf. Appendices 5 and 6).

Predominantly broadleaved stands are still in the majority, covering 64% of the forest area, or 8.9 million ha (Figure 3). Their annual rate of increase is now above that of conifer stands (+0.4% versus +0.2%). The different species of oak now represent more than 40% of the forest area of metropolitan France. Of these, sessile and pedunculate oaks cover 4.2 million ha, an area that has remained relatively steady over the last 10 years (Figure 2).

The main species that have expanded in the past decade are ash, pubescent oak, holm oak, beech, sessile oak, Corsican pine, Douglas fir, Aleppo pine and silver fir. Of these, pioneer species whose expansion can be explained by natural afforestation dynamics (ash, pubescent oak, Aleppo pine, holm oak) can be distinguished from species commonly utilised in silviculture programmes, for: afforestation and reforestation (Douglas fir, Corsican pine, silver fir), conversion to regular high forests (beech, sessile oak), and stand management (sessile oak, beech, ash, silver fir). The different explanations are not mutually exclusive–the expansion of beech is probably linked to its natural spreading tendency, to the silvicultural practices which favour it, particularly in oak-beech forests on the limestone plateau of northeastern France, and to its low palatability for large ungulates. The slight expansion of chestnut is the result of two contrasting phenomena: first, chestnut is declining due to the abandonment of old sweet chestnut groves and to the intended substitution of species in certain stands, particularly in the Massif Central and the Mediterranean region; secondly, it often takes over as the main species in mixed stands with pedunculate oak when the management of this later species is gradually halted, such as in the Limousin region.

There are various possible explanations for the reduction in the areas of certain main species. Common spruce is declining at the fastest rate, i.e. -0.4% or 2,600 ha per year. This is evidence that common spruce is gradually being replaced by other reforestation species (Douglas fir, broadleaved species, etc.). The regions most affected are Limousin, Rhône-Alpes and Alsace.

The slighter decline of Scots pine is actually the result of expansion via natural colonisation in the regions of southern France, and of a reduction by the substitution of species during reforestation in the other regions (in favour of Douglas fir, Corsican pine, white conifers and broadleaved species). The reduction in the area under maritime pine should be analysed while taking the relevant inventory dates into account. This decline is mainly the outcome of pest and disease problems affecting this species in the Provence-Alpes-Côte d'Azur region and the hurricane that hit Bretagne in 1987.

Finally, many studies are under way to assess the impact of climate change on the future spatial distribution of forest species. This includes, for instance, one component of the CARBOFOR project (cf. § 1.4) entitled "Modelling and cartography of the potential climatic area of major forest tree species". This study, which was undertaken between 2002 and 2004 by the French Institut national de la recherche agronomique (INRA) in collaboration with IFN, focused on 67 species. The main conclusions indicated a possible expansion of the potential area of Atlantic and Mediterranean species and a reduction in the areas of mountain species.

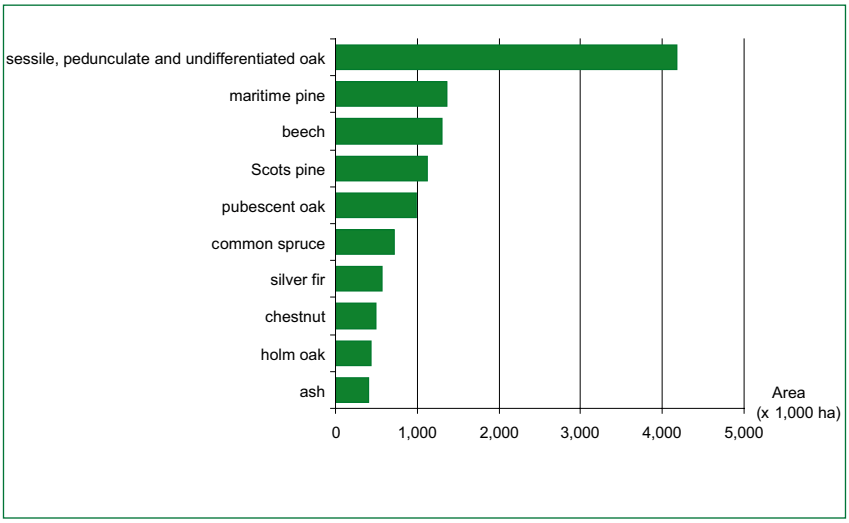
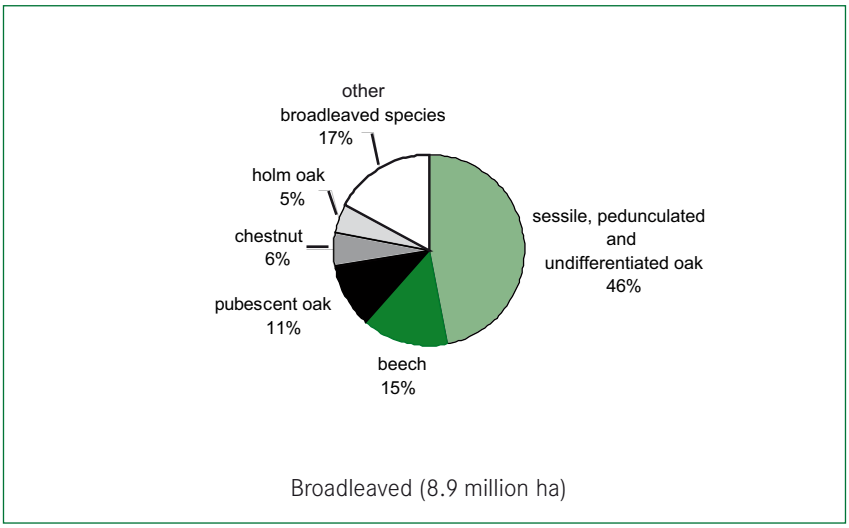


Figure 2: Forest areas of the top 10 tree species (source: IFN, 2004)



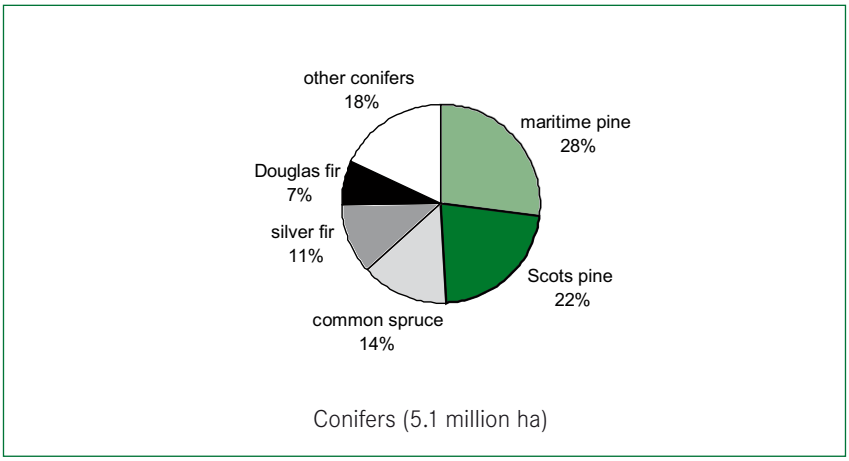


Figure 3: Forest area per main tree species (source: IFN, 2004)

INDICATOR 1.2

Growing stock on forest and other wooded land, classified by forest type and by availability for wood supply

Forest stands available for wood supply (excluding poplar plantations)

IFN stem volume (7 cm top diameter)

Forest type	1989		1994		1999		2004		1994-2004
	x 1,000 m³	%	x 1,000 m³	%	x 1,000 m³	%	x 1,000 m³	%	Annual variation rate
Broadleaved	1,003,991	58.3%	1,069,993	57.7%	1,147,815	57.7%	1,219,036	57.3%	1.3%
Conifers	558,873	32.4%	612,343	33.0%	648,956	32.6%	696,938	32.8%	1.3%
Mixed	159,687	9.3%	171,394	9.2%	194,093	9.7%	211,226	9.9%	2.1%
Total	**1,722,550**	**100%**	**1,853,730**	**100%**	**1,990,864**	**100%**	**2,127,201**	**100%**	**1.4%**

	m³/ha	m³/ha	m³/ha	m³/ha	%
Broadleaved	119	126	133	139	1.0%
Conifers	150	163	172	184	1.2%
Mixed	137	145	158	164	1.2%
Total	**129**	**138**	**146**	**154**	**1.1%**

(Source : IFN, apart from poplar plantations, for inventoried forests available for wood supply, based on overbark stem volumes to a 7 cm top diameter limit for stems with a diameter greater than 7.5 cm at breast height (1.30 m))

The increase in broadleaved growing stock is also associated with an increase in broadleaved stand area and with the aging of some stands, especially in the Centre, Midi-Pyrénées and Rhône-Alpes regions.

Cultivated poplar plantations were considered separately since the growing stock had only been estimated in the main departments involved, so this is an underestimation (cf. § 1.2.1).

Commentary: growing stock inventoried in production forests, excluding poplar plantations, is currently 2.1 billion m³ (expressed in IFN stem volume). The annual rate of increase is +1.4%, which is much higher than that of forest area–the average growing stock per ha is now 154 m³/ha, as compared to 138 m³/ha 10 years ago, and the capitalisation of standing wood noted in 1999 is ongoing.

This trend also applies to most other highly forested European countries. It is the result of a lower felling rate relative to the increment, and the overall increase in yield capacity of forest stands noted elsewhere (cf. § 3.1).

Broadleaved stands account for 57% of the growing stock, while conifer stands represent a third and mixed stands 10% (Figure 4). Despite this pattern, the greatest increase in growing stock concerns mixed stands (+2.1% per year). This phenomenon is associated with the rate of expansion of mixed stand area and with the high capitalisation rate, especially in mountain regions (Alps, Jura et Pyrenees).

Conifer stands have the highest growing stock per ha (currently 184 m³/ha). This trend is sharply increasing since many afforested and reforested areas are becoming productive, in addition to the capitalisation of some old mountain stands.

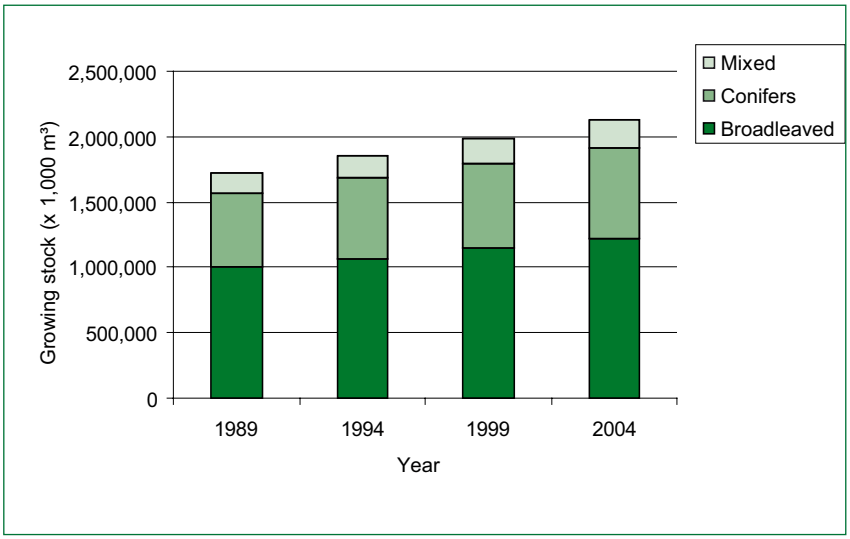


Figure 4: Growing stock patterns per forest type (source: IFN)

INDICATOR 1.2.1
Growing stock by IFN forest structure

Forest stands available for wood supply (including poplar plantations)

IFN stem volume (7 cm top diameter)

Forest structure (excluding poplar plantations)	Year	Volume (x 1,000 m³)	% volume	Volume per ha (m³/ha)	Annual variation rate Total volume 1994-2004
regular high forest	1989	932,260	54.1%	162	
	1994	1,046,411	56.4%	174	
	1999	1,163,922	58.5%	181	
	2004	1,285,378	60.4%	190	2.1%
irregular high forest	1989	108,661	6.3%	149	
	1994	108,891	5.9%	154	
	1999	111,892	5.6%	167	
	2004	107,198	5.0%	168	-0.2%
coppice	1989	138,463	8.0%	58	
	1994	137,194	7.4%	61	
	1999	137,725	6.9%	65	
	2004	139,865	6.6%	67	0.2%
mixed coppice/broadleaved high forest	1989	475,119	27.6%	129	
	1994	483,897	26.1%	135	
	1999	496,214	24.9%	142	
	2004	509,338	23.9%	148	0.5%
mixed coppice/ conifer high forest	1989	68,047	4.0%	100	
	1994	77,337	4.2%	104	
	1999	81,111	4.1%	109	
	2004	85,422	4.0%	112	1.0%
Total	**1989**	**1,722,550**		**129**	
	1994	**1,853,730**		**138**	
	1999	**1,990,864**		**146**	
	2004	**2,127,201**		**154**	**1.4%**

(Source : IFN, apart from poplar plantations, for inventoried forests available for wood supply, based on overbark stem volumes to a 7 cm top diameter limit for stems with a diameter greater than 7.5 cm at breast height (1.30 m))

pure poplar plantations	**1994**	**22,761**		149	
	1999	**20,592**		137	
	2004	**18,273**		121	-2.2%

(Source : IFN, special inventory of pure poplar plantations limited to the main departments concerned, based on overbark stem volumes to a 7 cm top diameter limit for stems with a diameter greater than 7.5 cm at breast height (1.30 m), it is not possible to recreate the 1989 situation)

Commentary: the capitalisation phenomenon under way in French forests involves all stand types, but especially regular high forests, which currently have a growing stock of 190 m³/ha. The conversion of mixed coppice/high forest stands has prompted a substantial increase in growing stock in favour of regular high forest. Moreover, when afforested and reforested areas become productive, there is a subsequent boom in growing stock, especially Douglas fir (+6.8% per year in regular high forest stands). There has also been a rise of 1% per year in conifer growing stock in mixed coppice stands. Despite conversion operations, standing timber in mixed coppice/broadleaved high forest and coppice stands is still being capitalised. These coppice stands currently have a growing stock of 67 m³/ha.

Finally, only cultivated poplar plantations have shown a decline in both total volume and per-hectare volume. This situation is associated with a recent renewal of cultivated poplar plantations, which has seriously imbalanced the age class distribution (cf. § 3.1). It also corresponds to a decrease in forest area, especially in Champagne-Ardenne, Centre and Picardie regions, where a total of 6,000 ha was lost in 10 years. Of course, the expansion of forest area noted in other regions just slightly boosts the growing stock. Note again that the dendrometric data recorded on cultivated poplar plantations involved only the most representative French administrative departments.

INDICATOR 1.2.2
Growing stock by tree species

Forest stands available for wood supply (excluding poplar plantations)

IFN stem volume (7 cm top diameter)

Tree species	1989		1994		1999		2004		1994-2004
	total growing stock (x1,000 m³)	% total volume	total growing stock (x1,000 m³)	% total volume	total growing stock (x1,000 m³)	% total volume	total growing stock (x1,000 m³)	% total volume	annual variation rate
sessile & pedunculate oak	434,356	25.0%	467,151	25.2%	499,795	25.0%	524,989	24.6%	1.2%
beech	214,044	12.4%	222,683	12.0%	234,972	11.8%	241,727	11.3%	0.8%
maritime pine*	164,565	9.6%	186,395	10.0%	188,855	9.5%	200,267	9.4%	0.7%
silver fir	145,114	8.4%	147,789	8.0%	156,560	7.8%	164,737	7.7%	1.1%
common spruce	124,454	7.2%	137,649	7.4%	152,197	7.6%	164,380	7.7%	1.8%
Scots pine	136,376	7.9%	137,574	7.4%	140,467	7.0%	142,736	6.7%	0.4%
chestnut*	85,911	5.0%	90,150	4.9%	97,622	4.9%	101,091	4.7%	1.2%
hombeam	61,620	3.6%	67,575	3.6%	75,801	3.8%	81,917	3.8%	1.9%
pubescent oak*	40,955	2.4%	46,230	2.5%	54,340	2.7%	67,937	3.2%	3.9%
ash	40,875	2.4%	45,663	2.5%	51,764	2.6%	57,556	2.7%	2.3%
Douglas fir	15,454	0.9%	27,974	1.5%	41,256	2.1%	53,619	2.5%	6.7%
birch	38,555	2.2%	39,103	2.1%	39,524	2.0%	38,561	1.8%	-0.1%
Austrian pine	21,927	1.3%	23,369	1.3%	23,629	1.2%	25,609	1.2%	0.9%
aspen	21,210	1.2%	22,054	1.2%	22,443	1.1%	22,328	1.0%	0.1%
Corsican pine	12,021	0.7%	15,274	0.8%	18,877	0.9%	21,738	1.0%	3.6%
false acacia	16,789	1.0%	17,788	1.0%	18,190	0.9%	20,281	1.0%	1.3%
larch	15,542	0.9%	15,309	0.8%	15,265	0.8%	19,740	0.9%	2.6%
large alder	17,002	1.0%	17,151	0.9%	17,452	0.9%	19,464	0.9%	1.3%
large maple	10,024	0.6%	11,433	0.6%	13,367	0.7%	16,074	0.8%	3.5%
cherry or wild cherry	10,875	0.6%	12,482	0.7%	14,223	0.7%	15,796	0.7%	2.4%
holm oak*	10,714	0.6%	13,019	0.7%	14,421	0.7%	15,734	0.7%	1.9%
small maple	10,568	0.6%	11,298	0.6%	13,004	0.7%	14,770	0.7%	2.7%
Aleppo pine	10,464	0.6%	10,976	0.6%	11,181	0.6%	13,543	0.6%	2.1%
linden	9,797	0.6%	10,992	0.6%	12,083	0.6%	12,931	0.6%	1.6%
other broadleaved	39,172	2.3%	38,540	2.1%	41,807	2.1%	45,424	2.1%	1.7%
other conifers	14,166	0.8%	20,944	1.1%	27,247	1.4%	29,732	1.4%	3.6%
total broadleaved*	**1,062,468**	**61.7%**	**1,133,311**	**61.0%**	**1,220,810**	**61.2%**	**1,296,580**	**60.8%**	**1.4%**
total conifers*	**660,082**	**38.3%**	**723,253**	**39.0%**	**775,533**	**38.8%**	**836,101**	**39.2%**	**1.5%**
Total*	**1,722,550**	**100.0%**	**1,856,564**	**100.0%**	**1,996,343**	**100.0%**	**2,132,680**	**100.0%**	**1.4%**

* including estimated growing stock in the types of formations not inventoried in 1994, 1999 and 2004

(Source : IFN, apart from poplar plantations, for inventoried forests available for wood supply, based on overbark stem volumes to a 7 cm top diameter limit for stems with a diameter greater than 7.5 cm at breast height (1.30 m)).

Commentary: the 1999 storms were only partially taken into account in the 2004 figures, which is also the case for other IFN data (cf. list of survey dates and departments in Appendix 3). However, these events could have significantly modified the growing stock of some species, especially beech and maritime pine.

Broadleaved species account for more than 60% of the growing stock (1.3 billion m³), representing the majority species in most French regions, except for Aquitaine, Rhône-Alpes, Auvergne, Languedoc-Roussillon and Provence-Alpes-Côte d'Azur (Map 5).

The top 10 species represent over 80% of the growing stock in France (Figure 5), with sessile and pedunculate oak accounting for a quarter of the total, i.e. 525 million m³.

The growing stock of almost all species has increased over the last decade, even species whose area has declined, such as common spruce, Scots pine and maritime pine.

In conifers, the most spectacular increase was noted in Douglas fir (+6.7% per year) and Corsican pine (+3.6%), with reforested stands of saplings now in full growth. The growing stock of common spruce has also significantly increased, i.e. currently 187 m³/ha as compared to 152 m³/ha 10 years ago. Old spruce stands are thus being

capitalised. The low increase in silver fir recorded in 2000 was not confirmed in the latest update, i.e. the per-hectare growing stock has been steadily rising to the current level of 239 m³/ha.

Maritime pine is still the top conifer species in French forests, with more than 200 million m³ of standing timber. The increase in this species' growing stock is directly linked with the fact that the highest yielding stands derived from intensive silviculture in the Landes massif are reaching maturity.

The broadleaved growing stock has also increased significantly over the last decade, by an annual rate of 16 million m³, including 6 million m³ for sessile and pedunculate oak alone. As the areas of these two species have remained relatively steady, this phenomenon simply corresponds to capitalisation associated with the conversion into high forest stands and coppice aging. The growing stock of sessile and pedunculate oak stands has risen from 96 to 103 m³/ha in 10 years. The sharp increase in pubescent oak growing stock (+3.9% per year) seems to be associated with coppice aging and natural afforestation.

A different pattern applies for species such as beech and ash as their total growing stock is rising faster than their per-hectare growing stock, respectively increasing from 131 to 136 m³/ha and from 75 to 76 m³/ha in 10 years. It is quite likely that the growing stock has increased most significantly in stands in which beech and ash are secondary species.

Forest stands available for wood supply (excluding poplar plantations)

main tree species	growing stock per ha of main species (m³/ha)			
	1989	1994	1999	2004
sessile & pedunculate oak	90	96	102	103
beech	130	131	134	136
maritime pine	113	130	132	142
silver fir	228	226	230	239
common spruce	141	152	170	187
Scots pine	99	101	105	105
chestnut	87	89	99	100
hornbeam	55	57	64	67
pubescent oak	41	46	50	56
ash	73	75	76	76
Douglas fir	54	82	109	129
birch	46	47	49	51
Austrian pine	108	110	116	117
aspen	64	65	69	68
Corsican pine	119	124	127	129
false acacia	64	71	73	78
larch	129	128	127	146
large alder	95	98	104	115
large maple	53	56	60	66
cherry or wild cherry	35	37	35	38
holm oak	23	26	28	30
small maple	30	28	28	27
Aleppo pine	42	44	44	51
linden	71	74	75	83
other broadleaved	45	48	48	48
other conifers	63	84	104	116
total broadleaved	**83**	**88**	**93**	**94**
total conifers	**119**	**128**	**135**	**143**
Total	**96**	**102**	**108**	**112**

(Source : IFN, apart from poplar plantations, for inventoried forests available for wood supply, based on overbark stem volumes to a 7 cm top diameter limit for stems with a diameter greater than 7.5 cm at breast height (1.30 m). Only the growing stock of the main species is considered and correlated with the inventoried area of this species.)

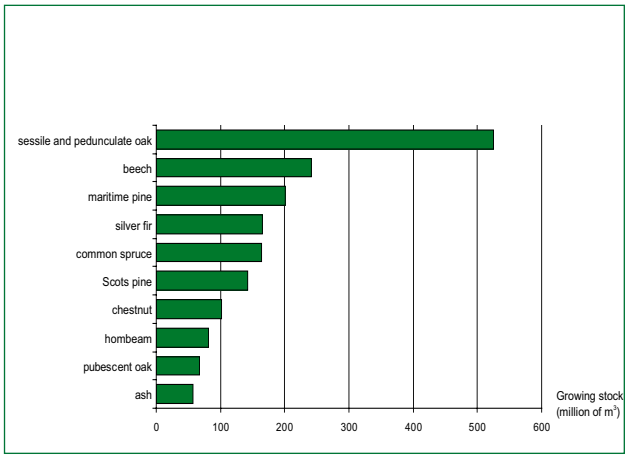
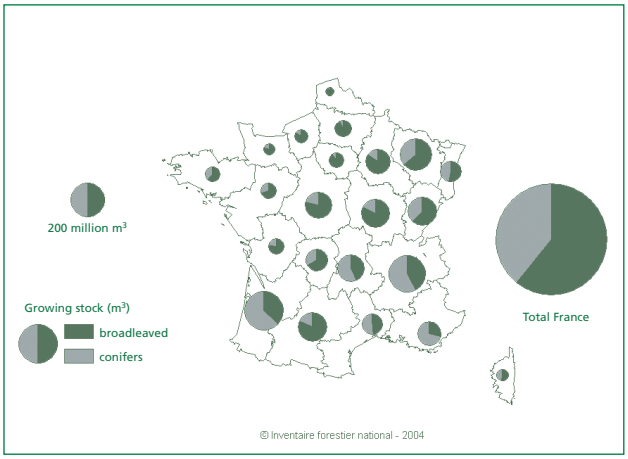


Figure 5: Growing stock of the top 10 species (source: IFN, 2004)



Map 5: Growing stock by administrative region and species group (source: IFN, 2004)

INDICATOR 1.3

Age structure and/or diameter distribution of forest and other wooded land, classified by forest type and by availability for wood supply

Forest stands available for wood supply (excluding poplar plantations)

Age distribution of regular high forest stands

Commentary: over half of regular high forests are now less than 60 years old, and the 20-40 year age category is the most represented, covering 20% of the area.

The table confirms the trends already recorded in 1999, i.e. a reduction in the area of stands less than 20 years old and over 180 years old, and an expansion of those in the 20-180 year age range. These trends, as expressed in proportions (Figure 6), are more manifest for young stands, which declined from 20% to 16.5% of the total area in 15 years, and for old stands as their share began diminishing as of 140 years old.

A breakdown of these results by species group shows a contrasting situation for broadleaved and conifer species. The reduction in the 0-20 age category applies only to conifers and reflects a slowdown in the pace of afforestation and reforestation, essentially in spruce and Scots pine. In contrast, the expansion of young broadleaved stands is probably due as much to regeneration and conversion as to natural afforestation.

The expansion of the 20-180 year categories cannot be explained solely by natural flows between age categories. It is obviously linked with the conversion of coppices and mixed coppice/high forest stands to regular high forests observed in § 1.1.3, which represents a considerable contribution, particularly in the 40-120 year category for sessile and pedunculate oaks.
Finally, the decline in high forests aged over 180 applies above all to pedunculate oak, beech and chestnut (cf. § 4.3.1).

Age class (years)	1989		1994		1999		2004		1994-2004
	x1,000 ha	%	x1,000 ha	%	x1,000 ha	%	x1,000 ha	%	annual variation rate
0-19	1,163	20.2%	1,133	18.8%	1,105	17.2%	1,118	16.5%	-0.1%
20-39	1,152	20.0%	1,190	19.8%	1,356	21.1%	1,351	20.0%	1.3%
40-59	881	15.3%	930	15.4%	1,001	15.6%	1,134	16.8%	2.0%
60-79	753	13.1%	817	13.6%	882	13.7%	956	14.1%	1.6%
80-99	585	10.2%	644	10.7%	715	11.1%	779	11.5%	1.9%
100-119	397	6.9%	432	7.2%	468	7.3%	519	7.7%	1.9%
120-139	330	5.7%	363	6.0%	383	6.0%	395	5.8%	0.8%
140-159	292	5.1%	309	5.1%	308	4.8%	313	4.6%	0.1%
160-179	61	1.1%	69	1.1%	76	1.2%	71	1.0%	0.3%
180-199	47	0.8%	48	0.8%	48	0.7%	46	0.7%	-0.4%
200-219	36	0.6%	34	0.6%	33	0.5%	35	0.5%	0.3%
220-239	36	0.6%	34	0.6%	33	0.5%	35	0.5%	0.3%
240 and over	18	0.3%	18	0.3%	15	0.2%	16	0.2%	-1.2%
unspecified	2	0.0%	0	0.0%	0	0.0%	0	0.0%	
Total	**5,753**	**100.0%**	**6,021**	**100.0%**	**6,423**	**100.0%**	**6,768**	**100.0%**	**1.2%**

(Source : IFN, apart from poplar plantations, only for regular high forests of inventoried forests available for wood supply, based on measurement of 20 year age classes in regular even-aged stands and by 30-80 year age classes in regular uneven-aged stands)

In conclusion, it should be borne in mind that regular high forests represent only 49% of the inventoried area and that this survey requires additional breakdown by diameter category in order to reach beyond the forest structures.

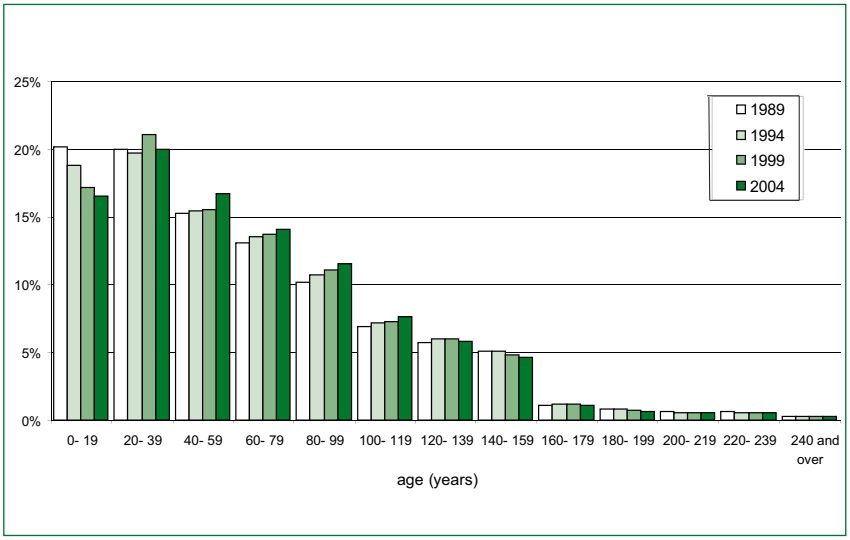


Figure 6: Variations in regular high forest by age class (source: IFN, total for France)

Tree diameter classes (for all structures combined)

IFN stem volume (7 cm top diameter)

Forest type	diameter class	1989		1994		1999		2004		1994-2004
		volume (x1,000 m³)	% volume	volume (x1,000 m³)	% volume	volume (x1,000 m³)	% volume	volume (x1,000 m³)	% volume	annual variation rate
Broad-leaved	10-25 cm	467,329	46.6%	489,208	45.7%	515,941	45.0%	536,165	44.0%	0.9%
	30-55 cm	431,611	43.0%	466,916	43.6%	503,265	43.9%	540,050	44.3%	1.5%
	60-85 cm	93,970	9.4%	103,093	9.6%	116,886	10.2%	130,445	10.7%	2.4%
	90-115 cm	8,946	0.9%	9,005	0.8%	9,759	0.9%	10,637	0.9%	1.7%
	120 cm and over	1,872	0.2%	1,615	0.2%	1,833	0.2%	1,738	0.1%	0.7%
Total broadleaved		**1,003,728**	**100.0%**	**1,069,836**	**100.0%**	**1,147,684**	**100.0%**	**1,219,034**	**100.0%**	**1.3%**
Conifers	10-25 cm	211,842	37.9%	233,798	38.2%	253,056	39.0%	256,946	36.9%	0.9%
	30-55 cm	307,865	55.1%	336,007	54.9%	352,144	54.3%	390,584	56.0%	1.5%
	60-85 cm	36,807	6.6%	39,971	6.5%	41,004	6.3%	47,004	6.7%	1.6%
	90-115 cm	2,038	0.4%	2,100	0.3%	2,321	0.4%	2,320	0.3%	1.0%
	120 cm and over	147	0.0%	116	0.0%	86	0.0%	85	0.0%	-3.1%
Total conifers		**558,699**	**100.0%**	**611,993**	**100.0%**	**648,611**	**100.0%**	**696,938**	**100.0%**	**1.3%**
Mixed	10-25 cm	61,811	38.7%	65,613	38.3%	74,365	38.4%	79,980	37.9%	2.0%
	30-55 cm	83,376	52.2%	89,417	52.2%	100,449	51.8%	109,299	51.7%	2.0%
	60-85 cm	13,377	8.4%	14,780	8.6%	17,456	9.0%	20,468	9.7%	3.3%
	90-115 cm	824	0.5%	1,129	0.7%	1,419	0.7%	1,321	0.6%	1.6%
	120 cm and over	259	0.2%	234	0.1%	186	0.1%	158	0.1%	-3.9%
Total Mixed		**159,647**	**100.0%**	**171,174**	**100.0%**	**193,875**	**100.0%**	**211,226**	**100.0%**	**2.1%**
All types	10-25 cm	740,983	43.0%	788,620	42.6%	843,362	42.4%	873,090	41.0%	1.0%
	30-55 cm	822,852	47.8%	892,339	48.2%	955,858	48.0%	1,039,933	48.9%	1.5%
	60-85 cm	144,153	8.4%	157,844	8.5%	175,346	8.8%	197,916	9.3%	2.3%
	90-115 cm	11,808	0.7%	12,234	0.7%	13,500	0.7%	14,277	0.7%	1.6%
	120 cm and over	2,278	0.1%	1,966	0.1%	2,104	0.1%	1,981	0.1%	0.1%
Subtotal		**1,722,074**	**100.0%**	**1,853,003**	**100.0%**	**1,990,171**	**100.0%**	**2,127,198**	**100.0%**	**1.4%**
unspecified		476		727		693		3		
Total		**1,722,550**		**1,853,730**		**1,990,864**		**2,127,201**		**1.4%**

(Source : IFN, apart from poplar plantations, for inventoried forests available for wood supply, based on overbark stem volumes to a 7 cm top diameter limit for stems with a diameter greater than 7.5 cm at breast height (1.30 m); the A diameter class refers to trees with a diameter ranging from A-2.5 cm to A+2.5 cm)

Commentary: the 1999 storms were only partially taken into account in the 2004 inventory update. However, the diameter class distribution could have been substantially modified since various studies have demonstrated that the storms had the greatest impact in forests with large diameter trees.

The increase in growing stock affected all diameter classes except the 10 cm class, which declined, and the 120 cm class and over, which remained virtually steady (Figure 7).
Despite the decrease in the number of 10 cm diameter trees, the growing stock of small diameter trees (10-25 cm) increased in all types of forest. The breakdown by species shows that this rise mainly involved Douglas fir, white conifers and broadleaved species other than oak and beech (cf. Appendix 11). The growing stock of medium diameter trees (30-55 cm) also increased, especially Douglas fir and other broadleaved species.

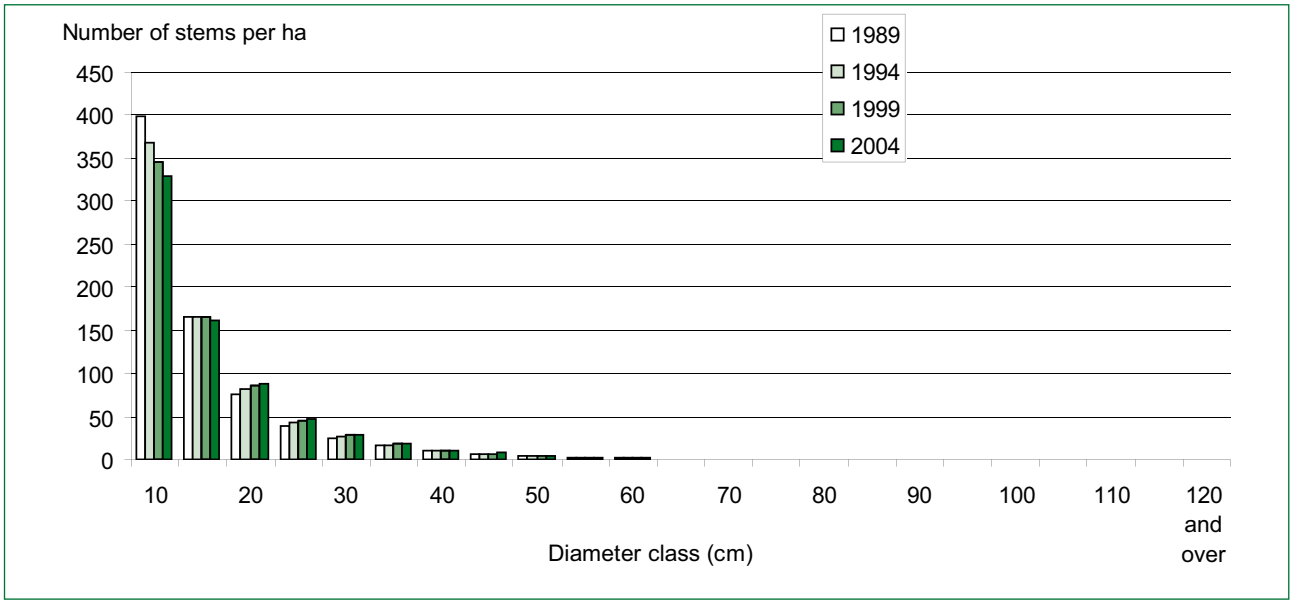
The stock of large diameter trees (60-85 cm) also increased, particularly in broadleaved stands, notably oak, and mixed stands. Growing stock of trees in the 120 cm and higher diameter classes declined in conifer and mixed stands, but these data are not very accurate due to the low volumes assessed.

Relative to the total growing stock, these results indicate that capitalisation has mainly been focused on medium diameter trees, which currently represent around 50% of the total growing stock, and on large diameter trees, whose stock has risen from 8.5% to 9.3% in 10 years. The share of capitalised very large diameter trees (90 cm and over) has levelled off.

Conversely, the proportion (in both number and stock) of small diameter trees continues to decrease. This

phenomenon is noted especially in sessile and pedunculate oak stands, with the number of 10 cm diameter trees dropping by 25% in 10 years. In view of the expansion of young age classes in regular high forest, it seems that this trend could mainly be attributed to coppice-with-standards management–their conversion into high forest has led to a sharp decline in oak and hornbeam coppice trees.

The extent of growing stock and density variations seems to differ within the same diameter class as a result of an increase in the mean tree stock, which in turn is mainly linked to an increase in mean tree height. It is, however, not clear whether silviculture or yield increases could have an impact on tree shape. A more in-depth analysis would now be required since the Inventaire forestier national (IFN) has changed its tree diameter calculation method, which could have slightly biased the results.



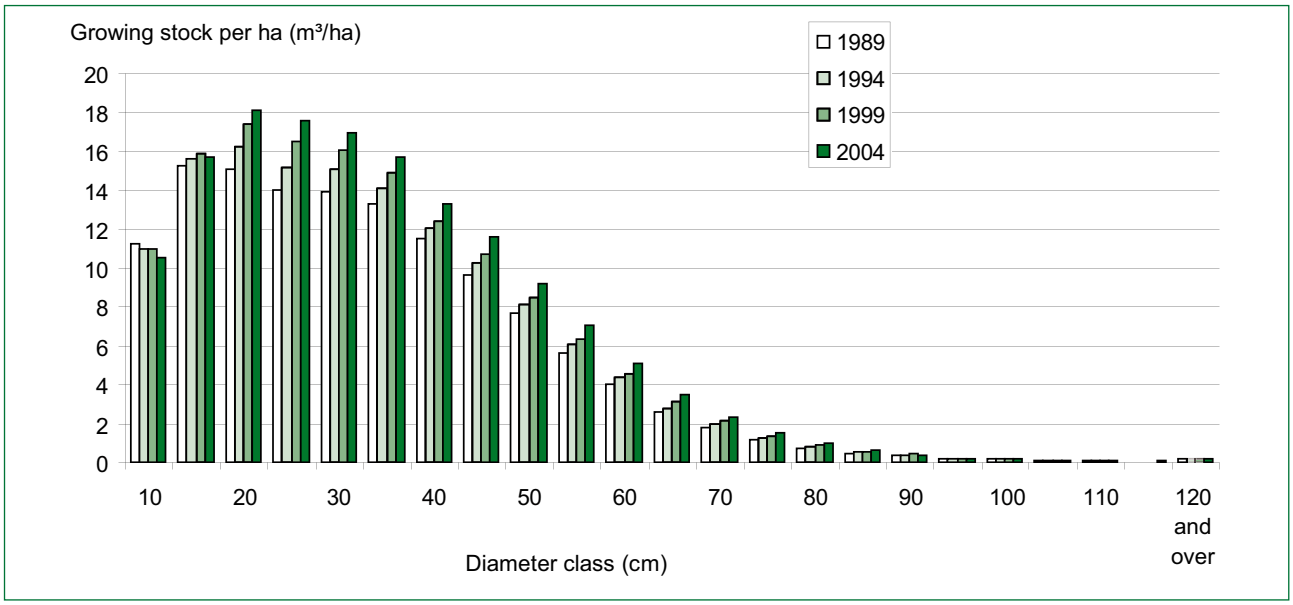


Figure 7: Variations in the number of stems and growing stock per ha and diameter class (source: IFN, total for France)

INDICATOR 1.4

Carbon stock of woody biomass and of soils on forest and other wooded land

Forest stands available for wood supply (excluding poplar plantations)

Compartment	Carbon stock (million t)				Carbone sink (million t/year)
	1989	1994	1999	2004	1994-2004
Tree above-ground biomass	603	654	714	765	11.1
Tree below-ground biomass	172	187	204	219	3.2
Subtotal forest biomass	**775**	**841**	**917**	**984**	**14.3**
per ha (t C/ha)	**58**	**63**	**67**	**71**	**0.9**
Forest soils (including litter)	ND	ND	1,074	1,074	ND
Total	ND	ND	**1,991**	**2,058**	ND
per ha (t C/ha)	ND	ND	**146**	**149**	ND

(Source : IFN, for inventoried forests available for wood supply, excluding poplar plantations, using LERFOB volume tables and the "root biomass expansion factor", "wood density" and "carbon content" coefficients given in the 2004 final report of the CARBOFOR France project; DSF 1993-94 was used to estimate carbon stocks in forest soils from the European network for forest damage monitoring (540 plots); the estimation includes carbon stored in the litter and in the 0-30 cm soil horizon; the 1999 value was retained for 2004 since the update will not be available until 2006).

⇨*Note : this table is based on a physical approach which does not go against the recording rules which apply within the framework of France's commitments under the Kyoto Protocol.*

Commentary: forests represent the most important carbon storage ecosystem in the world and are thus a key lever in policies designed to reduce greenhouse gas emissions.

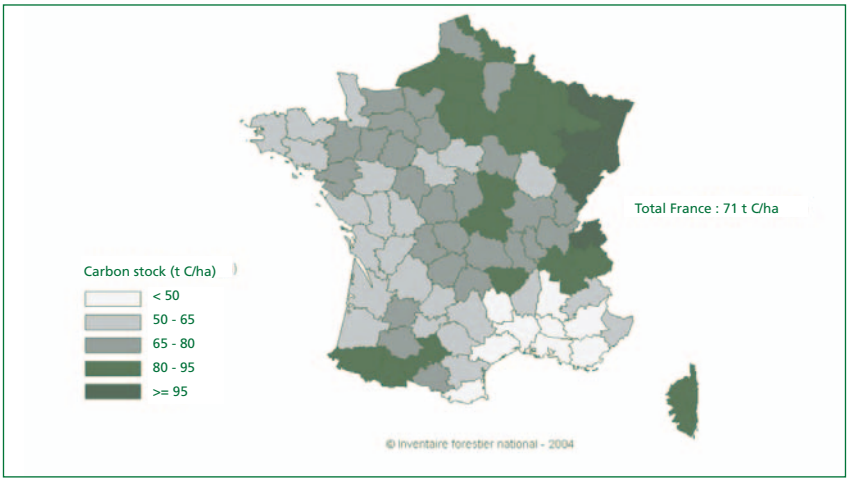
In forests, carbon is mainly stored in soilborne organic matter and tree biomass.

In 1993-94, the carbon stock in forest soils was assessed in 540 plots of the European network for forest damage monitoring (cf. § 2.3). This soil carbon stock was estimated to be 79 t/ha, or 54% of the total forest carbon stock. This proportion is slightly lower than that estimated in 1999 (60%) since the re-evaluation indicated a higher level of carbon stored in tree biomass. As these data are to be updated in 2006, temporal variations in this stock are still unknown. It seems certain that soilborne carbon increases with the tree age in new stands (natural colonisation or afforestation of farmland and heathland), but the patterns are less clear in long-established forests. Moreover, a network for soil quality measurement has been set up to assess soil carbon stocks and flows in other wooded lands (cf. § 2.2).

Carbon contained in tree biomass is increasing steadily, like the growing stock, and now amounts to 984 million t in inventoried production forest (excluding poplar plantations), or 71 t/ha. Below-ground tree biomass accounts for more than 20% of this total amount. The net annual carbon storage, or "sink", is estimated at 14.3 million t per year for the 1986-96 period (1994-2004 available data). This sink represents 13% of gross CO2 emissions, without taking land-use, land-use changes and forestry into account (cf. §1.4.1).

These estimates are substantially higher than those published in the 2000 edition of the present report–the carbon stock that was estimated at 51 and 55 t/ha for 1994 and 1999 have now been re-evaluated at 63 and 67 t/ha, respectively. This adjustment is based on the conclusions of the final report of the CARBOFOR project, published in 2004, which modified the proportions of branches and roots allocated to the IFN volumes (Box 2).

The highest carbon stocks are found in northeastern France (Alsace, Lorraine, Franche-Comté), the northern Alps and western Pyrenees (Map 6), while the lowest levels are found in the Mediterranean region. These results are linked with the stem volumes (IFN volumes) and the proportion of branches. Broadleaved stands thus have a higher per-hectare carbon stock than conifer stands even though their per-hectare IFN volume is lower (76 t C/ha versus 62 t C/ha for conifers).

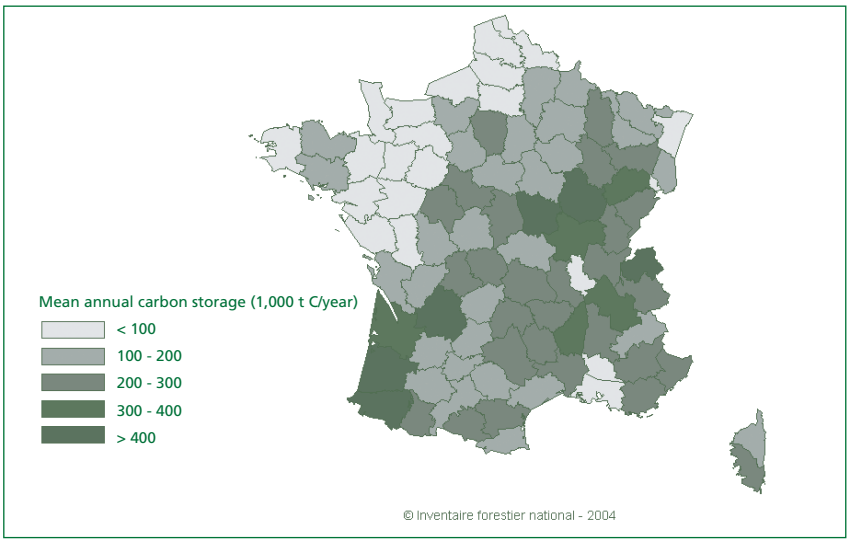


Map 6: Mean carbon stock per ha in forest biomass by department in the last inventory (source: IFN, 2004)

The greatest carbon sinks are located along a broad diagonal line tracking from the southwest to the northeast, especially in the Aquitaine and Bourgogne regions (Map 7). This situation was likely modified by the 1999 storms, but their impact was only partially taken into account in 2004–most departmental inventories after year 2000 were conducted in regions that were largely unaffected by the storms. These estimations will soon be updated via the new annual inventory method.
The results obtained in Aquitaine should be analysed with caution since they could be linked with the sharp rise in maritime pine yield capacity. Moreover, it should also be checked whether the change in tree diameter measurement method has had an effect (impact on tree volume table used). These results are at variance with the fact that Landes and Gironde departments have a high timber removal rate.

These estimates only concern inventoried production forests, excluding poplar plantations, for which reliable data are available. Other compartments could not be taken into account in this indicator due to the lack of reliable elements: deadwood and living biomass formed by woody and non-woody undergrowth and foliage. Substantial work is thus still required for a full assessment of carbon storage in forests by compartment:
- living biomass: other wooded lands, poplar plantations and other wooded areas (heathlands) to be taken into account; non-inventoried stems, shrubs, non-woody vegetation and foliage in all formations to be taken into account
- deadwood: to be taken into account in all formations
- soils and ground litter: poplar and other wooded areas (heathlands) to be taken into account.

Forests contribute to curbing the greenhouse effect, but this contribution not only involves their carbon stock. The use of timber produced by forests from atmospheric CO2 increases the carbon sustainably stored in forest products (buildings, constructions), while also reducing fossil fuel consumption. In addition to using fuelwood as an alternative to fossil fuel, timber use–at equivalent performance–consumes less energy than other competing raw materials (steel, concrete, PVC, etc.). This contribution is, however, hard to quantify.



Map 7: Annual variations in forest biomass carbon stock by department between the last two inventories (source: IFN, 2004)

Box 2: CARBOFOR project

The CARBOFOR project on carbon sequestration in large-scale forest ecosystems in France was jointly conducted from 2002 to 2004 by many partners and funded by the French Ministry of Ecology and Sustainable Development (MEDD) and the Forestry Ministry (MAP) via the ECOFOR public interest group. This research project compared ecosystem responses to a regionalised climatic scenario (1960-2100) with respect to the carbon cycle, biogeography and susceptibility to major pests and diseases.
The French Institut national de la recherche agronomique (INRA), Inventaire forestier national (IFN) and the Laboratoire d'études des ressources forêt-bois (LERFOB) have developed a new method for calculating carbon stocks in tree biomass on a national scale. The modifications relative to the method outlined in the year 2000 edition of the present report are as follows:
- the total above-ground carbon volume of trees is based on volume tables drawn up by LERFOB from French forest research archival data, so the mean branch biomass expansion factor is 1.61 for broadleaved species and 1.33 for conifers, as compared to 1.40 and 1.30, respectively (FAO/UNECE mean coefficients);
- the root biomass expansion factor, wood density and carbon content were modified on the basis of a bibliographical analysis. The root biomass expansion factors were readjusted from 1.14 to 1.28 for broadleaved species and 1.15 to 1.30 for conifers. The wood density was upgraded from 0.53 to 0.55 for broadleaved species and from 0.39 to 0.44 for conifers. Finally, the carbon content was reset at 0.475 instead of 0.5.
These modifications resulted in an overall ratio (t C/m³ IFN) of 0.53 for broadleaved species and 0.36 for conifers, as compared to 0.42 and 0.30, respectively, in the year 2000 report. The difference generally concerns the use of the LERFOB volume tables per main species types. These new results will have to be confirmed, but they already seem more suitable than the previous overall broadleaved/conifer coefficients.

INDICATOR 1.4.1
Annual carbon emission levels

Commentary: carbon dioxide (CO2) is a major greenhouse gas which contributed to more than 70% of the net global warming potential of France in 2002. This proposed indicator highlights the role of forests and land-use in overall carbon emissions in France.
Gross annual carbon emissions were estimated at 107 million t in 2002, excluding flows associated with land-use, land-use changes, and forestry (LULUCF).
These emissions are mainly linked with fossil fuel consumption, so the data are highly sensitive to climatic variations. Road transport, residential/service industries, industrial manufacturing and energy conversion are the main sectors involved.

	Units	1990	1992	1997	2002	Annual variation rate 1992-2002
gross annual CO_2 emission excluding land-use, land-use changes and forestry (LULUCF)	million t of carbon equivalent	106	110	107	107	-0.3%
net CO_2 sink (LULUCF : land-use, land-use changes and forestry)	million t of carbon equivalent	7	7	11	13	6.4%
net annual **CO_2 emission**	million t of carbon equivalent	99	103	96	94	-0.9%
	t of carbon equivalent per capita	1.75	1.79	1.64	1.58	-1.3%

(Source : Citepa/Coralie/UNFCCC format - metropolitan France - updated 19/12/2003 and INSEE/national population census; the net CO_2 sink is the balance between carbon destocking (emission) and storage (gross sink) noted during land-use changes and forest operations (LULUCF); the main emission concerns timber fellings in forests and trees out of forests; conversely, tree biomass volume increment represents most of the gross carbon sink, the difference between gross carbon emissions excluding LULUCF and the net carbon sink represents the net emission).

A comparison with 1990–the Kyoto Protocol reference year–revealed that gross CO2 emissions, excluding LULUCF, have remained relatively steady in metropolitan France. This phenomenon is tied closely with the increase in road transport, which offsets the advances achieved in other areas such as energy conversion.
Net carbon emissions have markedly decreased, with 94 million t recorded in 2002. In relation to the French population, they represented 1.58 t per capita in 2002 versus 1.75 in 1990. These results highlight the importance of taking forest carbon sinks into consideration in policies geared towards reducing greenhouse gas emissions in France. The net carbon sink has increased from 7 to 13 million t since 1990 and progressed by 2 million t over the last 5 years. This clear trend could be explained by the differential between increment and timber fellings in forests, which increased during this period. It could also, in some situations, be reversed when large-scale accidental events such as the 1999 storms occur. It is probable that such events could reoccur considering the present climate change setting.
These data cannot be directly compared with those presented in § 1.4 because the methods implemented and the fields concerned are not exactly the same (cf. Box 3).
The measures to be implemented to curb CO2 emissions in France were described in the Plan Climat 2004, which are aimed at saving 54 million t of CO2 equivalent yearly by 2010, or 15 million t of carbon equivalent. For the forestry sector, the main measures concern the effective use of biomass-derived products (fuelwood and timber) and increasing forest carbon sinks.

Box 3: CITEPA estimation of net carbon sinks

The carbon sink associated with land-use, land-use changes and forestry (LULUCF) is estimated annually by the Centre interprofessionnel technique d'études de la pollution atmosphérique (CITEPA). It is based on different estimations:

- **variations in forest carbon stocks are calculated through:**
  - **an assessment of forest and non-forest tree biomass increment based on Inventaire forestier national (IFN) data; this provides a gross carbon sink estimate**
  - **an assessment of fellings based on data from the Service central des enquêtes et études statistiques (SCEES) for commercial fellings, and from the Observatoire de l'Energie for self-consumption. The total fellings represent the gross carbon emission**
- **deforestation (gross carbon emission)**
- **variations in carbon stock due to land-use changes: conversion of grassland and uncultivated farmland into forests, and grassland into uncultivated farmland (carbon sink), and conversion of forests and grassland into farmland (carbon source). The balance is negative, thus inducing net carbon emission.**

Concerning variations in forest carbon stocks, carbon flows in forests (increment and fellings) can be estimated directly using the CITEPA method. It thus differs from the method outlined in § 1.4, which is based on a comparison of carbon stocks at different dates and is limited to production forests inventoried by IFN. The expansion coefficients used by CITEPA to correct increment are not the same as those used by IFN in § 1.4. Finally, net soil carbon emissions that occur for 15-30 years after intensive cutting or clearcutting are currently not taken into account.

Criterion 2

Maintenance of forest ecosystem health and vitality

INDICATOR 2.1

Deposition of air pollutants on forest and other wooded land, classified by N, S and base cations

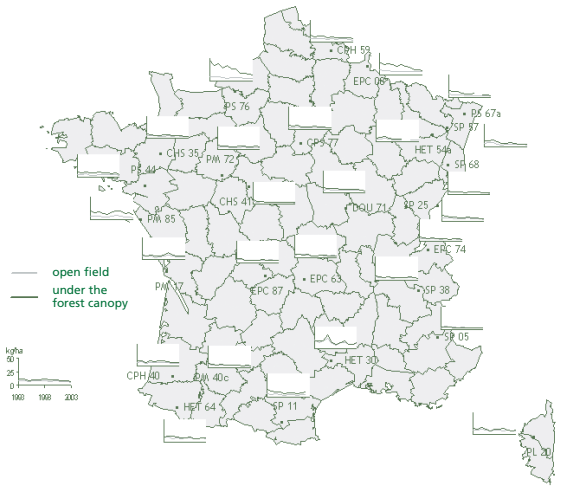
1) Estimate of atmospheric deposition under the forest canopy (throughfall) in the RENECOFOR network - 1999-2003 averages*

Plot	Mean annual deposition												Mean precipitation under the forest canopy
	H+	Cl	S-SO_4	N-NO_3	Na	N-NH_4	K	Mg	Ca	Fe	Al	Mn	
	g/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	kg/ha	g/ha	g/ha	g/ha	mm
CHP 40	12.1	55.6	9.0	2.4	28.6	4.2	39.3	5.7	12.1	105	93	443	811
CHP 59	30.1	22.9	9.5	2.9	10.6	11.9	43.3	4.2	9.9	120	96	1,229	850
CHS 35	8.8	32.6	5.1	2.4	15.7	7.0	24.7	3.2	6.2	95	58	1,473	637
CHS 41	13.5	16.0	3.7	2.8	7.2	3.5	18.8	2.2	7.9	74	59	1,226	634
CPS 77	10.3	15.9	4.7	3.1	6.3	5.1	19.6	2.9	11.3	126	107	1,937	552
DOU 71	76.6	22.3	6.9	9.0	12.9	5.4	12.4	3.2	8.0	77	160	827	1,122
EPC 08	158.5	29.2	14.3	10.3	15.7	9.2	23.8	2.9	9.4	164	484	1,846	1,108
EPC 63	29.2	16.0	4.2	4.4	8.1	2.6	12.9	2.6	6.9	103	236	570	508
EPC 74	72.6	7.5	5.0	7.3	3.0	5.3	13.2	1.5	10.8	127	201	208	1,004
EPC 87	24.6	27.7	6.2	5.3	14.0	4.4	26.5	3.1	7.0	90	212	351	784
HET 30	130.7	32.4	12.8	8.5	19.0	7.4	17.3	3.6	19.7	149	176	607	2 036
HET 64	19.1	27.7	9.1	5.0	13.9	4.3	19.0	2.8	10.7	54	74	384	914
PL 20	51.8	99.1	10.5	3.9	56.0	0.8	12.7	8.7	21.2	124	598	340	1,059
PM 17	97.1	142.6	10.0	3.6	78.6	2.3	7.5	10.7	11.4	55	95	133	717
PM 40c	60.6	39.2	5.3	2.8	19.4	2.4	13.2	5.0	10.5	71	238	91	629
PM 72	22.6	35.1	6.1	6.1	18.3	9.2	12.4	3.3	6.9	68	114	433	730
PM 85	66.2	239.0	15.3	4.4	133.4	3.7	15.7	17.8	12.9	77	71	112	591
PS 44	73.5	80.9	8.4	3.5	43.5	6.5	19.2	6.1	6.4	74	219	219	701
PS 67a	95.2	12.2	6.2	6.8	5.7	10.4	11.9	1.4	6.3	68	176	868	589
PS 76	282.1	63.1	17.9	6.2	35.4	7.4	14.6	5.3	10.1	84	344	1,262	692
SP 05	2.9	5.4	3.9	0.7	1.6	0.8	31.4	2.3	14.0	72	236	106	611
SP 11	27.1	26.4	9.1	3.6	13.2	2.2	36.9	2.9	13.6	137	259	255	827
SP 25	110.6	14.9	7.0	6.9	7.2	4.6	19.1	2.1	12.6	143	147	378	1,523
SP 38	32.3	5.8	5.3	1.7	1.8	1.9	19.5	1.5	8.3	87	162	1,147	1,107
SP 57	91.4	12.6	6.9	5.3	5.5	3.7	19.0	1.4	7.2	95	151	2,369	811
SP 68	53.2	8.6	4.4	6.0	4.0	3.6	17.4	1.4	5.8	69	190	247	755
Mean 1999-2003	63.6	41.9	8.0	4.8	22.3	5.0	20.1	4.1	10.3	96	191	733	858
Mean 1993-1998	113.0	43.6	11.0	4.8	23.0	4.8	21.5	4.2	11.3	63	235	854	813
Absolute variation	-49.4	-1.6	-3.0	0.0	-0.7	0.2	-1.4	-0.1	-1.0	34	-44	-121	-45
Relative variation	-43.7%	-3.7%	-27.4%	0.0%	-3.0%	3.2%	-6.7%	-1.9%	-9.1%	53.6%	-18.8%	-14.1%	-5.6%

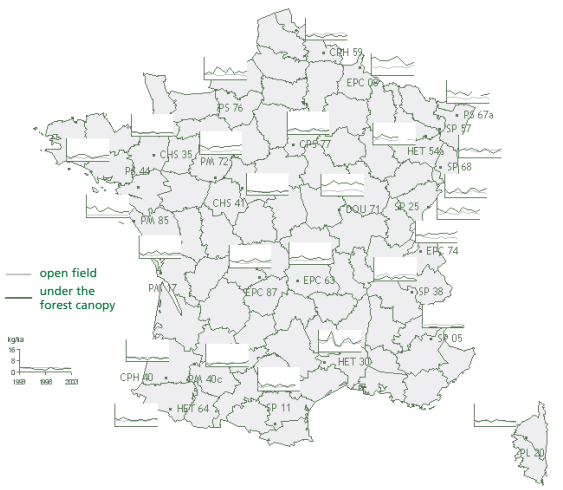
* except for PS 67a : 1999-2003 (not 2000) and SP 11 : 1999-2002

(Source : ONF (mean 1999-2003*), manager of the French RENECOFOR network (Réseau National de suivi à long terme des Ecosystèmes Forestiers) and the CATAENAT sub-network (Charge Acide Totale d'origine Atmosphérique dans les Ecosystèmes Naturels Terrestres) ; the plots are identified by their predominant species (CHS for sessile oak, CHP for pedunculate oak, CPS for pedunculate oak and sessile oak cumbined, HET for beech, EPC for Norway spruce, PS for Scots pine, PM for maritime pine, PL for Corsican pine, DOU for Douglas fir, SP for silver fir), followed by the department number of the plot)

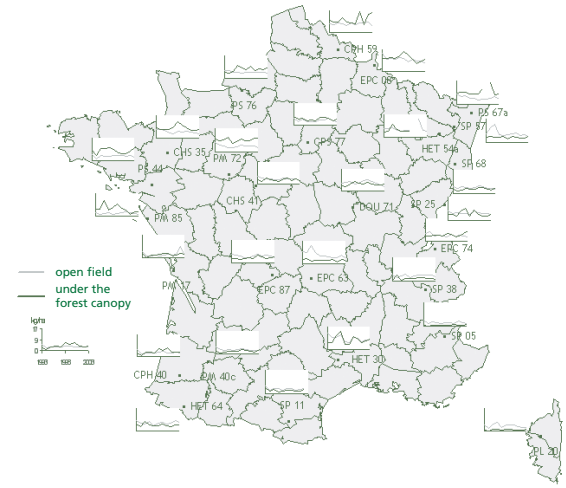
RENECOFOR - CATAENAT
Variations in *open field and throughfall deposition* of sulfate ($S\text{-}SO_4$) from 1993 to 2003



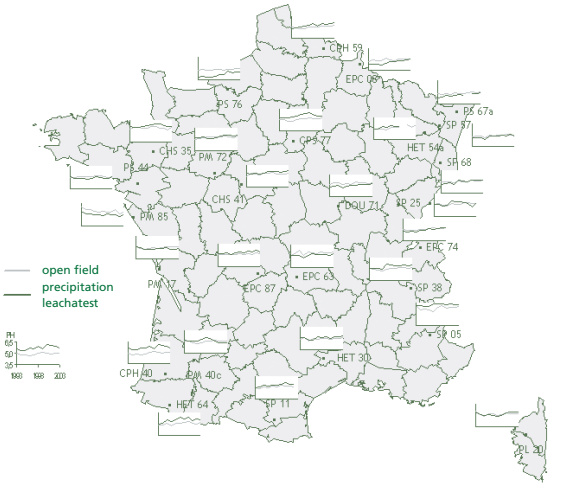
RENECOFOR - CATAENAT
Variations in *open field and throughfall deposition* of nitrate ($N\text{-}NO_3$) from 1993 to 2003



RENECOFOR - CATAENAT
Variations in *open field and throughfall deposition* of ammonium ($N\text{-}NH_4$) from 1993 to 2003



RENECOFOR - CATAENAT
Variations in *pH* in open field precipitation and throughfall from 1993 to 2003



(Source: ONF (1993-2003 averages), manager of the French RENECOFOR network (Réseau National de suivi à long terme des Ecosystèmes Forestiers) and the CATAENAT sub-network (Charge acide totale d'origine atmosphérique dans les écosystèmes naturels terrestres); the plots are identified by their predominant species (CHS for sessile oak, CHP for pedunculate oak, CPS for pedunculate oak and sessile oak combined, HET for beech, EPC for Norway spruce, PS for Scots pine, PM for maritime pine, PL for Corsican pine, DOU for Douglas fir, SP for silver fir), followed by the department number of the plot)

Map 8: Variations in open field and throughfall deposition of sulfate, nitrate, ammonium and associated precipitation pH from 1993 to 2003 - CATAENAT sub-network (source: ONF)

CRITERION 2 - DEPOSITION OF AIR POLLUTANTS

Commentary: the main purpose of the CATAENAT network, set up by the French Office national des forêts (ONF) in late 1992, is to quantify atmospheric deposition on forests. The network consists of 27 sites in open fields and 26 sites within forests located throughout metropolitan France, varying in terms of both the predominant species in the stand and its geographical location, without claiming to be statistically representative. A time-series of 11 years of annual precipitation and atmospheric deposition in the open field and under the forest canopy (throughfall deposition) is available for the 1993-2003 period (Map 8). As an in-depth specialised analysis of these results will soon be published, only the main trends reported in ONF scientific reports are discussed here.
Details on the 1993-98 and 1999-2003 comparisons are given in Appendix 11.

Throughfall deposition is usually quite different from open field deposition. Several factors of differing significance are involved, i.e. the type of local or regional pollution, tree species, presence of mist or cloud droplets, stemflow and canopy exchange (absorption or leaching of elements). All of these factors generally lead to a net increase in throughfall deposition, except for nitrogen compounds (especially ammonia) which tend to diminish in regions where nitrogen deposition is low due to canopy uptake. Cation exchange on leaf surfaces can also reduce proton deposition under the canopy.
Furthermore, throughfall deposition is often greater under conifers–except for larch–than under broadleaved species in the same forest area owing to the persistence of conifer foliage in winter.

a) Acid deposition induced by **protons** in open field precipitation and throughfall is mostly low, i.e. in all plots they are under 1 kg (Keq)/ha/year. The maxima obtained in throughfall occur in Seine-Maritime (PS76), Ardennes (EPC08) and at Mont Aigoual (HET30). Apart from Jura (SP 25), where proton deposition increased by 10%, all the other sites showed a clear decrease in direct acid deposition between the two periods 1993-98 and 1999-2003. This decline generally ranged from 33 to 55%. The sharpest decrease was noted in Seine-Maritime (PS 76), in the Brotonne forest, located midway between Le Havre and Rouen.

b) During the 1993-98 period, **sulphur** was the main acidic compound at half of the sites, whereas during the 1999-2003 period it was the main acidic compound at 30% of the sites. This pattern was marked by two contrasting trends. First, sulphur depositions following the massive reduction in emissions declined at almost all of the sites (except PM17, in Charente-Maritime, near the coast) and, secondly, total mineral nitrogen (N-NO3+N-NH4) depositions increased at 14 out of 26 sites, while levels remained steady at three sites and decreased at nine sites. Nitrogen is thus slowly becoming the predominant acidic compound. Depending on the prevailing soil fertility, forest soil acidification can rise substantially when sulfate depositions surpass 4-16 kg/ha/year. The progress made in SO2 emission reductions from 1980 onwards now seems to be having a marked impact.
With a few exceptions, throughfall sulphur deposition is always higher than open field sulphur deposition, thus perfectly demonstrating the filtering effect of the canopy. Two plots situated close to an industrial site or region (PS76 and EPC08) showed high deposition loads in throughfall which are likely to upset the balance of the forest ecosystem, even though they can to some extent be offset by calcium inputs. The Vendée site (PM 85), where sulphur deposition is also high, is close to the Atlantic coast and thus also benefits from depositions of marine sulphur and other neutralising compounds (potassium, calcium, magnesium).

c) **Ammonium** deposition (precipitation leachates and not total deposition in modelled forests) varies considerably between regions. An increase was noted at 17 out of 26 sites. In the northwestern quarter (PM85 to CHP59) and Alsace (PS67a), throughfall ammonium fluxes are high because of nearby intensive farming (livestock breeding and fertilisation).
The highest nitrate deposition rates are found in the northeastern quarter of France, ranging from 7 to 10 kg/-ha/year, where throughfall fluxes are up to twice the open field deposition fluxes (EPC08, PS67a, DOU71). Mont Aigoual (HET 30), which receives exceptional precipitation, has a high nitrogen deposition level which can eventually lead to ecosystem degradation due to soil eutrophication. An increase in nitrate deposition of 5 to 41% was observed at 11 sites, with a decrease of 0.4 to 32% noted at 15 sites.

d) Average total mineral **nitrogen** (N-NO3+N-NH4) deposition is quite high, i.e. 10 kg/ha/year (range 4-20 kg/-ha/year). These inputs increased at 14 sites (from 2 to 37%), decreased at 9 sites (from 2 to 40%) and remained steady at three sites.

e) Deposition loads of **sodium** and **chloride**, when elevated (PL20, PM17, PM85), are essentially derived from the sea, with trees subjected to extreme salinity conditions.

f) Considerable **aluminium** deposition is generally related to the proximity of polluting industries (PS76, PS67a). For plot PL20, the probable cause is more contingent (road traffic or soil erosion).

g) Of the **heavy metals**, manganese deposits represent the highest levels, particularly in plots SP57, PS76 and EPC08. Additional analyses are currently under way to confirm the link between these deposits and nutritional deficiency in conifer stands.

The nitrogen and sulphur deposition patterns suggest that poor to moderately poor soils are subjected to accelerated acidification and that all ecosystems with high nitrogen inputs will likely undergo eutrophication. Analyses of soils of plots in the RENECOFOR network are to be replicated 10 years after the initial analysis (1993/95)–these analyses should reveal the actual impact of these deposits on forest ecosystems.

2) Variations in overall precipitation quality <u>in open fields</u> in the CATAENAT sub-network from 1993 to 2003 (mean national concentrations weighted by the precipitation)
Units: per mm of precipitation in mg/mm, with pH and protons in g/l

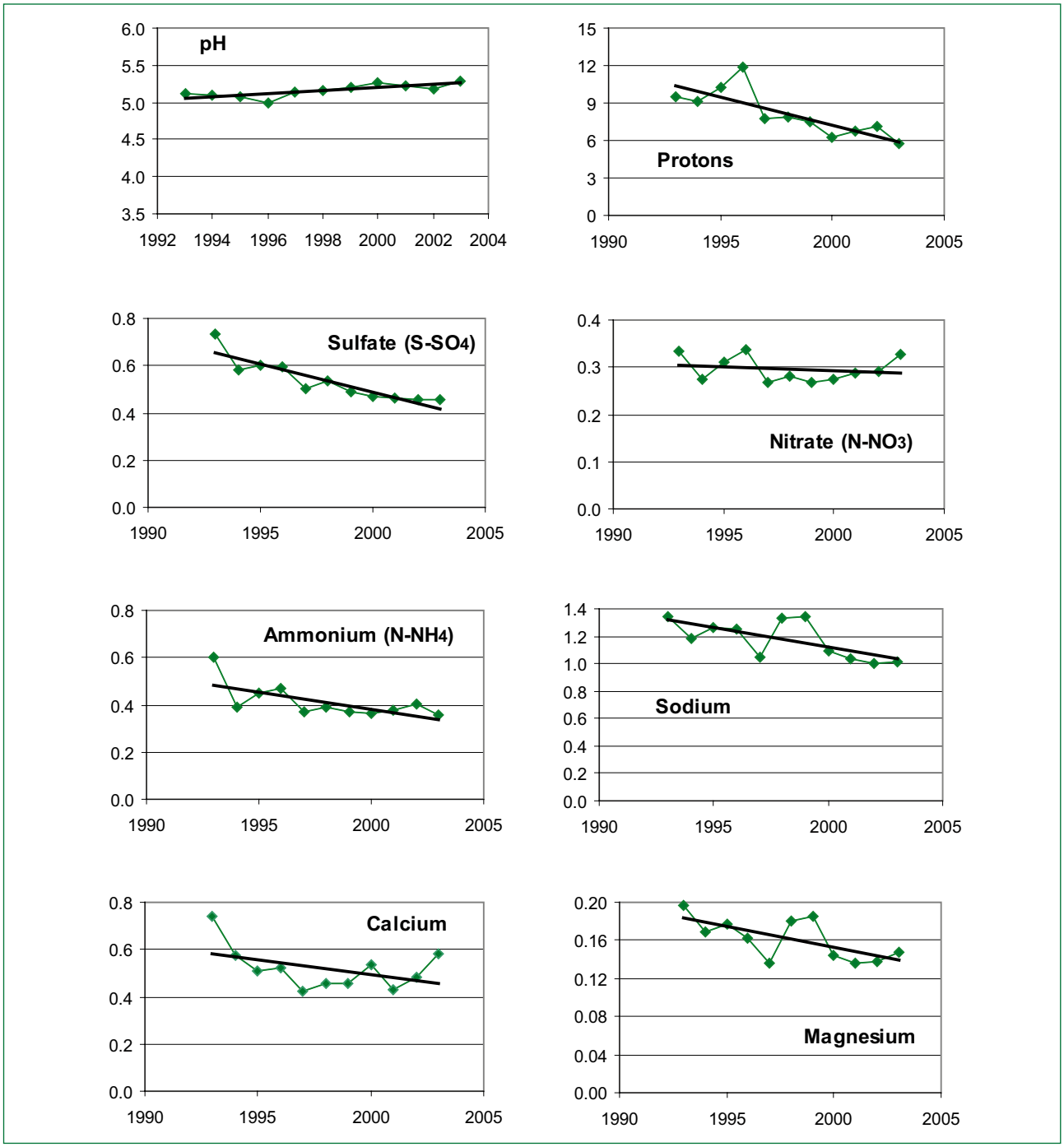
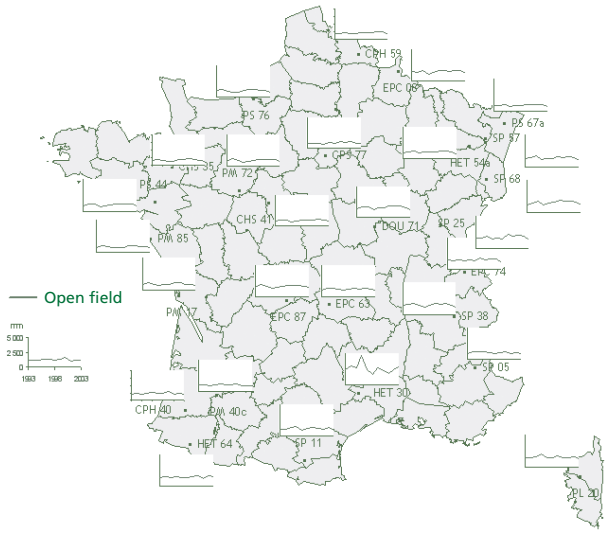


Figure 8: Variations in overall precipitation quality in open fields in the CATAENAT sub-network from 1993 to 2003 (source: ONF)

Commentary: indicators of the mean overall precipitation quality in France can be calculated simply by dividing the sum of annual depositions at all sites by the sum of their precipitations. The result is the mean annual concentration per mm of precipitation for all 27 sites located in the open field. From a scientific standpoint, this is the only national indicator for monitoring long-term precipitation quality trends (Figure 8 and Map 9).

The mean precipitation acidity has decreased over the last 10 years–the mean pH has been steadily rising since 1993, with a decrease of 43% in the proton concentration within 11 years. This could be partially explained by the 36% decrease in sulfate concentrations during the same period. Nitrate concentrations have unfortunately levelled off, while ammonium levels have been dropping, but this trend will have to be confirmed in the coming years. Annual variations in other ions are still much too marked to be able to accurately determine the trends.

RENECOFOR - CATAENAT
Variations in open field *precipitation* from 1993 to 2003



(Source: ONF, manager of the French RENECOFOR network (Réseau National de suivi à long terme des Ecosystèmes Forestiers) and the CATAENAT sub-network (Charge acide totale d'origine atmosphérique dans les écosystèmes naturels terrestres); the plots are identified by their predominant species (CHS for sessile oak, CHP for pedunculate oak, CPS for pedunculate oak and sessile oak combined, HET for beech, EPC for Norway spruce, PS for Scots pine, PM for maritime pine, PL for Corsican pine, DOU for Douglas fir, SP for silver fir), followed by the department number of the plot))

Map 9: Variations in open field precipitation from 1993 to 2003 - CATAENAT sub-network (source: ONF)

INDICATOR 2.1.1
Atmospheric pollutant emission patterns

Commentary: atmospheric pollutants are among the factors that contribute to forest damage. Sulphur dioxide (SO_2) is an acidifying factor (sulphuric acid). Nitrogen oxide (NO_x) contributes to acidification (nitric acid) and eutrophication (nitrogen enrichment); it also contributes to the production of ozone (O_3), through reactions with non-methane volatile organic compounds (NMVOC). Ammonia (NH_3) contributes to nitrogen deposition and acidification of soils.

Over the past 10 years, considerable scientific research has been focused on "critical loads", i.e. deposition levels below which there is no adverse effect on susceptible components of the ecosystem. This has provided a basis for negotiation on all pollutants (SO_2, NO_x, COV, NH_3) in terms of their contribution to acidification, eutrophication and photochemical pollution (O_3). The resulting "multi-pollutants – multi-effects" protocol (Gothenburg Protocol, 1999) sets new pollutant reduction targets for 2010–it is more restrictive than existing protocols, and for the first time includes NH_3.

SO_2 emissions have dropped sharply since 1980, especially because of the closure of thermal power plants, the

	Units	1980	1985	1992	1997	2002	Annual variation rate 1992-2002
SO_2	x1,000 tonnes	3,214	1,497	1,261	806	537	-8.2%
NO_x	x1,000 tonnes	2,024	1,847	1,914	1,607	1,352	-3.4%
NH_3	x1,000 tonnes	795	799	765	783	778	0.2%
COVNM	x1,000 tonnes			2,424	1,947	1,542	-4,4%
acidification and eutrophication (SO_2, NO_x et NH_3)	in acid equivalent (Aeq)	191.3	133.9	126.0	106.1	91.9	-3.1%

(Source : Citepa/Coralie/Secten format - Update : 27 April 2004)

desuphurisation of industrial emissions and the use of low-sulphur fuels. France has thus fulfilled its commitments of 1985 and 1994 under the "Convention on Long-Range Trans-boundary Air Pollution" (Geneva, 1979). The second protocol (Oslo, 1994) set its sights on a 74% reduction of 1980 levels by 2000, a target that has largely been met. This reduction trend should continue in coming years with the implementation of regulations aimed at more severely controlling the threshold emission limits for large-scale combustion plants, while also reducing the sulphur content in liquid fuel. This is in line with the quite restrictive targets for 2010, through the "National Emission Ceilings" directive, which is geared towards reducing emissions by around 40% relative to current levels.

The protocol on the reduction of nitrogen oxide emissions (NO_X) signed in Sofia in 1988 set two commitments: stabilisation of emissions at 1987 levels by 1994 and a 30% reduction of the 1980 levels by 1998. The first commitment has been fulfilled, but not the second. Road traffic represents the prime emitter (48% in 2002), even though its contribution has declined over the last 10 years owing to the fact that vehicles are progressively being fitted with catalytic converters. There should be further reductions in the near future as large-scale combustion plants are forced to comply with the directive.

The agriculture sector accounts for a major share of ammonia (NH_3) emissions, i.e. around 97% of total emissions in metropolitan France in 2002, with 78% just for livestock production. The emission fluctuations noted in recent years are related to variations in livestock numbers. The current emission level corresponds to the 2010 target under the National Emission Ceilings directive, i.e. 780 kilo-tonnes. Considering the predicted increase in some livestock herds in coming years, measures will be required to reduce agricultural ammonia emissions in order to be able to meet the national target.

Non-methane volatile organic compound (NMVOC) levels have dropped considerably since 1988, mainly in road transport and energy transformation (road vehicles fitted with catalytic converters, progress in storage and distribution of hydrocarbons). France's commitment to reduce emissions by 30% between 1988 and 1999 (Geneva Protocol, 1991) has been fulfilled. Further substantial progress is needed in the coming years to reach the target set by the National Emission Ceilings directive, i.e. 1050 kilo-tonnes.

The "acidification and eutrophication" indicator aims to assess the overall quantity of compounds released into the atmosphere which contribute to acidification and eutrophication phenomena. Deposition levels have dropped by around 50% since 1980 due to the marked reduction in SO2 emissions. Ammonia currently represents half of the contribution of this indicator, as compared to 24% in 1980.

INDICATOR 2.2

Chemical soil properties (pH, CEC, C/N, organic C, base saturation) on forest and other wooded land related to soil acidity and eutrophication, classified by main soil types

Commentary: forest soils were first analysed in 1993-1994 in plots of the European network for forest damage monitoring (European network level 1) that were set up throughout France on the basis of a 16 x 16 km square grid in 1989. This network is extended to non-forest areas through a soil quality measurement network, with plots set up as of 2001 according to the same square grid and managed by the "Sols" scientific interest group. Variations in soil quality, according to 2000 assessment points, are thus being monitored throughout France via these networks.

Soil type	Number of plots monitored	Water pH	Cation exchange capacity (CEC)	Base saturation rate	Organic carbon content	Carbon/nitrogen ratio (C/N)
Cambisol	222	5.5	11.5	57.6	36.0	14.9
Leptosol	123	7.0	27.0	93.5	47.1	14.1
Luvisol	72	4.8	5.6	47.6	27.5	16.5
Podzol	47	4.7	3.3	32.6	26.5	24.5
Gleysol	10	5.8	19.2	75.4	41.2	13.0
Regosol	3	6.7	13.6	82.6	37.3	17.8
Arenosol	2	5.3	1.4	60.1	12.5	25.5
Others	29	5.8	8.7	70.2	34.8	16.3

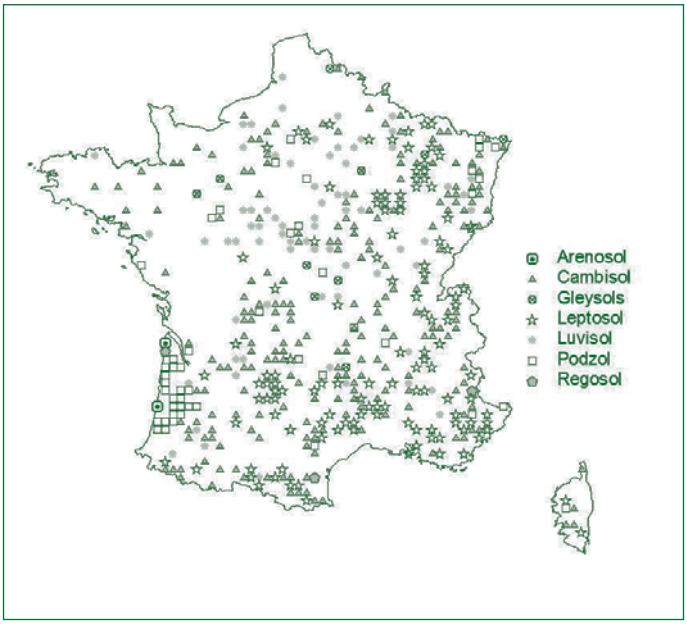
(Source : Département de la santé des forêts - inventaire des sols forestiers européens (16 km x 16 km) ; means for 1993-94 in the 0-20 cm horizon; Histosols were not found in the 508 monitored plots; an update will be available in 2006.)

The second forest network in France, i.e. the REseau National de suivi à long terme des ECOsystèmes FORestiers (RENECOFOR), managed by the Office national des forêts, aims to gain insight into changes in forest ecosystems based on intensive monitoring of around 100 sampling plots. This network is not statistically representative of the entire French forest, but studies on forest soils (also sampled between 1993 and 1995) will provide reliable data, especially on changes in acidic forest soils which are very prevalent in this network.

A second analysis of soils in plots of the European network for forest damage monitoring (level 1) is planned for 2006-2007. The date of the second resampling of soils of the RENECOFOR network has not yet been set. While awaiting these new inventory surveys, the main characteristics of French forest soils could be represented by the 1993-94 soil sampling results.

The distribution of types of forest soils sampled in the plots of the European network (level 1) is given in the table according to the 1999 FAO classification. The spatial distribution is also shown on Map 10. Cambisols and Leptosols predominate throughout France, accounting for two-thirds of the soils in the sampling plots. The chemical characteristics, which can change due to the impact of silviculture and atmospheric inputs, are also presented for each soil type. However, these mean values mask the very high heterogeneity within the same FAO class, e.g. the variation coefficient (CV) for the cation exchange capacity of Cambisols is above 100%. The base saturation rate and organic carbon content are also highly variable (CV over 50%). Although this variability is artificial and linked with the classification system used, it highlights that the spatial variability in soils must be carefully taken into account during the sampling phase. This spatial variability has to be substantially reduced during sampling within the monitoring network – where pedological characteristics are the main focus of investigation – in order to allow detection of fine temporal changes in the soils.

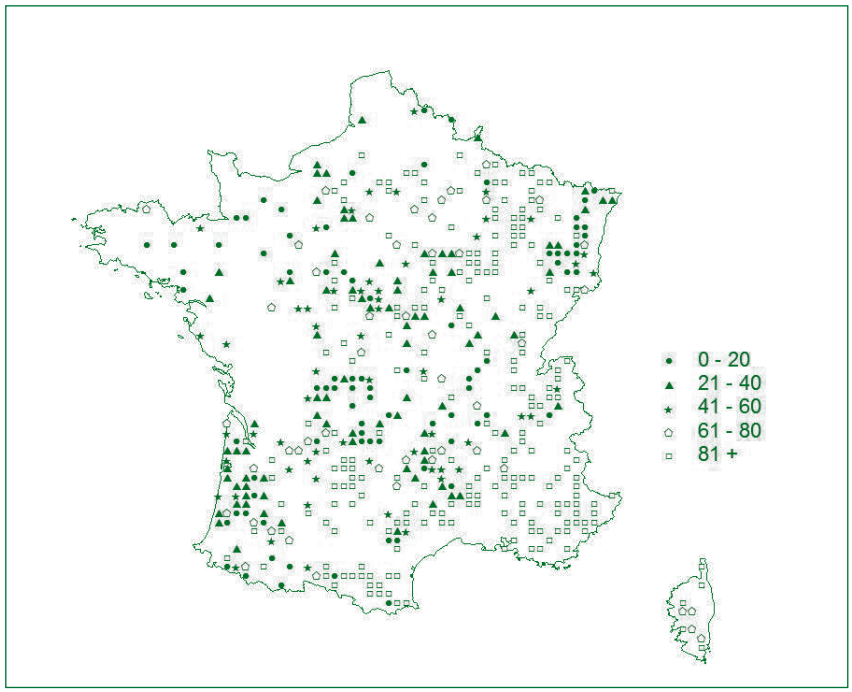
The historical data show that forest soils in northeastern France have become impoverished in recent decades, but there is not enough available data to quantify the extent of these trends in the various regions and for the different types of soil. The networks recently set up will make it possible to monitor future trends.



Map 10: Types of soil found in the plots of the European monitoring network over a 16 x 16 km grid (source: DSF, 1993-94)

Forest soils are much more acidic and unsaturated (low proportion of base cations in the cation exchange complex) than agricultural soils. The differences could be explained by the fact that forest stands often grow on barren soils (mountain, hydromorphic and superficial soils, etc.), without any inputs (fertilisers and other soil conditioners). Moreover, mineral losses regularly occur as a result of silvicultural nutrient export without subsequent mineral restoration, litter extraction, and increased leaching of minerals by acidic atmospheric depositions.

Map 11 highlights the spatial distribution in rates of nutrient (calcium, magnesium, potassium) saturation of the cation exchange complex within the 0-20 cm horizon in soils from sampling plots in the European monitoring network. 45% of these soils have a base saturation rate of over 80%, whereas 16% have a rate of less than 20%. No precise minimum thresholds have been set, below which forest trees would have mineral nutrition problems, but it is known that the risks increase considerably when the base saturation rate is under 10% (6% of soils). The most unsaturated soils are mainly found in Vosges, the northwestern regions (Normandie, Bretagne), Massif Central and the Landes massif.



Map 11: Base saturation rates recorded in plots of the European monitoring network over a 16 x 16 km grid (source: DSF, 1993-94)

INDICATOR 2.3

Defoliation of one or more main tree species on forest and other wooded land in each of the defoliation classes: "moderate", "severe" and "dead"

Defoliation class	Species	Proportion of trees affected							
		1997	1998	1999	2000	2001	2002	2003	2004
moderate (25% to 60%)	Broadleaved	27.5%	25.0%	21.7%	20.3%	21.8%	23.8%	30.0%	34.1%
	Conifers	14.2%	15.4%	13.2%	10.7%	12.8%	13.8%	16.8%	15.8%
	All species	**22.9%**	**21.6%**	**18.7%**	**17.0%**	**18.7%**	**20.3%**	**25.4%**	**27.7%**
severe (over 60%)	Broadleaved	2.2%	1.7%	1.0%	1.2%	1.6%	1.5%	3.3%	4.1%
	Conifers	1.7%	1.3%	0.8%	1.0%	1.1%	1.2%	1.9%	1.5%
	All species	**2.1%**	**1.6%**	**0.9%**	**1.1%**	**1.4%**	**1.4%**	**2.8%**	**3.2%**
dead trees	Broadleaved	0.2%	0.2%	0.1%	0.1%	0.1%	0.2%	0.2%	0.5%
	Conifers	0.3%	0.1%	0.1%	0.2%	0.2%	0.2%	0.2%	1.3%
	All species	**0.2%**	**0.2%**	**0.1%**	**0.1%**	**0.2%**	**0.2%**	**0.2%**	**0.8%**
Total : over 25% defoliation	Broadleaved	29.9%	26.9%	22.8%	21.6%	23.6%	25.4%	33.4%	38.7%
	Résineux	16.2%	16.8%	14.2%	12.0%	14.1%	15.1%	19.0%	18.6%
	All species	**25.2%**	**23.3%**	**19.7%**	**18.3%**	**20.3%**	**21.9%**	**28.4%**	**31.7%**

(Source : Département de la santé des forêts - European network for forest damage monitoring. Due to a change of method during the 1995-1997 period, data recorded before 1994 cannot be compared with those recorded after 1997, so the results presented here were recorded as of 1997. Defoliation of a tree was assessed relative to a reference tree (nul defoliation). The references are defined for each species, region and stand. Comparisons between species or main categories (broadleaved, conifers) are thus difficult. When considering the data presented on the table, it is important to focus on relative defoliation trends for a given species rather than on absolute values.)

⇨ *Note : the European network for forest damage monitoring is a network of permanent plots, each consisting of 20 trees installed on a systematic 16 x 16 km grid. There are potentially 558 plots in the French part of this network (which involves around 30 countries). Recordings are only done on plots with a stand that has grown to a certain height (over 60 cm). Since the 1999 storms, just over 40 plots have been temporarily suspended until a new stand meets the monitoring criteria. Hence, just over 510 plots have been monitored since year 2000. They are surveyed every summer by a team of two pest and disease specialists. The state of the tree crowns is visually assessed and potential causes of damage are determined when possible.*

Commentary: the defoliation status generally reflects the vitality of the tree, and is the result of various factors: tree age, silvicultural history, pest insects, pathogenic fungi, climatic stress, atmospheric pollution, mineral deficiency, etc. It is, however, often hard to assess theextent of impact of these factors.

Two major climatic events affected forest stands in France during the 2000-2004 period–the 1999 storms and the 2003 drought-heat wave.
The severe storms in December 1999 caused major damage to French forests. In the European network for forest damage monitoring, stands on 41 plots were decimated by more than 50% and 23 of them were completely destroyed. Windfall and broken trees began being replaced in the summer of year 2000 when possible in the stands. However, sampling on 29 plots was suspended (impossible to obtain a suitable sample within a 40 m radius). For the other plots, 1,051 trees of the 1999 sampling were replaced, i.e. about 10% of the total 1999 sample. No major crown degradation was noted during the years following the storms since branches broken by the storms were not recorded as defoliation elements.

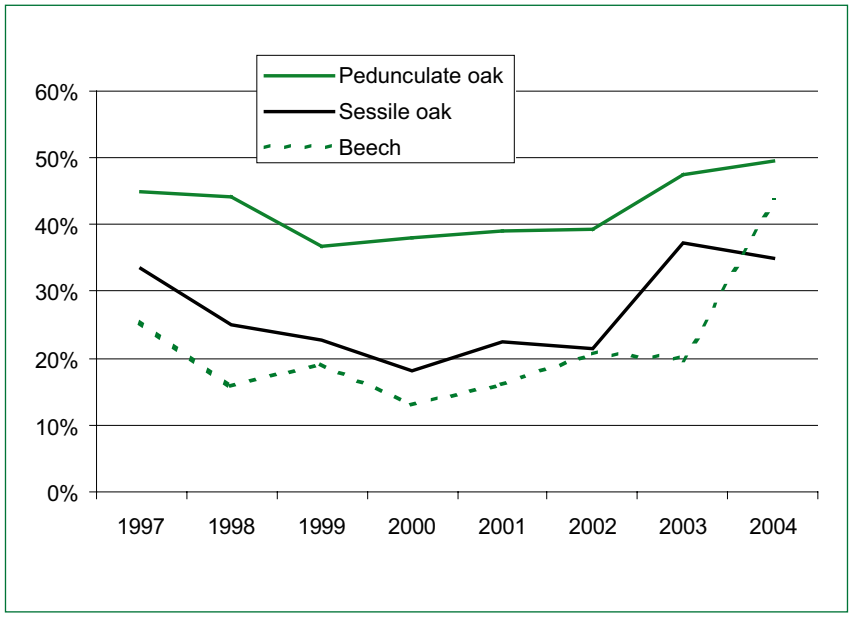


Figure 9: Variations in the percentage of broadleaved trees with a defoliation rate above 25% from 1997 to 2004 (source: DSF)

Overall, there was a steady improvement in most species from 1997 to 2002, but this trend was more substantial in broadleaved species than in conifers, except for maritime pine and Scots pine whose defoliation rates began increasing as early as 2000 (Figures 9 and 10). Of the broadleaved species, oaks–especially pedunculate and pubescent oaks–had very high defoliation rates. Fir and spruce, which were in an alarming state in the 1980s, remained stable during this 1997-2002 period.

In 2003, the drought and heat wave had a major impact on tree crowns, as early as 2003 for some species (sessile oak, pedunculate oak, birch, etc.), but for most species the effects were noted as of 2004 (beech, spruce, etc.).

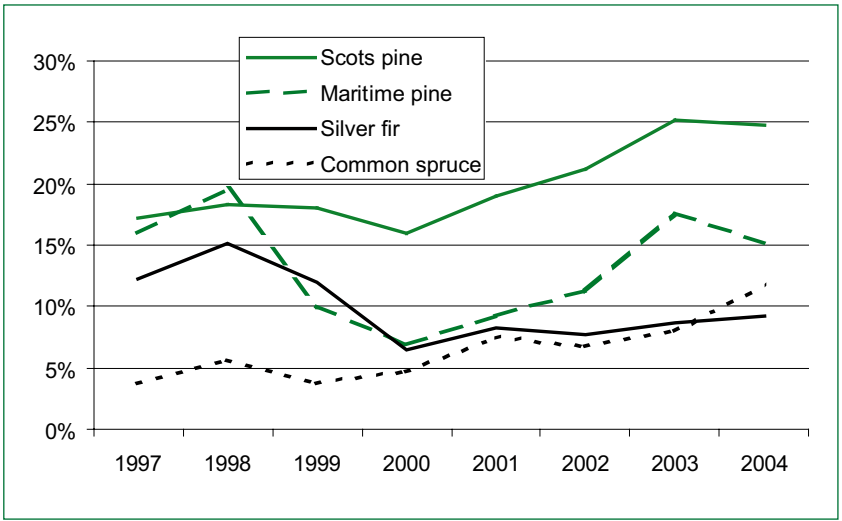


Figure 10: Variations in the percentage of conifer trees with a defoliation rate above 25% from 1997 to 2004 (source: DSF)

Number of trees monitored

Species	1997	1998	1999	2000	2001	2002	2003	2004
Sessile oak	1,212	1,229	1,237	1,233	1,236	1,243	1,246	1,248
Pedunculate oak	1,218	1,219	1,185	1,196	1,178	1,179	1,170	1,170
Holm oak	407	388	386	386	380	362	362	359
Pubescent oak	858	843	845	834	844	845	807	811
Beech	1,039	1,010	1,135	1,060	1,093	1,094	1,100	1,104
Maple	169	164	152	139	139	140	138	139
Birch	243	209	200	175	181	180	177	162
Hornbeam	281	281	279	281	269	264	269	266
Chestnut	531	523	510	481	476	477	467	463
Ash	306	295	298	291	292	290	286	288
Poplar	203	174	171	140	142	142	139	139
Wild cherry	130	132	131	110	112	113	109	105
Other broadleaved	477	464	457	428	425	422	425	421
Total broadleaved	**7,074**	**6,931**	**6,986**	**6,754**	**6,767**	**6,751**	**6,695**	**6,675**
Common spruce	597	603	584	548	550	546	547	519
Silver fir	512	501	520	464	464	481	482	486
Scots pine	761	748	745	633	633	635	632	631
Maritime pine	970	974	961	907	927	906	906	887
Austrian pine	278	280	278	231	235	235	235	236
Aleppo pine	105	125	226	226	222	226	226	226
Douglas fir	243	318	319	320	341	341	341	325
Larch	140	141	141	142	142	142	142	143
Other conifers	120	119	119	92	92	92	92	91
Total conifers	**3,726**	**3,809**	**3,893**	**3,563**	**3,606**	**3,604**	**3,603**	**3,544**
Total all species	**10,800**	**10,740**	**10,879**	**10,317**	**10,373**	**10,355**	**10,298**	**10,219**

Moderate defoliation (25% to 60%)

Species	1997	1998	1999	2000	2001	2002	2003	2004
Sessile oak	32.0%	24.1%	22.3%	17.8%	21.9%	20.8%	34.9%	32.5%
Pedunculate oak	42.0%	41.3%	35.3%	36.1%	36.5%	36.8%	43.7%	44.4%
Holm oak	20.9%	26.5%	25.6%	28.2%	30.8%	32.6%	49.2%	39.6%
Pubescent oak	40.2%	41.9%	28.6%	31.4%	28.6%	35.3%	37.8%	38.7%
Beech	21.8%	15.2%	19.0%	13.1%	16.0%	20.0%	19.0%	39.5%
Maple	9.5%	14.0%	9.2%	6.5%	7.2%	11.4%	25.4%	31.7%
Birch	21.8%	15.8%	20.5%	9.7%	17.7%	15.6%	24.3%	29.0%
Hornbeam	15.7%	18.1%	5.7%	3.2%	7.8%	11.4%	15.6%	33.1%
Chestnut	10.9%	7.8%	8.4%	6.2%	5.7%	6.1%	9.0%	15.1%
Ash	16.3%	13.6%	10.4%	11.0%	13.7%	16.2%	23.1%	21.9%
Poplar	25.1%	19.5%	22.2%	27.1%	18.3%	20.4%	20.9%	28.8%
Wild cherry	32.3%	35.6%	26.0%	20.0%	22.3%	24.8%	24.8%	28.6%
Other broadleaved	16.1%	11.2%	10.5%	12.6%	14.6%	16.4%	20.2%	17.8%
Total broadleaved	**27.5%**	**25.0%**	**21.7%**	**20.3%**	**21.8%**	**23.8%**	**30.0%**	**34.1%**
Common spruce	3.0%	4.8%	3.3%	4.2%	6.9%	6.2%	7.1%	6.9%
Silver fir	11.3%	14.0%	11.3%	5.6%	7.3%	6.7%	6.6%	8.0%
Scots pine	14.5%	16.8%	16.5%	13.6%	16.4%	18.0%	22.2%	20.3%
Maritime pine	14.7%	17.9%	9.3%	6.2%	8.8%	10.7%	16.4%	13.8%
Austrian pine	8.6%	8.9%	11.2%	12.1%	14.5%	17.4%	19.6%	20.8%
Aleppo pine	47.6%	41.6%	38.1%	37.6%	36.5%	42.0%	54.4%	43.8%
Douglas fir	25.1%	17.9%	17.6%	11.9%	11.1%	11.4%	15.2%	15.4%
Larch	38.6%	33.3%	27.7%	21.8%	28.9%	24.6%	12.0%	20.3%
Other conifers	8.3%	5.9%	10.9%	9.8%	10.9%	9.8%	9.8%	8.8%
Total conifers	**14.2%**	**15.4%**	**13.2%**	**10.7%**	**12.8%**	**13.8%**	**16.8%**	**15.8%**
Total all species	**22.9%**	**21.6%**	**18.7%**	**17.0%**	**18.7%**	**20.3%**	**25.4%**	**27.7%**

Severe defoliation (> 60%)

Species	1997	1998	1999	2000	2001	2002	2003	2004
Sessile oak	1.2%	0.8%	0.2%	0.2%	0.5%	0.6%	2.2%	2.4%
Pedunculate oak	2.8%	2.3%	1.5%	1.8%	2.4%	2.4%	3.8%	5.0%
Holm oak	1.2%	1.5%	0.8%	1.0%	4.5%	3.9%	1.4%	7.0%
Pubescent oak	2.3%	3.0%	1.3%	1.9%	2.4%	1.8%	4.7%	3.8%
Beech	3.8%	0.6%	0.2%	0.0%	0.2%	0.5%	0.5%	2.8%
Maple	0.0%	0.6%	0.0%	0.7%	0.0%	0.0%	0.0%	3.6%
Birch	0.4%	1.0%	0.0%	0.0%	0.6%	0.0%	1.7%	2.5%
Hornbeam	0.0%	2.5%	0.4%	0.0%	0.0%	0.4%	4.1%	16.9%
Chestnut	3.6%	3.3%	2.7%	3.3%	2.5%	2.1%	7.9%	4.8%
Ash	1.3%	0.3%	0.7%	0.7%	0.7%	0.3%	1.0%	0.7%
Poplar	1.0%	1.1%	1.2%	0.7%	6.3%	5.6%	6.5%	5.0%
Wild cherry	6.2%	2.3%	4.6%	10.0%	4.5%	3.5%	17.4%	7.6%
Other broadleaved	2.3%	2.4%	2.2%	1.4%	2.1%	1.4%	4.0%	1.7%
Total broadleaved	**2.2%**	**1.7%**	**1.0%**	**1.2%**	**1.6%**	**1.5%**	**3.3%**	**4.1%**
Common spruce	0.7%	0.7%	0.3%	0.5%	0.5%	0.4%	0.7%	1.3%
Silver fir	1.0%	1.0%	0.4%	0.9%	0.9%	0.8%	1.9%	0.4%
Scots pine	2.0%	1.5%	1.2%	2.1%	1.9%	2.7%	2.5%	3.3%
Maritime pine	1.0%	1.5%	0.6%	0.2%	0.1%	0.6%	0.9%	0.7%
Austrian pine	0.0%	0.0%	0.0%	0.0%	0.4%	0.4%	5.5%	1.7%
Aleppo pine	3.8%	3.2%	2.2%	4.9%	5.9%	4.9%	6.6%	2.7%
Douglas fir	8.2%	2.5%	1.9%	0.9%	0.3%	0.3%	0.3%	1.2%
Larch	5.0%	0.7%	0.0%	0.0%	1.4%	0.0%	0.0%	0.0%
Other conifers	0.0%	0.8%	0.8%	1.1%	1.1%	2.2%	2.2%	3.3%
Total conifers	**1.7%**	**1.3%**	**0.8%**	**1.0%**	**1.1%**	**1.2%**	**1.9%**	**1.5%**
Total all species	**2.1%**	**1.6%**	**0.9%**	**1.1%**	**1.4%**	**1.4%**	**2.8%**	**3.2%**

Percentage of dead trees

Species	1997	1998	1999	2000	2001	2002	2003	2004
Sessile oak	0.2%	0.0%	0.1%	0.1%	0.0%	0.1%	0.0%	0.0%
Pedunculate oak	0.1%	0.4%	0.1%	0.3%	0.1%	0.2%	0.1%	0.1%
Holm oak	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%	0.3%	0.0%
Pubescent oak	0.1%	0.1%	0.0%	0.0%	0.1%	0.2%	0.0%	0.4%
Beech	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.3%	1.0%
Maple	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Birch	1.2%	1.0%	0.5%	0.0%	0.0%	0.6%	0.0%	3.7%
Hornbeam	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Chestnut	0.0%	0.4%	0.2%	0.2%	0.2%	0.6%	0.6%	1.9%
Ash	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Poplar	0.0%	2.3%	1.2%	0.7%	1.4%	0.7%	0.0%	1.4%
Wild cherry	0.8%	0.0%	0.0%	0.0%	0.9%	0.0%	0.0%	1.9%
Other broadleaved	1.0%	0.2%	0.2%	0.2%	0.7%	0.2%	0.7%	0.0%
Total broadleaved	**0.2%**	**0.2%**	**0.1%**	**0.1%**	**0.1%**	**0.2%**	**0.2%**	**0.5%**
Common spruce	0.0%	0.2%	0.2%	0.0%	0.0%	0.2%	0.2%	3.5%
Silver fir	0.0%	0.2%	0.2%	0.0%	0.0%	0.2%	0.2%	0.8%
Scots pine	0.8%	0.0%	0.3%	0.3%	0.6%	0.6%	0.5%	1.1%
Maritime pine	0.2%	0.1%	0.1%	0.6%	0.3%	0.0%	0.3%	0.7%
Austrian pine	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.0%
Aleppo pine	1.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.4%	0.9%
Douglas fir	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%
Larch	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Other conifers	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total conifers	**0.3%**	**0.1%**	**0.1%**	**0.2%**	**0.2%**	**0.2%**	**0.2%**	**1.3%**
Total all species	**0.2%**	**0.2%**	**0.1%**	**0.1%**	**0.2%**	**0.2%**	**0.2%**	**0.8%**

(Source : Département de la santé des forêts - European network for forest damage monitoring)

Mortality trends

Species	Mean mortality rate		
	1990-94	1995-99	2000-04
Sessile oak	0.03%	0.06%	0.03%
Pedunculate oak	0.15%	0.20%	0.14%
Holm oak	0.17%	0.00%	0.16%
Pubescent oak	0.08%	0.12%	0.14%
Beech	0.00%	0.10%	0.29%
Maple	0.13%	0.00%	0.00%
Birch	1.34%	0.63%	0.80%
Hornbeam	0.21%	0.35%	0.00%
Chestnut	0.43%	0.51%	0.72%
Ash	0.08%	0.00%	0.00%
Poplar	1.78%	1.01%	0.85%
Wild cherry	0.17%	0.19%	0.55%
Other broadleaved	0.89%	0.58%	0.38%
Total broadleaved	**0.28%**	**0.22%**	**0.23%**
Common spruce	0.00%	0.04%	0.74%
Silver fir	0.21%	0.05%	0.25%
Scots pine	0.29%	0.33%	0.63%
Maritime pine	0.43%	0.18%	0.38%
Austrian pine	0.00%	0.09%	0.60%
Aleppo pine	0.19%	0.95%	0.36%
Douglas fir	0.25%	0.10%	0.18%
Larch	0.00%	0.00%	0.00%
Other conifers	0.00%	0.21%	0.00%
Total conifers	**0.23%**	**0.17%**	**0.43%**
Total all species	**0.26%**	**0.20%**	**0.30%**

(Source : Département de la santé des forêts - European network for forest damage monitoring)

⇨*Note : changes in the methods of assessing damage to crowns from 1994-97 have not affected the counting of dead trees. Tree mortality is assessed by the observers during their summer visit. It applies only to predominant and co-dominant trees (the only ones assessed in the European network). Windfalls from the 1999 storms were not integrated in this dead tree count. The real rate is probably (slightly) higher, since dead trees have already been felled before the summer assessment and the observers cannot always determine if the trees have been felled for thinning or sanitation purposes. While it is true that silvicultural intensity (removal frequency) has remained constant overall since the founding of the network in 1989 (though probably not everywhere), this "annual mortality rate" is still a relevant criterion for assessing the health of the forest.*

Commentary: overall, after a slight mortality peak in the early 1990s resulting from the 1989-91 drought, the mortality rate generally levelled off at an annual rate of 0.2% until 2003. This established mortality rate is much lower than the removal rates, estimated for the same network at 1-3% per year, i.e. 5-fold higher. However, there was a subsequent mortality peak in 2004 in both broadleaved and conifer stands, with some species being harder hit (common spruce, birch). This mortality peak was directly related to the 2003 drought-heat wave.

INDICATOR 2.4

Forest and other wooded land with damage, classified by primary damaging agents (abiotic, biotic and human induced) and by forest type

Cause of damage	Main species	Area (ha/an)			Number of damaged plots (%)		Number of damaged trees (%)	
		1985-94	1995-99	2000-04	1995-99	2000-04	1995-99	2000-04
Pest insects	Broadleaved	ND	ND	ND	40.3%	39.9%	17.9%	18.0%
	Conifers	ND	ND	ND	9.5%	8.6%	3.4%	1.8%
	All species	**ND**	**ND**	**ND**	**34.7%**	**34.2%**	**12.8%**	**12.3%**
Fungal diseases	Broadleaved	ND	ND	ND	13.4%	13.0%	3.7%	3.6%
	Conifers	ND	ND	ND	9.3%	14.6%	4.5%	7.3%
	All species	**ND**	**ND**	**ND**	**14.2%**	**16.0%**	**4.0%**	**4.9%**
Climatic stress	Broadleaved	ND	ND	ND	15.4%	10.3%	5.6%	3.8%
	Conifers	ND	ND	ND	8.2%	8.1%	4.5%	2.3%
	All species	**ND**	**ND**	**ND**	**15.1%**	**10.5%**	**5.2%**	**3.3%**
Fire	All species	34,660	17,220	32,330	-	-	-	-
Storms	All species	9,300	231,000	0	-	-	-	-

(Source : see details per topic below)

⇨*Note : Concerning the first three categories on the table, an assessment was conducted for the first two editions of the present report (1995 and 2000) based on the main pest and disease events reported during the 5 previous years and by using a multiplicative correction factor to account for non-inventoried situations. This is the only method that can be used with currently available data. However, considering the error level, it did not seem useful to conduct a new assessment for the 2000-2004 period. It is not possible to clearly determine exactly how the areas would have changed relative to the previous period.*

It is hard to set up a reliable system for monitoring this indicator because of several factors:

- *damage symptoms due to pest insects (e.g. defoliators) and fungal diseases are often temporally limited and thus a suitable statistical system has to be available to be able to quantify the damage at the right time;*
- *some pathogenic fungi (e.g. conifer polypores) are very hard to detect if there is no mortality in the affected trees or if they are not logged;*
- *relations between the extent of symptoms and the extent of increment losses are often unknown;*
- *trees can die several months or even years after being damaged by pest insects or fungal diseases. These trees are often scattered throughout the stands and the mortality threshold beyond which the stand may be rehabilitated can vary markedly depending on the forest manager's priorities.*

Commentary: national data are available on damage caused by pest insects, fungal diseases, climatic stress, fires and storms. For the first three factors, the reliable available data can only be expressed according to the number of plots and trees affected, but not in terms of area, contrary to the fire and storm damage data (cf. note). An in-depth analysis of this damage is provided hereafter.

Only partial surveys have focused on damage caused by large ungulates, but it is possible to monitor annual changes in areas protected from game within regenerating stand plots (cf. § 2.4.1). No national surveys have been conducted so far to assess logging damage. A European Life project, entitled "Demonstration of methods to monitor sustainable forestry" was conducted by the French Institut pour le développement forestier (IDF) and Cemagref from 1999 to 2002. Within the framework of this project, a logging damage assessment method was tested in plots visited by the Inventaire forestier national.

1) <u>Damage caused by pest insects, fungal diseases and abiotic stress</u>

Damage caused by pest insects, fungal diseases and abiotic stress, such as spring frost and summer drought, varies widely from year to year–it can be limited to 1 year or fluctuate over several years, depending on the specific dynamics of these pest populations, and in interaction with the climatic stress factors (particularly water stress). Mortality is often the ultimate stage of progressive weakening (aging, root rot fungi, etc.). Tree death can occasionally become more frequent due to a combination of unfavourable factors (e.g. drought and insect defoliators) or outbreaks of bark beetles after storms or droughts.

Because of the lack of an operational measurement instrument capable of supplying reliable quantitative data at the national level on the impact of different biotic and abiotic factors, the question is covered here from three complementary angles:

- **the proportion of trees and plots in the European network affected by "known causes"**: the sampling density is sufficient to reflect major health problems, but probably not more localised problems. Moreover, the summer rating underestimates the damage symptoms and causes because the factors of spring stress (insects, frosts, etc.) are not always identifiable in summer and certain problems (e.g. root problems) are difficult to diagnose. The recent data cannot be compared to those for the initial 1990-1994 period because observer training levels have been raised considerably.

- **assessment of the severity of serious pest and disease problems on the basis of observations made by the correspondents-observers of the Département santé des forêts** (several thousand observations per year): these problems have been documented, but the proportion of stands affected in a given region is unknown. The observations collected enable us to monitor fluctuations in the main pests affecting French forests.

a) damage of known origin in the European network for forest damage monitoring (mean frequencies of problems linked with attacks by pest insects and fungal diseases and with climatic stress)

• Number of plots

Species	number of plots with at least one tree of the species	number of plots in which insect pests were reported		number of plots in which pathogenic fungi were reported		number of plots in which damage due to a climatic factor was reported	
	mean 2000-2004	mean 2000-2004	%	mean 2000-2004	%	mean 2000-2004	%
Sessile oak	130.8	44.6	34.1%	10.2	7.8%	5.0	3.8%
Pedunculate oak	153.0	63.6	41.6%	22.6	14.8%	8.4	5.5%
Holm oak	27.6	9.2	33.3%	0.4	1.4%	4.0	14.5%
Pubescent oak	67.4	30.4	45.1%	5.4	8.0%	10.2	15.1%
Beech	131.6	26.0	19.8%	2.2	1.7%	8.6	6.5%
Maple	60.4	5.2	8.6%	1.0	1.7%	2.6	4.3%
Birch	44.0	5.4	12.3%	0.0	0.0%	2.0	4.5%
Hornbeam	56.2	11.2	19.9%	0.2	0.4%	3.2	5.7%
Chestnut	60.4	3.8	6.3%	8.6	14.2%	3.2	5.3%
Ash	64.0	12.0	18.8%	0.0	0.0%	3.8	5.9%
Poplar	30.6	6.0	19.6%	0.4	1.3%	2.6	8.5%
Wild cherry	45.2	11.2	24.8%	4.8	10.6%	2.2	4.9%
Other broadleaved	89.0	15.8	17.8%	3.8	4.3%	5.2	5.8%
Total broadleaved	**395.0**	**157.6**	**39.9%**	**51.2**	**13.0%**	**40.8**	**10.3%**
Common spruce	49.4	2.4	4.9%	0.8	1.6%	2.0	4.0%
Silver fir	48.4	2.6	5.4%	10.4	21.5%	3.2	6.6%
Scots pine	66.4	6.0	9.0%	10.2	15.4%	4.4	6.6%
Maritime pine	54.0	7.0	13.0%	1.2	2.2%	2.8	5.2%
Austrian pine	22.8	0.8	3.5%	1.8	7.9%	1.6	7.0%
Aleppo pine	15.0	0.4	2.7%	6.6	44.0%	2.6	17.3%
Douglas fir	22.6	1.0	4.4%	2.8	12.4%	1.6	7.1%
Larch	12.2	0.6	4.9%	0.0	0.0%	1.2	9.8%
Other conifers	10.0	0.4	4.0%	0.0	0.0%	0.4	4.0%
Total conifers	**238.4**	**20.6**	**8.6%**	**34.8**	**14.6%**	**19.4**	**8.1%**
Total all species	**515.8**	**176.4**	**34.2%**	**82.6**	**16.0%**	**54.0**	**10.5%**

(Source : Département de la santé des forêts - European network for forest damage monitoring. Current methods do not allow us to estimate errors due to low sampling rates. The figures are probably acceptable only for well-represented species (e.g. > 50 plots and > 300 trees). The values for "other broadleaved", "total broadleaved", "other conifers", "total conifers" and "total all species" are calculated for each of these collective samples and do not represent the weighted average of the figures by species. This explains why the values for these collective samples may be higher than the average value for each species.)

Commentary: for all species, the three most frequent stress factors during the 2000-2004 period are:

- pest insect attacks: 34% of plots and 12% of trees

- attacks by pathogenic fungi: 16% of plots and 5% of trees

- climatic stress: 10% of plots and 3% of trees

The degree of damage is difficult to interpret, as it can be both overestimated (detected damage is variable and often of low severity) and underestimated (trees sometimes have partially replaced their foliage by the time of the summer observations).

It can, however, be noted that the hierarchy of factors over the most recent period is the same as that of the previous period. The rates are also within the same range between the two consecutive periods, except for climatic stress, which seems to be lower for the most recent period.

Broadleaved species are generally much more severely affected by pest insect attacks than conifers, while there is less of a difference for fungal diseases.

Of the broadleaved species, pedunculate and sessile oaks, i.e. the most

• **Number of trees**

Species	number of trees	number of trees on which insect pests were reported		number of trees on which pathogenic fungi were reported		number of trees on which damage due to a climatic factor was reported	
	mean 2000-2004	mean 2000-2004	%	mean 2000-2004	%	mean 2000-2004	%
Sessile oak	1,241.2	282.0	22.7%	34.6	2.8%	40.3	3.2%
Pedunculate oak	1,178.6	347.4	29.5%	100.4	8.5%	34.0	2.9%
Holm oak	369.8	43.2	11.7%	22.0	5.9%	29.6	8.0%
Pubescent oak	828.2	155.2	18.7%	25.0	3.0%	51.4	6.2%
Beech	1,090.2	155.0	14.2%	12.0	1.1%	45.4	4.2%
Maple	139.0	8.6	6.2%	1.3	0.9%	4.2	3.0%
Birch	175.0	11.6	6.6%	0.0	0.0%	7.2	4.1%
Hornbeam	269.8	50.4	18.7%	1.0	0.4%	14.0	5.2%
Chestnut	472.8	6.2	1.3%	41.4	8.8%	14.6	3.1%
Ash	289.4	48.6	16.8%	0.0	0.0%	8.4	2.9%
Poplar	140.4	18.2	13.0%	24.0	17.1%	10.0	7.1%
Wild cherry	109.8	21.2	19.3%	17.7	16.1%	5.5	5.0%
Other broadleaved	424.2	61.2	14.4%	16.7	3.9%	17.5	4.1%
Total broadleaved	**6,728.4**	**1,208.8**	**18.0%**	**244.4**	**3.6%**	**257.8**	**3.8%**
Common spruce	542.0	7.0	1.3%	4.3	0.8%	5.0	0.9%
Silver fir	475.4	7.0	1.5%	37.2	7.8%	15.4	3.2%
Scots pine	632.8	19.4	3.1%	75.6	11.9%	19.6	3.1%
Maritime pine	906.6	21.2	2.3%	2.7	0.3%	8.3	0.9%
Austrian pine	234.4	1.0	0.4%	7.6	3.2%	4.3	1.8%
Aleppo pine	225.2	3.5	1.6%	117.3	52.1%	11.8	5.2%
Douglas fir	333.6	6.3	1.9%	44.0	13.2%	12.5	3.7%
Larch	142.2	3.5	2.5%	0.0	0.0%	14.3	10.1%
Other conifers	91.8	2.0	2.2%	0.0	0.0%	2.5	2.7%
Total conifers	**3,584.0**	**62.8**	**1.8%**	**262.4**	**7.3%**	**81.4**	**2.3%**
Total all species	**10,312.4**	**1,271.6**	**12.3%**	**506.8**	**4.9%**	**339.2**	**3.3%**

(Source : Département de la santé des forêts - European network for forest damage monitoring. Current methods do not allow us to estimate errors due to low sampling rates. The figures are probably acceptable only for well-represented species (e.g. > 50 plots and > 300 trees). The values for “other broadleaved”, “total broadleaved”, “other conifers”, “total conifers” and “total all species” are calculated for each of these collective samples and do not represent the weighted average of the figures by species. This explains why the values for these collective samples may be higher than the average value for each species.)

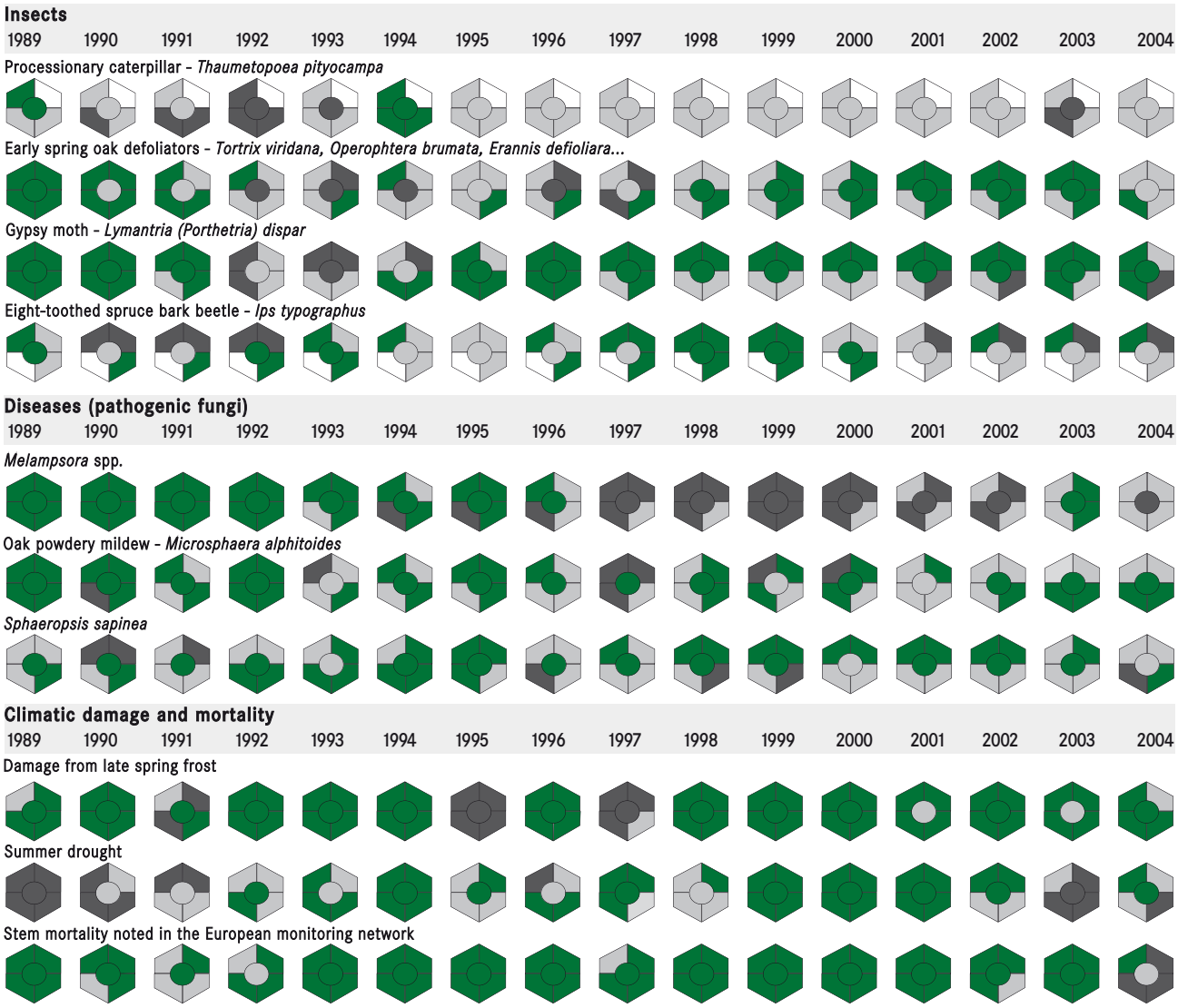
abundant French species, are stillmost frequently attacked by pest insects (especially defoliating insects).

However, during the recent period (2000-2004), poplars and wild cherry trees were the broadleaved species most attacked by pathogenic fungi.

For conifer species, maritime and Scots pines were also the most affected by insect attacks (especially the pine processionary caterpillar). Allepo pine is regularly hampered by fungal diseases.

The results on climatic stress are not very reliable because the symptoms of some major stresses, especially water stress, are usually not very specific. Moreover, the 2000-2004 period was very heterogeneous, with substantial rainfall at the beginning of the period (2000-2002) and exceptionally dry weather at the end (2003-2004). Mean values for the 2000-2004 period are therefore not very representative.

b) severity of the 10 major pest and disease problems affecting French forests from 1989 to 2004 (source: DSF)



The hexagons represent France:
Northwest Northeast
Massif Central
Southwest Southeast

Severity of problems:
Green: absence, trace, slight, endemic
Light grey: moderate
Dark grey: marked, epidemic

The white part of some hexagons indicates that the pest mentioned was absent from the concerned regions.

Commentary: windfalls due to the 1999 storms had a marked impact at the beginning of the 2000-2004 period. Outbreaks of subcortical insects were noted in pine stands, especially in the Landes region, and in spruce stands in eastern France (Vosges, Jura, northern Alps). Bark beetles caused considerable damage (several million m³). Apart from the storms, following the severe frost in November 1998, spectacular infestations of xylophagous beetles were noted in beech stands in northeastern France (mainly in the Ardennes massif) from 2000 to 2002. As a result of the 2003 drought-heat wave, new subcortical insect outbreaks occurred, especially on silver fir in medium mountain regions.

Populations of early spring defoliators of broadleaved species generally remained at a low level, but at the end of the period they seemed to increase again in many regions.

High poplar rust infestations that began in 1997 continued until 2002, and then considerably declined as a result of the 2003 drought. In conifers, during the 2000-2004 period, pine stands sometimes presented symptoms of intense red stain due to the presence of red band disease, especially in the eastern regions.

The overall forest decline observed in the early 1990 has clearly slowed down. However, during the 2000-2004 period, beech stands were found to be declining in many regions. These trends could be explained by many factors, such as destructuring of stands by the 1999 storms, soil compaction due to windfall logging, and the extreme climatic conditions in 2003. The effects of the 2003 drought-heat wave were still partially evident in 2004, including high mortality in Douglas fir and birch stands, etc., along with the onset of the decline in pedunculate oak, silver fir, etc.

2) Fires observed in forests and other wooded lands

Année	Area destroyed by fire (ha)				Number of fires
	Outside of Mediterranean region	Mediterranean region (1)		Total	
1979	6,376	53,351	89%	59,727	ND
1980	5,988	16,188	73%	22,176	ND
1981	4,233	23,478	85%	27,711	ND
1982	6,486	48,659	88%	55,145	ND
1983	5,239	48,490	90%	53,729	ND
1984	12,507	14,696	54%	27,203	ND
1985	9,861	47,507	83%	57,368	ND
1986	4,460	47,400	91%	51,860	ND
1987	3,714	10,395	74%	14,109	ND
1988	1,494	5,208	78%	6,702	ND
1989	18,695	56,871	75%	75,566	6,743
1990	18,728	53,897	74%	72,625	5,881
1991	3,581	6,549	65%	10,130	3,888
1992	3,828	12,765	77%	16,593	4,002
1993	4,797	11,901	71%	16,698	4,769
1994	2,390	22,605	90%	24,995	4,618
1995	8,149	9,988	55%	18,137	6,563
1996	8,281	3,119	27%	11,400	6,401
1997	9,331	12,250	57%	21,581	8,005
1998	7,837	11,243	59%	19,080	6,288
1999	3,123	12,782	80%	15,905	4,960
2000	5,162	18,864	79%	24,026	4,553
2001	2,502	17,970	88%	20,472	4,260
2002	23,860	6,299	21%	30,159	4,097
2003	11,771	61,507	84%	73,278	7,023
2004	3,114	10,596	77%	13,710	3,767

(1) Languedoc-Roussillon, Provence-Alpes-Côte d'Azur, Corsica, Drôme, Ardèche

mean 1980-84 (ha/an)	6,891	30,302	81%	37,193	
% total area				*0.23%*	
mean 1985-89 (ha/an)	7,645	33,476	81%	41,121	
% total area				*0.25%*	
mean 1990-94 (ha/an)	6,665	21,543	76%	28,208	4,632
% total area	*0.05%*	*0.63%*		*0.18%*	
mean 1995-99 (ha/an)	7,344	9,876	57%	17,221	6,443
% total area	*0.06%*	*0.24%*		*0.10%*	
mean 2000-2004 (ha/an)	9,282	23,047	71%	32,329	4,740
% total area	*0.07%*	*0.54%*		*0.19%*	

(Source : French Ministry of Agriculture and Fisheries and Ministry of the Interior, based on the Prométhée files for the Mediterranean region and statements by DRAF and DDAF for the other regions. Burnt areas are relative to forest areas and other wooded lands from the Teruti survey of SCEES.)

Commentary: from 1991 to 2002, the area affected by fires in France ranged from 10,000 to 30,000 ha per year, which differed markedly from the trend of the previous decade (Figure 11). These encouraging results were upset by the drought-heat wave of 2003, when there was a record number of more than 7,000 fires, with 73,300 ha burnt. The Mediterranean region was especially affected, with more than 60,000 ha burnt in 2003, including 27,400 ha in Corsica and 18,800 in the Var region, thus surpassing the scores of 1989 and 1990. The mean burnt area per fire was more than 10 ha throughout France, as was also the case in 1989 and 1990. These mean results conceal the marked variations between regions, with the largest forest fires recorded in the Mediterranean region.

Another unique feature in recent years concerns the peak in burnt areas recorded in 2002 outside of the Mediterranean area, corresponding to very large forest fires that occurred in the Aquitaine and Midi-Pyrénées regions. The situation returned to normal in 2004, with less than 14,000 ha burnt throughout France.

Experimental findings after the 2003 fires highlighted the following points:
- the extreme climatic conditions of 2003 considerably depleted the soil water reserves and transformed the Mediterranean vegetation into a virtual tinder box;
- the brush infestation of rural areas, resulting from agricultural abandonment and poor maintenance, increased the combustible area and inflammability level, especially between wooded massifs and inhabited zones. Fire fighting resources were focused around inhabited areas because of the lack of maintenance around houses, which meant that these resources were no longer available for fighting forest fires. Moreover, this brush infestation phenomenon was ironically boosted by the low level of fires recorded during the previous decade;
- the quantity of combustible biomass increased sharply during the previous decade because of the low forest fire rate;
- the good results recorded between 1991 and 2002 could have led to a reduction in forest fire prevention resources (funding, enforcement of regulations, forest-fire experience, equipment maintenance, etc.).

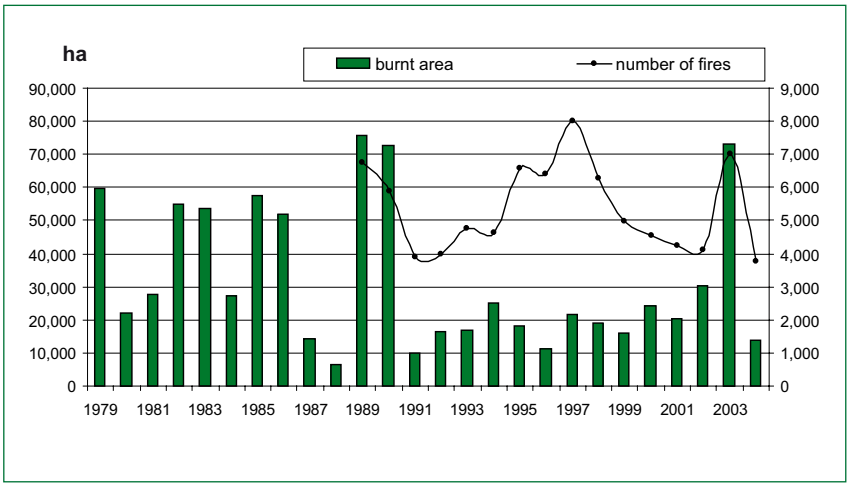


Figure 11: Variations in the number of fires and burnt areas in forests and other wooded lands from 1979 to 2003 (sources: French Ministry of Agriculture and Fisheries, and Ministry of the Interior)

Several recommendations were put forward on the basis of these points, including:
- better adaptation of the system to extreme climatic conditions;
- effectively controlling urbanisation in forest areas and better self-protection of homes;
- regular clearing maintenance in collaboration with crop and livestock farmers when possible;
- more effective coordination of stakeholders;
- enhanced public awareness on forest fire prevention.

3) Storms

	1965-74	1975-84	1985-94	1995-2004
volume in state-owned forest	3 M m³	3.6 M m³	9.7 M m³	61.7 M m³
volume in private forest	0.7 M m³	12 M m³	6.5 M m³	115.4 M m³
total volume	3.7 M m³	15.6 M m³	16.2 M m³	177.1 M m³
% of growing stock	0.23%	0.95%	0.87%	8.3%
% of production of the corresponding period	-	2.58%	2.16%	20.0%
mean volume per ha of metropolitan forest per year	0.026 m³/ha/year	0.111 m³/ha/year	0.114 m³/ha/year	1.149 m³/ha/year
from 1965 to 1998: area-equivalent of volumes destroyed; 1999: IFN estimation of stand areas in which more than 10% of the cover is destroyed	approx. 2,500 ha/year	approx. 9,800 ha/year	approx. 9,300 ha/year	approx. 115,300 ha/year

(Source: from 1965 to 1998: ONF and MAP, only for exceptional windfalls, thus not taking into account windfall volumes regularly removed in mountains at the end of winter; for private forests, most of the figures come from M. Doll's thesis "Disastrous Meterorological Events in Forests", 1988; the area-equivalent of the volumes destroyed per year is calculated from the mean volume per hectare of regular high forest, the type of stand most often affected by windfalls. For the 1999 storms, IFN estimations were based on analyses of aerial photos and field surveys after the storms (see details below); the exceptional windfall volume between year 2000 and 2004 was null)

Commentary: the storms of December 1999 had a very damaging impact on French forests. These storms hit many regions from southwestern to northeastern France (Map 12), contrary to storms during previous periods that mainly just affected single regions (Massif Central, 1982; northeastern France, 1984; Bretagne, 1987; northern France, 1990). The extent of the damage boosted the damage indicators 10-fold for the last decade relative to the previous ones. The proportion of destroyed growing stock rose to 8.3% (1.1 m³/ha/year) from the maximum level of 1% over the previous 30 years (0.1 m³/ha/year). The proportion of current production destroyed was 20% as compared to a maximum of 2.6% for the previous period.

Finally, the damaged area increased from less than 10,000 ha per year to more than 115,000 ha per year between 1995 and 2004. These latter results should, however, be considered in the light of the fact that the assessment results for previous decades (based on area equivalents) were likely underestimated, i.e. if this area-equivalent method were to be used to evaluate the 1999 data, only stands damaged by more than 50% would have been taken into account.

The total volume destroyed over the last decade is estimated at 177.1 million m³, including 175.9 million m³ just for 1999 and 1.2 million m³ in 1996 in the private Landes massif. Two-thirds of the volumes destroyed were located in private forests.

Storms of December 1999

Commentary: The Inventaire forestier national (IFN) was assigned to evaluate the damage caused by the 1999 storms. Forest damage was mainly assessed by cartographic procedures using aerial photographs and satellite images and via field surveys in a few departments. In some 30 administrative departments, this assessment was supplemented with data from the current update of inventories undertaken since year 2000. In this new update, for each sampling plot of the last inventory, IFN allocated a damage rate according to four classes:

- sparse damage: 0-10%
- substantial damage: 10%-50%
- severe damage: 50-90%
- massive damage: more than 90%

The results indicated that 1.1 million ha of forest were damaged by more than 10%, i.e. 8.3% of the inventoried area. This includes an estimated 450,000 ha of stands that had been damaged by more than 50%–conifer stands were the hardest hit, representing 60% of the severe and massive damage classes in terms of both area and volume. Lorraine, Limousin and Aquitaine were the most affected regions, with a mean estimated area damage rate of 30%, 22% and 20%, respectively (Map 12), followed by Basse-Normandie (18%), Champagne-Ardenne (15%), Poitou-Charentes (14%) and Alsace (12%). More than half of the stands affected in Limousin and Poitou-Charentes suffered severe to massive damage, and the damage rate was also high in Lorraine, Aquitaine and Alsace.

The total volume destroyed is estimated at 176 million m³, including 30% in stands with sparse damage (0-10% class).

The actual volume destroyed in this 0-10% class is hard to determine, especially for departments that were only assessed cartographically. A few hypotheses were thus put forward on the actual rates of damage in these stands. However, this 30% estimate does not seem excessive compared to the mean 50% destroyed volume recorded in the five departments where field surveys had been conducted. The Service central des enquêtes et études statistiques (SCEES) also estimated that 119 million m³ of windfalls have been logged, including self-consumption. These data were converted into overbark volumes, including logging losses, and the results indicated that 140 million m³ have been logged, as compared to 176 million m³ estimated by IFN, which means that the non-utilised windfall volume left in the forest was 20%.

IFN's difficulties in evaluating the storm damage was one of the reasons for the adoption of a new method in 2005–the switch to a systematic annual method should enable IFN to respond quicker and more reliably in assessing damage caused by extreme events in the future.

The total volume destroyed represents 8% of the growing stock, 2-fold the current production and 3- to 4-fold the annual fellings over the 1995-99 period, irrespective of whether self-consumption is considered or not. France was the European country most severely affected by the 1999 storms, especially as compared to Switzerland (2.8-fold the annual removals) and Germany (0.8-fold).

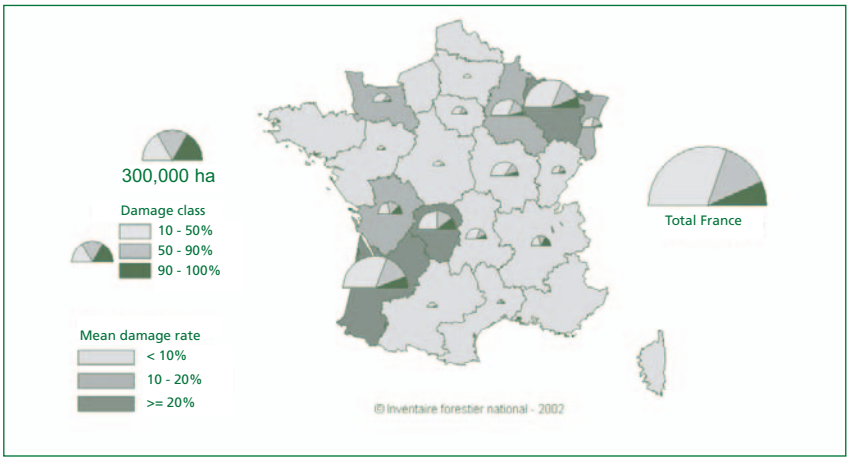
This situation prompted the French ministry for forests to assess the impact of these storms on the conifer availability for wood supply in France up until 2015. This assessment was carried out by IFN and the Association forêt-cellulose (AFOCEL). The conclusions indicated that the overall loss of conifer availability for wood supply will be limited, i.e. 700,000 m³ per year over the next 5 years, but with a major impact on the regions most affected by the storms.

Damage class	Area per main species				Windfall volume per species				Windfall volume per ha
	Broadleaved	Conifers	Total		Broadleaved	Conifers	Total		Total
	x 1,000 ha			%	x 1,000 m³			%	m³/ha
0-10%	8,140	4,440	12,580	91.7%	32,452	20,185	52,638	29.9%	4
10-50%	341	353	694	5.1%	21,037	19,346	40,383	23.0%	58
50-90%	133	167	299	2.2%	21,345	25,041	46,386	26.4%	155
90-100%	49	103	153	1.1%	12,342	24,125	36,466	20.7%	239
Total	**8,664**	**5,062**	**13,726**	**100.0%**	**87,176**	**88,697**	**175,873**	**100.0%**	**13**
> 10%	523	623	1,146	**8.3%**	54,724	68,511	**123,236**	70.1%	108
> 50%	182	270	452	**3.3%**	33,687	49,166	**82,852**	47.1%	183

(Source : IFN 2002, based on damage recorded at each IFN plot. The damage rate was calculated according to fiels survey data - including departments normally monitored after storms - or on the basis of a cartographic analysis of damage noted on aerial photographs. The windfall volume for the 0-10% class was difficult to determine in departments where no field surveys had been conducted because the proportion of destroyed volume was highly variable.)

A national research programme entitled "Forests, winds and risks" was initiated in year 2000 and coordinated by the ECOsystèmes FORestiers (ECOFOR) public interest group. The research results presented in 2005 enhanced awareness on the vulnerability of French forest ecosystems and on ways to stabilise them.

Finally, many issues have yet to be investigated concerning the rehabilitation of plot stands after the 1999 storms. The Laboratoire d'études des ressources forêt-bois (LERFOB), the Institut pour le développement forestier (IDF) and the Office national des forêts (ONF) thus initiated a national observatory on post-storm vegetation dynamics in 2002. The overall aim is to monitor changes in herbaceous vegetation and tree regrowth in a network of permanent plots that are representative of relatively unknown but highly problematic situations. The sites will thus be periodically monitored over a 10-15 year period on the basis of different characteristics: soil, tree regrowth, herbaceous vegetation, lying wood, holdover trees and the surrounding stand.

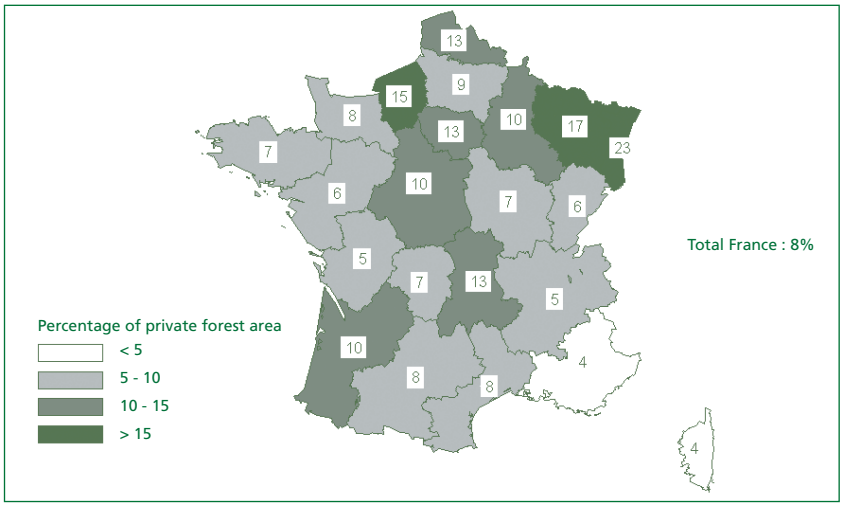


Map 12: Area of stands damaged by more than 10%, ranked by damage class and mean damage rate per administrative region (source: IFN, 2002)

INDICATOR 2.4.1
Regenerations protected from damage by large ungulates

Forest category	Area protected from large ungulates (ha/an)	
	1998-99	2002-03
State-owned forest	4,220	3,000
Other public forests governed by forest regulations	4,320	2,850
Total public forests	**8,540**	**5,850**

(Source : ONF, working database)



Map 13: Proportion of private forest area in administrative regions damaged by game according to forest owners' declarations (source: SCEES, 1999)

Commentary: initiatives to protect regenerated stands from large ungulates are aimed at avoiding three types of damage, i.e. browsing, rubbing and debarking, by fencing in the plots or by installing individual plastic sleeves around tree trunks.
6,000 ha per year are currently protected in this way in state-owned forests, but this figure has dropped by 30% in the last 5 years because of the high protection cost.

A survey on private forest structures conducted by the Service central des enquêtes et études statistiques (SCEES) in 1999 assessed how private forest owners view this problem. 13% of these owners declared that they had noted serious damage incurred on 8% of their private forest area. Alsace, Lorraine and Haute-Normandie were the regions most affected by this problem in terms of area (Map 13), while very little impact was noted in Corsica and Provence-Alpes-Côte d'Azur.

CRITERION 2 - FOREST DAMAGE

The increase in deer populations to the current level of 0.7 red deer and 10 roe deer per 100 forested ha (cf. § 4.9.1) has substantially increased forest owners' management expenditures.

It is generally considered that protection against roe deer can double plantation costs, while anti-red deer protection can quadruple them. It is thus essential to ensure the silviculture-hunting balance by implementing hunting plans.
The Observatoire national des dégâts de cervidés et du plan de chasse published a highly informative study on this topic that was conducted in five test departments (Landes, Oise, Sarthe, Tarn and Vosges) in 2003.

The main recommendations are:

- to establish a cartographic system for forecasting damage risks through the creation of regularly updated departmental databases on susceptible stands;
- to regularly monitor damage in susceptible stands;
- to enhance the efficacy of hunting programmes;

- to increase the involvement of concerned stakeholders, especially forest owners.

Finally, this study highlighted the advantages of tailoring silvicultural techniques to the presence of deer and the importance of analysing the relations between irregular forest management and damage.

Criterion 3

Maintenance and encouragement of productive functions of forests (wood and non-wood)

INDICATOR 3.1

Balance between net annual increment and annual fellings of wood on forest available for wood supply

Forest stands available for wood supply (excluding poplar plantations)

⇨Note : owing to the initially very cautious application of the increment assessment method of the Inventaire forestier national (IFN), the 1989 results were underestimated by about 12.7% and those for 1994 by about 4.4%. The results in the table have been corrected. The relative imperfection of these estimates should be noted; they are due to partial overlap of the increment data (due to the timeframe of the inventory operations) and the felling data. IFN's new annual inventory method should improve these evaluations.

		1983-87	1988-92	1993-97	1998-2002	Annual variation rate 1988-2002*
Net current production (increment + recruitment - mortality)	x1,000 m³	71,805	75,929	81,727	88,331	1.5%
	m³/ha/an	5.4	5.6	6.0	6.4	1.2%
Fellings	x1,000 m³	48,185	52,864	51,406	61,011	1.4%
Ratio of fellings to net current production	**%**	**67.1%**	**69.6%**	**62.9%**	**69.1%**	**-0.1%**

* focused on the 1990-2000 period

(Source: IFN, only for inventoried forests available for wood supply, excluding poplar plantations, and SCEES/EAB. Net current production is the sum of the current increment of trees eligible for inventory, recruitment and increment in the form of felled trees, after deducting the mortality rate, for the 5-year period preceding the inventory. Fellings represent the sum of the marketed removals and self-consumption. Marketed removals were evaluated on the basis of an annual survey of the branch (5-year means), obtained by reincorporating the bark volume (conifers) and the logging losses, estimated at 10% of the EAB volume, and subtracting poplar construction timber. Self-consumption was evaluated on the basis of the combined results of the two most recent inventories available in each department; it is the difference between the estimated global fellings and the EAB results during the period between inventories; it was estimated at 14,418 thousand m3/year for the 1983-1997 period and 18,396 thousand m3/year for the 1998-2002 period. The increment data presented for 1983-87, 1988-92, 1993-97 and 1998-2002 correspond to the years 1989, 1994, 1999 and 2004, respectively, for which IFN inventory data are available.)

Commentary: the productivity of French forests has been sharply increasing over the last 10 years and has now reached 6.4 m³/ha/year. There are many reasons for this trend. The scale of the afforestation and reforestation under way over the last 50 years is a clear factor, as these stands are now in full growth, and also because of the use of species prized for their productivity (white conifers, Douglas fir). It is likely that environmental changes have also played a role in this rise in productivity but their contribution cannot yet be established with certainty (increase in nitrogen deposition in forests and in atmospheric CO2 levels, climatic warming, etc.). To place these data in a wider perspective and despite the high uncertainty concerning the equivalence of measured volumes, the Daubrée statistics for 1908-1913 should be mentioned as they indicated a total annual production of 23.5 million m³, corresponding to a productivity level of 2.3 m³/ha/year, excluding the Alsace-Lorraine region.

The felling rate between 1998 and 2002 was 61 million m³ per year. This is a sharp rise in comparison with the 1993-97 period, mainly due to the high windfall volume in 1999. This assessment is likely lower than the actual felling rate since the increase in self-consumption windfall volumes could only be taken into account in the departments inventoried by Inventaire forestier national (IFN) after the storms.

This underestimation is likely partially offset by relating the fellings to the net production (itself underestimated)–the mean for the 1992-96 period was that used for the IFN production assessment. Again IFN's new annual inventory method should overcome this problem by providing recent volume production estimates.

The resulting felling rate, i.e. 69% for 1998-2002, is lower than that noted 10 years earlier (Figure 12). This indicates that there is generally no risk of overlogging in French forests. Fellings are actually increasing at a slower pace than net production, excluding high windfall periods. Hence, it is essential that timber mobilisation initiatives be continued, especially in some types of stand in certain regions.

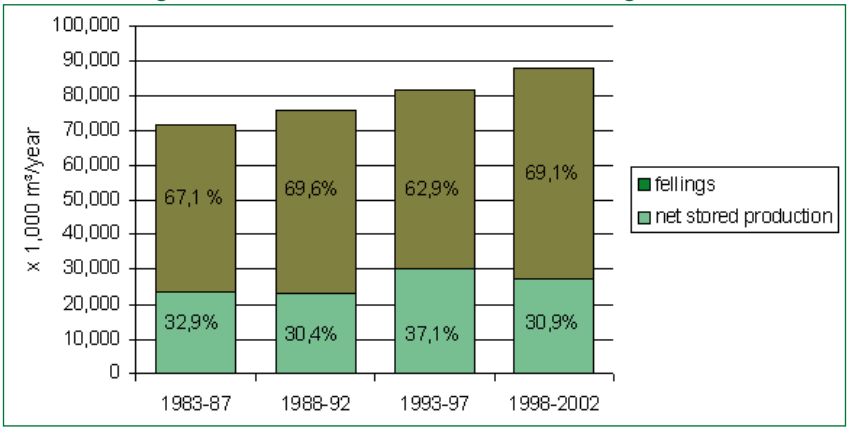


Figure 12: Variations in net stored production* and fellings (source: IFN and SCEES)
* increment + recruitment - mortality

FAO and the United Nations Economic Commission for Europe (UN-ECE) conducted a survey on temperate and boreal forest resources in year 2000 (TBFRA 2000). It provided a few elements of comparison concerning fellings noted in Europe in forests available for wood supply. The felling rate in France falls between that of Mediterranean countries (Spain 39%, Italy 47%) and Germany (55%) and that of Scandinavian countries (Sweden 77%, Finland 75%) and Poland (77%).
Finally, self-consumption volumes represent a very high proportion of total fellings (30-40%). They correspond to the unmarketed removal volume (fuelwood, posts, etc.), which is very hard to estimate–a more accurate evaluation would be needed be able to more reliably and accurately follow up this indicator.

Poplar plantations

Commentary: the poplar situation is very unique in French forestry because of its growth cycle, generally lasting 15 to 25 years, and its planting is managed in a cyclical manner resembling the strategy adopted for certain agricultural products. The fellings/production ratio remained at a historically high level over the past decade, especially in 1988-92, when the ratio was 130% of the overall stand production. This has led to substantial rejuvenation of French poplar plantations. Since then, removals have sharply declined despite the high windfall volume in 1999, estimated at 4 million m³ by the Association forêt-cellulose (AFOCEL). The annual felling rate for the 1998-2002 period decreased to 74%, i.e. 2.1 million m³/year.

These figures are uncertain because removals of industrial timber (not estimated but probably low) were not included, and also because part of the construction timber declared to the Enquête Annuelle de Branche (EAB) likely came from forests, not from cultivated poplar plantations. Poplar is indeed also found in forests, with a net current production estimated in the last inventory at more than 500,000 m³/year, without even counting aspen, which had a net current production of 1.2 million m³/year.

		1988-92	1993-97	1998-2002	Annual variation rate 1988-2002*
Mean per-ha IFN production(increment + recruitment)	m³/ha/year	10.9	11.2	11.0	0.1%
SCEES/Teruti area of poplar plantations and scattered poplars	x1,000 ha	240	256	260	0.8%
Teruti extrapolated total IFN production	x1,000 m³/year	2,622	2,861	2,863	0.9%
Fellings (only timber)	x1,000 m³/year	3,438	2,703	2,114	-4.7%
Ratio of fellings to mean production	**%**	**131%**	**94%**	**74%**	**-5.6%**

* focused on 1990-2000 period

(Source : IFN for the production data and SCEES/Teruti and EAB for the area and fellings. The production evaluated by IFN in cultivated poplar plantations is the mean production, not the current production as in forests; the selected value is the mean production of poplar plantations over 15 years old; this value was extrapolated to the area of cultivated and associated poplar plantations and scattered poplars estimated in the Teruti survey of SCEES in 1993, 1998 and 2003 (codes 24 to 26). Fellings were evaluated on the basis of EAB declared poplar timber removal values and increased by 10% logging losses (5-year means). Production data presented for 1988-92, 1993-2002 correspond to the years 1994, 1999 and 2004, respectively, for which IFN data are available.)

INDICATOR 3.1.1
Forest accessibility

Forest stands available for wood supply (excluding poplar plantations)

Area

logging class	1989 x1,000 ha	1989 %	1994 x1,000 ha	1994 %	1999 x1,000 ha	1999 %	2004 x1,000 ha	2004 %	1994-2004 annual variation rate
easy	8,174	61.3%	8,253	61.4%	8,366	61.5%	8,541	61.8%	0.3%
average	1,516	11.4%	1,469	10.9%	1,464	10.8%	1,426	10.3%	-0.3%
difficult	3,330	25.0%	3,483	25.9%	3,587	26.4%	3,671	26.6%	0.5%
very difficult	313	2.3%	239	1.8%	180	1.3%	183	1.3%	-2.6%
Subtotal	**13,333**	**100.0%**	**13,444**	**100.0%**	**13,597**	**100.0%**	**13,821**	**100.0%**	**0.3%**
unspecified	4		127		270		270		
Total	**13,337**		**13,571**		**13,867**		**14,091**		**0.4%**

IFN stem volume (7 cm top diameter)

logging class	1989 growing stock (x1,000 m³)	1989 % growing stock	1994 growing stock (x1,000 m³)	1994 % growing stock	1999 growing stock (x1,000 m³)	1999 % growing stock	2004 growing stock (x1,000 m³)	2004 % growing stock	1994-2004 annual variation rate
easy	1,066,940	62.0%	1,146,185	61.8%	1,227,941	61.7%	1,312,382	61.7%	1.4%
average	192,531	11.2%	199,565	10.8%	207,128	10.4%	216,129	10.2%	0.8%
difficult	427,830	24.8%	476,949	25.7%	529,799	26.6%	567,541	26.7%	1.8%
very difficult	34,846	2.0%	31,031	1.7%	25,996	1.3%	31,149	1.4%	0.0%
Subtotal	**1,722,148**	**100.0%**	**1,853,730**	**100.0%**	**1,990,864**	**100.0%**	**2,127,201**	**100.0%**	**1.4%**
unspecified	402		unknown		unknown		unknown		
Total	**1,722,550**		**1,853,730**		**1,990,864**		**2,127,201**		**1.4%**

(Source : IFN, excluding poplar plantations, criterion determined only for inventoried forest stands available for wood supply. The "unspecified" category combines inventoried forests without logging codification (1989) and non-inventoried accessible forests (1994, 1999 and 2004)

Commentary: conditions in over 60% of the inventoried forest area are currently easy for logging (cf. definitions in Appendix 7). The same proportion also applies to growing stock (Figure 13). However, around 4 million ha are difficult to very difficult to log, for a growing stock of 600 million m³, or 28% of the total inventoried volume. This mean value conceals the marked differences between regions. Of course, the greatest difficulties are found in mountain regions, thus boosting this rate to above 50% in Languedoc-Roussillon (55%), Midi-Pyrénées (55%) and Rhône-Alpes (66%) regions, with peaks at 71% in Provence-Alpes-Côte d'Azur and 73% in Corsica.

An analysis of changes in hauling distances revealed that accessibility has been improved for around 600,000 ha in the last 10 years, representing 12% of stands where logging is average to very difficult (excluding extensions of forest area).

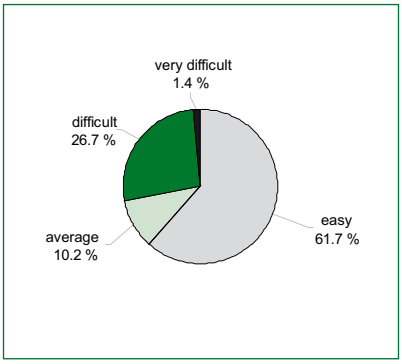


Figure 13: Growing stock per logging class (source: IFN, 2004)

INDICATOR 3.2

Value and quantity of marketed roundwood

Quantity of marketed roundwood

Commentary: after a relatively steady period in the 1960s and 1970s, marketed removals sharply increased in the 1980s to hover around 35 million m³ per year until 1999 (Figure 14). There were many sudden fluctuations during this latter period associated with severe storms (1982, 1984, 1987, 1990) and economic conditions (1993). The peak removal rates noted in 2000 and 2001 highlights the unprecedented severity of the last storms, with 46 and 40 million m³ mobilised, respectively. In 2002, removals had decreased to the prestorm level, but subsequently declined in 2003 in all usage categories. The mean annual removal rate for the 1998-2002 period was 38.5 million m³, including 63% construction timber, 30% industrial wood and 7% fuelwood (marketed). The proportion of softwoods has been increasing to the current rate of 60%, as compared to 51% for the 1988-92 period. This phenomenon cannot solely be explained by the high volume of softwood windfalls available and the fact that many reforested stands are now beginning to yield, i.e. removals of hardwood construction timber dropped sharply from 8 million m³ before the storms to 6 million m³ in 2002 (Figure 15). This decline continued in 2003, with a removal rate of only 5.7 million m³. This trend involves the three main hardwood species, with construction timber removals of oak dropping by 13%, of beech by 42% and of poplar by 36% between 1999 and 2003. In 2003, softwood construction timber removals had risen to the 1999 level, but the patterns vary for the different species–removals of species that were hard hit by the storms decreased substantially (fir-spruce 109,000 m³; maritime pine 300,000 m³), whereas removals of Douglas fir increased dramatically by around 700,000 m³. Windfalls thus seem to have only partially affected the increment potential of this latter species.

The peak in industrial wood removals associated with the 1999 storms only concerned softwoods (Figure 16). In 2003, industrial hardwood and softwood removals had recovered the 1998 level. Despite this ostensible stability, there were marked variations between species, especially softwoods, i.e. maritime pine pulpwood removals dropped by more than 300,000 m³, while fir-spruce and Douglas fir continued to increase.

The marketable share of fuelwood removals was very small relative to the total fuelwood removal volume. The rate declined just after the storms when windfalls were being logged, but then by 2002 it had risen to the prestorm level. There was a subsequent decline again in 2003, but the factors underlying this trend are hard to analyse since no accurate data on fuelwood self-consumption are currently available.

Usage category	Marketed volume (x 1,000 m³/year)				Annual variation rate 1988-2002*
	1983-87	1988-92	1993-97	1998-2002	
marketed construction timber	19,118	22,729	20,794	24,345	0.7%
marketed industrial wood	10,004	10,909	10,883	11,575	0.6%
marketed fuelwood	1,968	2,669	2,646	2,608	-0.2%
Total	**31,090**	**36,307**	**34,323**	**38,528**	**0.6%**

* focused on the 1990-2000 period

(Source : SCEES/EAB, raw data, 5-year means, without correction for bark or logging losses)

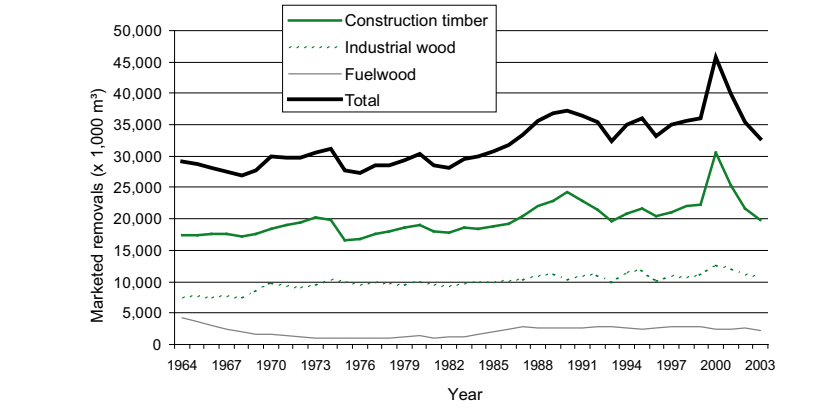


Figure 14: Variations in marketed removals declared to EAB from 1964 to 2003 (source: SCEES)

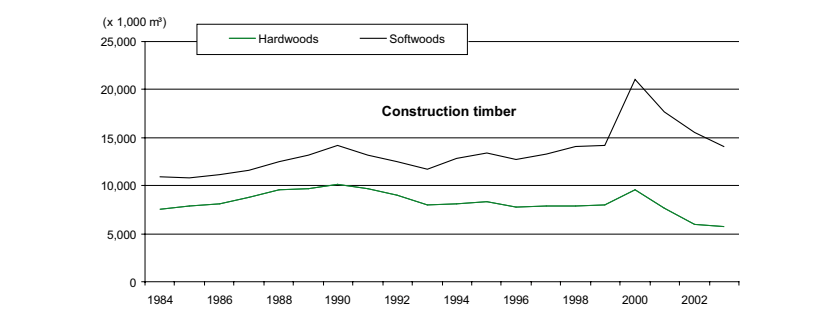


Figure 15: Variations in construction timber removals declared to EAB from 1984 to 2003 (source: SCEES)

Figure 16: Variations in industrial wood removals declared to EAB from 1984 to 2003 (source: SCEES)

Value of marketed roundwood

Commentary: the value of marketed roundwood has been declining steadily for 10 years, in all usage categories, to reach €1,685 million per year over the 1998-2002 period.
Relative to marketed volumes, the m³ value dropped from €51.2 to 43.7 over the last 5 monitored years, i.e. a decrease of 3.1% per year. The value of construction timber decreased from €65.8 to 55.8 per m³, with the fuelwood value dropping from €37.5 to 32.3 per m³. The most marked proportional decrease was noted in industrial wood (-4.8%), dropping from €26.7 to 20.9 per m³. However, the slump in the construction timber value has had the greatest impact on the overall wood value–this decline was accentuated by the 1999 storms.

Usage category	Wood value after logging (million euros 2002/year)			Annual variation rate 1991-2002*
	1991-92	1993-97	1998-2002	
marketed construction timber	1,522	1,367	1,359	-1.4%
marketed industrial wood	299	291	241	-2.7%
marketed fuelwood	107	99	84	-2.9%
Total	**1,929**	**1 757**	**1 685**	**-1.7%**
Wood value in euros/m³	**53.7**	**51.2**	**43.7**	**-3.1%****

* focused on the 1992-2000 period
** 1993-2002 period, variation rate for the 1995-2000 period

(Source : SCEES/Agreste, survey on wood values after logging; no data are available on wood values prior to 1991)

This situation is critical for private forest owners, whose income is declining yearly (cf. also § 6.3).

INDICATOR 3.2.1
Cellulose fibre recovery and recycling; by-product processing

Recovery and recycling of paper and cardboard

	1988	1993	1998	2003	Annual variation rate 1993-2003
Recovery rate	34.2%	36.0%	43.7%	54.4%	4.2%
Utilisation rate (recycling)	44.5%	47.4%	53.8%	58.2%	2.1%

(Source : COPACEL; the recovery rate is the quantity of paper and cardboard recovered relative to overall paper and cardboard consumption; the utilisation rate is the recycled paper and cardboard consumption relative to overall paper and cardboard consumption)

Commentary: the rate of used paper and cardboard recovery has continued to increase at a steady pace with the development of separate collection of these products and mobilisation of the paper industry. It increased from 43.7% in 1998 to 54.4% in 2003, but is still lower than rates in

Scandinavian countries (67.6-72.9%) and Germany (73.7%). More than 80% of the paper and cardboard that is recovered comes from the industrial sector.

Apparent consumption of paper and cardboard was estimated to be 10.9 million t in 2003, or 180 kg per capita, with France ranking 4th in Europe and 7th worldwide in terms of this consumption.

Paper and cardboard production was estimated to be 9.9 million t in 2003. Recycled fibres account for 58.2% of the raw material used by the paper and cardboard industry (utilisation rate).

The growth in used paper recycling is, however, more a response to industrial (reducing paper industry expenditures) and waste management priorities than to forest protection concerns, especially since forest felling rates are moderate in France (cf. § 3.1).

By-product processing

Commentary: the overall quantity of processed sawmill by-products reached 7.6 million t in 2003 (offcuts, chips, bark, sawdust). The increase that began more than 15 years ago is still under way, but at a slower pace. The ratio with respect to processing of sawnwood, cask wood and railway ties was 0.78 t/m³ in 2003. The pulpwood share has been decreasing with time but is still over 50%.

	Units	1988	1993	1998	2003	Annual variation rate 1993-2003
Processed sawmill by-products	x 1,000 t	5,298	6,263	7,583	7,599	2.0%
including by-products for pulping	x 1,000 t	3,240	3,623	4,312	4,197	1.5%
Production of sawnwood, cask wood and railway ties	x 1,000 m³	10,269	9,319	10,220	9,756	0.5%
Processed by-products / Production of sawnwood, cask wood and railway ties	**t/m³**	**0.52**	**0.67**	**0.74**	**0.78**	**1.5%**

(Source : SCEES/EAB, raw annual data)

Wood by-product utilisation enhances sawmill cost-effectiveness, reduces pulpwood industry supply expenses, while boosting wood-use efficiency.

INDICATOR 3.2.2
Marketing wood felled in certified forests*

* wood from certified sustainably managed forests that has been logged by certified enterprises

Commentary: the volumetric proportion of certified wood in marketed removals is still very low, i.e. 7.8% or 2.5 million m³. Volumes nevertheless tripled between 2002 and 2003, a trend which highlights the vitality of the certification process implemented in France, involving both forest owners and downstream subsectors.
Construction timber accounts for 60% of all certified wood, while industrial wood represents 30%, proportions that are consistent with the total marketed volume shares.

These results can be directly related to the extent of certified area, which accounted for almost a quarter of the forest area in late 2004 (cf. Appendix 8). There are two certification systems in France, i.e. the Program for the Endorsement of Forest Certification schemes (PEFC) and the Forest Stewardship Council (FSC). French forest owners prefer the PEFC system because it helps to overcome the land parcelling problem (cf. § 6.1)–forest certification is achieved at the regional level despite the fact that each forest owner or group of owners has to subscribe.

Virtually all state-owned forests are now certified as well as a third of other public forests. It is harder to implement the certification process in private forests because of the high number of forest owners involved, but considerable progress has been made, with more than 10% of the private forest area already certified. The current extent of certified forest area reflects the commitment of French forest owners in the sustainable forest management certification process, and this obviously reaches well beyond the wood marketing issue.

Quality	Certified marketed volume*				Variation rate
	2002		2003		
	m³	% total marketed	m³	% total marketed	
Construction timber	382,800	1.8%	1,522,900	7.7%	298%
Industrial wood	150,400	1.3%	775,800	7.2%	416%
Fuelwood	97,900	3.6%	246,600	10.8%	152%
Total	**631,100**	**2.2%**	**2,545,300**	**7.8%**	**303%**

(Source : SCEE/EAB, 2002 et 2003, raw data - without correction for bark or logging losses)

INDICATOR 3.3

Value and quantity of marketed non-wood goods from forest and other wooded land

Commentary: forests provide a variety of different non-wood goods ranging from venison to gathered plants, including mushrooms, honey and even cork in Mediterranean forests. It is generally hard, due to the very marked fluctuations, to assess the quantities harvested and their value (e.g. for mushrooms, honey, gathered plants). The total mean "wholesale" value of these products ranges from €97 to 109 million per year, which is quite substantial. Venison represents more than half of this total value, with honey representing 20-28% and mushrooms 10-11%, but harvests of these latter two goods can sometimes be very low.

The benefits of these goods go beyond their economic value as they also provide valuable services. For instance, it is now clearly established that cork oak stands are an important element in land-use management and forest fire protection. The importance of the recreational aspect of some plant gathering activities and the key role of bees in maintaining plant biodiversity via pollination are also well known.

Non-wood goods	quantity (t/year)		"wholesale" value (million € 2002/year)		
	1998-99	2002-03	1998-99	2002-03	%
venison*	18,400	22,900	57.831	60.48	55% to 62%
mushrooms (including truffles)	3,100	2,400	15.1	10.8	10% to 11%
cork	5,700 to 8,200	4,700 to 5,700	1.1 to 1.6	1.3 to 2	2%
honey	ND	5,600 to 7,100	ND	19.8 to 30.4	20 to 28%
gathered plants	4,300 to 5,000	4,300 to 5,000	5.1 to 5.4	5.1 to 5.4	5%
Total	**-**	**-**	**-**	**97.5 to 109.1**	**100%**

* including self-consumption

(Source: see detailed tables below. Considering the high values for venison and the low accuracy of the other data, then: 1) the values of other goods were aggregated and expessed in 2001 or 2004 euros without conversion, 2) the totals were considered to correspond to the 1998-99 and 2002-03 periods on average and the results were expressed in 2002 euros. Gathered plant production was also considered to have remained stable as no updated data were available)

Box 4: LEF/ENGREF survey on plant gathering in France

The Laboratoire d'économie forestière LEF ENGREF/INRA of Nancy conducted a survey in 2002, on a sample of 2,575 households selected from a list of telephone subscribers, to record quantities of mushrooms, fruits and decorative goods gathered on a private personal basis by the sampled households in 2001. The results revealed that around 12,650 t of mushrooms, 4,360 t of fruits, including 80% chestnuts (with mulberries, bilberries and raspberries accounting for most of the rest), 330 t of flowers and other decorative elements are gathered yearly. According to the same survey, the hunting harvest for the same household sample included 588,000 wild boars, 444,000 deer and 5.7 million small game animals and birds.

Venison

Commentary: the quantity of hunted venison has sharply increased in recent years, rising from 18,000 to 23,000 t in 4 years. Wild boar accounts for two-thirds of the total, and the quantity is rising faster than the trend noted for deer. The quantity of red and roe deer venison reached 7,400 t during the 2002-2003 season, and this rise is associated with the yearly increase in kills (cf. § 4.9.1).

Venison is usually self-consumed. Its value can only be roughly estimated on the basis of expert opinion since this type of game is no longer sold at Rungis market due to current commercial constraints and regulations. It was estimated at €60.5 million for the 2002-2003 period, including 51% for wild boar and 40% for roe deer.

venison	quantity (t)			value (million € 2002)		
	1998-99	2002-03	annual variation rate	1998-99	2002-03	annual variation rate
red deer	1,617	1,830	3.1%	4.2	4.6	2.3%
roe deer	4,748	5,540	3.9%	24.5	24.9	0.4%
wild boar	12,027	15,486	6.5%	29.1	31.0	1.5%
Total	**18,392**	**22,857**	**5.6%**	**57.8**	**60.5**	**1.1%**

(Source: ONCFS, based on kills by multiplying the values by the mean weights estimated on the basis of expert opinion at 50 kg for a red deer, 12 kg for a roe deer and 35 kg for a wild boar. 1998-99 period: value estimated in F 1998 at 16 F/kg for a red deer, 32 F/kg for a roe deer and 15 F/kg for a wild boar with conversion into 2002 euros. 2002-03 period: value estimated in 2002 euros at €2.5/kg for a red deer, €4.5/kg for a roe deer and €2/kg for a wild boar.)

Mushroom harvest

Commentary: data on forest mushroom harvests are very incomplete. The last in-depth survey by the Fédération nationale des producteurs de champignons was conducted in 1997 and an update is not yet available.
Harvests fluctuate yearly because mushrooms are sensitive to climatic variations. A marked decrease in boletus, chanterelle and truffle harvests has been noted in recent years, i.e. dropping from 4,100 to 2,400 t between 1999-2000 and 2002-2003. Although the reasons underlying this situation are unclear, professional operators fear that this resource is becoming scarce.

The main producing regions are the Massif Central, Périgord and northeastern and southwestern France. The total harvest value is estimated at €15-20 million per year. This should be supplemented with the production for self-consumption, but this is very hard to evaluate. The economic weight of forest mushrooms is far from insignificant, especially in certain regions. French consumption is much higher than the harvest and this gap, currently filled by imports, represents a potential market outlet for the cultivation of forest mushrooms.
The positive role of mycorrhizan mushrooms in the functioning and productivity of forest ecosystems has been known for many years. Continued research on the production of mycorrhizan mushrooms (boletus, saffron milk cap, etc.) and on optimisation of forest management should eventually strike a balance between timber production and edible mushroom production. The latter could provide extra income for forest owners in certain regions, provided that the problem of unauthorised picking can be solved locally.

mushroom category	marketed quantity (t)							"wholesale" value (million € 2001)	
	1997-98	1998-99	1999-2000	2000-01	2001-02	2002-03	2003-04	1997-98	2001-02
black Perigord truffles	30	14	35	35	15	39	39	9.6	6.0
1/3 harvested in forests	10	5	12	12	5	13	13	3.2	2.0
other truffles*	ND	ND	ND	ND	ND	ND	17	-	-
boletus	2,120	ND	2,400	1,100	1,000	ND	ND	8.5	4.0
chanterelles	1,000	ND	1,700	1,800	1,400	ND	ND	3.4	4.8
Forest harvest Subtotal	**3,130**	**-**	**4,112**	**2,912**	**2,405**	**-**	**-**	**15.1**	**10.8**
other forest mushrooms	1,710	ND	ND	ND	ND	ND	ND	5.8	-
Forest harvest Total	**4,840**	**-**	**-**	**-**	**-**	**-**	**-**	**20.9**	**-**

* theoretically harvested in forests

(Source: Fédération Nationale des Producteurs de Champignons, Fédération Française des Producteurs de Truffes, Forêt Privée Française et Service des Nouvelles du Marché; in 1997, an in-depth study was conducted by FNPC on forest mushrooms. A new survey is under way but the results are not yet available. The per-kg values used are: 1) for truffles: 2,000 F1997/kg and 400 € 2001/kg - 2001/02 estimate based on 2004/05 rates of SNM evaluated at €490/kg; 2) for boletus: 25 F1997/kg or 4 € 2001/kg, also retained for 2001/02 due to a lack of updated data; 3) for chanterelles and other forest mushrooms: 21 F1997/kg or 3.4 € 2001/kg, also retained for 2001/02 due to a lack of updated data.)

Cork production

Commentary: French cork oak production stands are mainly found in three regions, i.e. Corsica, Var and Pyrénées-Orientales. The annual harvest is evaluated at 4,700 to 5,700 t, but it has been declining over the last 5 years. This decline is linked with overharvesting, as observed in Corsica, and this slump will likely continue in the coming years considering the long rehabilitation cycle for cork (12 years).

Stumpage of cork harvested in the three regions is estimated at €1.3 to 2 million per year, but this is hard to evaluate because average prices estimated on the basis of expert opinion integrate a broad range of qualities and situations.

Cork oak stand management policies have long been focused on different aspects of fire prevention. In recent years, local stakeholders have expressed an interest in enhancing these policies by including a gradual return to production. Different experiments in this direction have been undertaken in the Pyrénées-Orientales and Var regions since 1980. They have enabled the different stakeholders to determine the conditions required for a return to production: the presence of a real production potential for cork of marketable quality, the existence of minimal facilities for access and fire protection, motivation of owners and official control over the choice of lots and monitoring of harvests.

The recent rise in the price of cork due to world shortages could provide a new and interesting opportunity for owners.

Location	Annual harvest (t/year)		Stumpage (million € 2004)	
	1999	2004	1999	2004
Corsica	3,000 to 5,000	2,000 to 2,500	0.6 to 1	0.4 to 0.8
Var	2,000 to 2,500	2,000 to 2,500	0.4 to 0.5	0.5 to 0.8
Pyrénées-Orientales	700	700	0.1	0.4
total	**5,700 to 8,200**	**4,700 to 5,700**	**1.1 to 1.6**	**1.3 to 2**

(Source: Institut méditerranéen du liège; SRFB Languedoc-Roussillon, PACA and Corsica; CRPF PACA; ODARC; 1999 and 2004. The harvest estimates are based on expert opinion.)

Forest honey production

Commentary: the quantity of marketed forest honey ranges from 5,600 to 7,000 t per average year. Acacia honey accounts for more than half of this volume and chestnut honey represents around 30%. This production can fluctuate substantially as a result of weather conditions and other factors– production can sometimes even be null, especially for fir honey. Forest honey accounts for 15-20% of the total honey production in France, which ranges from 30,000 to 40,000 t per year.
The total value of forest honey ranges from €20 to 30 million per average year. Fir honey is the most sought-after type, with a "wholesale" value of €5.5-6 per kg.

Species	Quantity marketed (t/year)	"Wholesale" value (million €)
acacia	3,000 to 4,000	10.5 to 18
chestnut	1,500 to 2,000	4.5 to 7
linden	500	1.5 to 1.8
fir	600	3.3 to 3.6
Total	**5,600 to 7,100**	**19.8 to 30.4**

(Source: Coopérative France miel 2004; mean current production estimated on the basis of expert opinion due to a lack of more accurate statistical data. The production can vary markedly between years, especially for fir honey.)

Gathered plants

Commentary: the annual gathered plant harvest is hard to estimate because this sector is loosely organised and the activity is often marginal. No updated data is currently available to distinguish between gathered forest plants and crops.
The gathered plant harvest estimated in 1997 was 4,000 to 5,000 t, for a value of 5-6 million. Harvesting mainly takes place in the French mountain massifs, i.e. Vosges, Alps, Pyrenees and especially the Massif Central (Cévennes, Auvergne, Limousin). According to the Office national interprofessionnel des plantes à parfum, aromatiques et médicinales (ONIPPAM), most of these harvests are declining, except for lichens for perfumery and cosmetics, where production has remained stable.

Plant type	1997 production (t/year)	Value (million € 2004)
lichen (perfumery and cosmetics)	2,000 to 2,500	0.3 to 0.4
butcher's broom leaves	200	0.4
butcher's broom rhizomes (pharmacy)	150 to 200	0.3 to 0.5
rock-rose leaves and branches (perfumery)	800	1.1
bilberries (cosmetics and pharmacy)	1,000	2.5
linden leafy bracts and flowers	80	0.5
ash leaves	100	0.2
Total	**4,330 to 4,880**	**5.3 to 5.6**

(Source: Office national interprofessionnel des plantes à parfum, aromatiques et médicinales (ONIPPAM) 1997 production data, except for butcher's broom leaves, i.e. 1989 data, due to a lack of available updated data for 2004; 1997 values converted into 2004 euros)

INDICATOR 3.4

Value of marketed services on forest and other wooded land

Marketed services	Ownership category	Value (million € 2003)			Annual variation rate
		1993	1998	2003	1993-2003
Hunting licences	state-owned forest	29.2	29.7	31.4	0.7%
	other public forest governed by forest regulations	16.5	17.8	17.1	0.4%
	private forest	23.7	ND	24.0	0.1%
Total Hunting		**69.4**	**ND**	**72.5**	**0.4%**
Fishing licences	state-owned forest	**0.2**	**0.3**	**0.3**	**2.7%**
Royalties and rental charges	state-owned forest	8.5	8.2	8.4	-0.1%
	other public forest governed by forest regulations	6.9	6.7	6.3	-0.9%
Total Royalties and rental charges		**15.4**	**15.0**	**14.7**	**-0.5%**
All services	state-owned forest	37.9	38.2	40.1	0.6%
	other public forest governed by forest regulations	23.4	24.5	23.4	0.0%
	private forest	23.7	ND	24.0	0.1%
Total All services		**85.0**	**ND**	**87.5**	**0.3%**
		€5.7/ha	**ND**	**€5.7/ha**	**0.0%**

(Source: public forests: ONF; private forests: SCEES/Enquête sur les structures économiques de la sylviculture (ESSES 1976-83) and Enquête sur la structure de la propriété forestière privée (1999) for the leased area; estimation of the mean 2003 hunting licence fee in private forests by applying the increase noted in state-owned forests during the 1993-2003 period to the 1993 value.)

Commentary: forests represent a setting for many services, some of which generate income for the forest owner. This includes hunting and fishing licences, as well as royalties and rental charges in public forests.

The value of these services was evaluated at €87.5 million in 2003, with hunting licences accounting for 80% of this amount. This service value has been increasing over the last 10 years because of the increase in hunting tender fees for state-owned forests. There has only been a slight decrease in royalties and rental charges. Income from fishing licenses in state-owned forests is marginal.
Overall, these services generate a mean income of €5.7/ha, irrespective of the ownership category. This income has remained stable over the last 10 years because the forest area has substantially expanded.

It is hard to estimate the value of hunting licences for private forests since conditions vary widely with respect to hunting in these forests.

A survey of private forest structures conducted by the Service central des enquêtes et études statistiques (SCEES) in 1999 revealed that more than half of the surveyed owners were voluntarily or obligatorily attached to an authorised communal or intercommunal hunting association (ACCA or AICA). This situation concerned 45% of the forest area. A quarter of these owners provide their relatives, friends or local hunting groups with free hunting access to their forests, especially in southern France.

Paid hunting leases apply to 13% of the forest area, but only 2% of private owners. This generally concerns large-scale properties (51 ha on average) belonging to corporate bodies. Only 8% of private owners (16% of the area) maintain exclusive hunting rights in their forests.

Most hunting plots rented in state-owned forests are allocated by public tender, otherwise plots are generally allotted on a licensing or friendly basis.

INDICATOR 3.5

Proportion of forest and other wooded land under a management plan or equivalent

Formal management plans

Ownership category		Units	Managed area					Annual variation rate
			1974	1984	1994	1999	2004	1994-2004
state-owned forest*		ha	1,184,400	1,421,000	1,610,100	1,704,500	1,633,000	0.1%
		%	71.0%	82.3%	90.5%	93.3%	89.1%	-0.2%
other public forest governed by forest regulations		ha	1,316,400	1,650,800	1,983,700	2,197,700	2,193,000	1.0%
		%	54.4%	66.1%	75.0%	80.9%	78.9%	0.5%
private forest	compulsory simple management plan**	ha	94,900	2,345,900	2,479,800	2,551,700	2,487,000	0.0%
		%	2.8%	71.2%	73.9%	75.9%	73.1%	-0.1%
	voluntary simple management plan	ha	-	-	16,700	26,400	35,200	7.7%
	total	ha	94,900	2,345,900	2,496,500	2,578,100	2,522,200	0.1%
		%	-	23.8%	24.0%	24.1%	23.4%	-0.3%
total		**ha**	**2,595,700**	**5,417,700**	**6,090,300**	**6,480,300**	**6,348,200**	**0.4%**
		%	**-**	**38.5%**	**41.1%**	**42.6%**	**41.2%**	**0.0%**

* including state-owned forests allocated to various ministries

** presented % are relative to the area prior to implementation of a simple management plan in compliance with the law

(Source: ONF for state-owned forests and other public forests governed by forest regulations, based on an estimate of current management plans, without taking into account logging regulations for coppices and coppices-with-standards and considering total forested and unforested areas; CNPPF for private forests, with an approved current simple management plan, including voluntary management plans; the percentage of all managed metropolitan forests is calculated on the basis of Teruti survey areas (headings 18 to 21, 24, 25) 1983 (old data series), 1993, 1998 and 2003 (new data series); managed areas were established for 1st January of the concerned year).

Commentary: the French forest area for which a "formal" management plan has been drawn up is currently 6.3 million ha, or 41.2% of the overall area. This area increased by 25,800 ha per year between 1994 and 2004, including 20,900 ha just for non-state-managed public forests. The decline noted in the last 5 years is due to damage incurred by the 1999 storms–many managed areas and simple management plans have been revised and the approval process is under way, especially concerning private forests. Some forest owners are thus also in a standby situation due to financial and technical uncertainty concerning rehabilitation of their forest stands.

A high proportion of public forests are managed, i.e. 89% of state-owned forests and 79% of other public forests governed by forest regulations. Ecological and landscape concerns are now taken into account and managers of each new public forest management plan systematically receive a map of forest sites and of fragile landscapes. Moreover, the steady rise in the number of sites of ecological interest is a definite sign that managers are more aware that it is essential to take forest biodiversity into serious consideration in their management practices. New pilot management projects implement the European "Habitats – Fauna – Flora" directive.

For private forests, 73% of forests whose owners were obliged to draw up a simple forest management plan, i.e. Plan simple de gestion (PSG), are now classified as managed. The forest law passed in July 2001 modified the area threshold for private forests from the previous limit of 25 ha per tenant to the current limit of 10-25 ha, depending on the department concerned (Box 5). The slight decline noted in the last 5 years is a direct result of the storms of December 1999. First, current compulsory PSGs have more than doubled in 5 years, i.e. they represented 105,200 ha in 2004 as compared to 46,500 ha in 1999. Moreover, private forest owners' situations were often disrupted by the damaging storms. With massive stand destruction, problems in clearing the stands and marketing the timber, uncertainty on obtaining reconstruction credits, many owners opted to delay renewal of their PSG while awaiting stabilisation of the situation. However, the 2005 data, which were not taken into account in the table, revealed that compulsory PSG submissions and approvals are again on the increase.

Voluntary PSGs are still increasing, but at a slightly slower pace in comparison to the 1994-1999 period.

In addition, the proportion of managed French forests is much higher than that of forests under a "formal" management plan, especially with respect to private forests. A survey on private forest structures carried out by the Service central des enquêtes et études statistiques (SCEES) in 1999 provided an assessment of the level of involvement of owners in forest development. A quarter of private forest owners–holding around 60% of the forest area–sought information or called in external assistance to enhance management of their forest properties.

These proportions increased as the forest size increased: 89% of owners with 100 ha or more were concerned (91% of the area) as compared to 19% of owners with less than 10 ha (24% of the area). Moreover, half of private forest owners (560,000) were active in maintaining, felling, etc., their stands, alone or with the help of their relatives. This work time is estimated at 20 days per year and per owner, representing more than 11 million work days.

Box 5: Management records required by the French forest law of 9 July 2001

Four management record categories are stipulated under the French forest law of 9 July 2001 (Loi d'orientation forestière du 9 juillet 2001):
- management records
- simple management plans
- model management regulations
- codes of good silvicultural practices

These records must be drawn up in compliance with regional development directives (DRA) for state-owned forests, regional management schemes (SRA) for other public forests governed by forest regulations, and regional silvicultural management schemes (SRGS) for private forests. DRA, SRA and SRGS are defined in the regional forest guidelines (ORF), which in turn are drawn up by regional commissions for forests and forest goods, with the participation of concerned partners.
For **public forests**, the management record is generally a detailed **management record**. It can be replaced by a **model management regulation** (RTG), i.e. a simple record, for forests with a low economic potential and ecological interest.
For **private forests**, a **simple management plan** (PSG) is compulsory for forested properties with an area (for a single tenant) that is equal to or higher than the threshold set for the administrative department, ranging from 10 to 25 ha. An owner with a forest area under the preset departmental threshold, but equal to or above 10 ha, can submit a voluntary PSG. Compulsory and voluntary PSG records are comparable to public forest management documents.
Private forest owners with properties that do not qualify under this category can concur to a **model management regulation** (RTG) drawn up by a common forest management and logging organisation or a forest expert. They can also comply with a **code of good silvicultural practices** (CBPS) drawn up by the Centre régional de la propriété forestière and approved by the prefect of the region. The CBPS contains key sustainable forest management guidelines classified by region or group of natural regions.
Forests managed in compliance with these four management record categories are confirmed as being sustainably managed forests, conditional to a 10-year (minimum) commitment by the owner when they qualify under RTG and CBPS categories. These sustainable management commitments are required to obtain government subsidies.

INDICATOR 3.5.1
Forest area covered by a catalogue of sites and area covered by a simple species guide

Commentary: catalogues of forest sites include, amongst other elements, a description and a key for identifying different forest ecosystems in a natural region. They are developed by scientists, generally on the basis of the results of analyses of the topography and landforms, climatic characteristics, types of rock, soil, humus and vegetation composition.

It was felt that these catalogues should be transformed into clear and easy to use tools that could help forest managers in making accurate ecological analyses of their forest sites–a prerequisite for sustainable management.
Guides were thus drawn up to facilitate identification of forest sites and species–they summarise knowledge in the form of site units with known potentials for the main forest species of one or several natural regions.

Coverage	Forest area covered by a catalogue of forest sites (x 1,000 ha)					Forest area covered by a simple guide (x 1,000 ha)				
	2000		2005		Annual variation rate 2000-2005	2000		2005		Annual variation rate 2000-2005
	forested	total	forested	total	forested	forested	total	forested	total	forested
complete	5,636	18,128	6,742	22,326	3.6%	3,100	9,617	5,102	15,251	10.5%
partial	453	2,257	584	2,596	5.2%	232	1,135	368	1,591	9.7%
total	**6,089**	**20,385**	**7,326**	**24,922**	**3.8%**	**3,332**	**10,752**	**5,470**	**16,842**	**10.4%**
% total France	**43.2%**	**37.1%**	**52.0%**	**45.4%**		**23.6%**	**19.6%**	**38.8%**	**30.7%**	

(Source: IFN, 1/01/2000 and 1/01/2005; calculations were done per IFN departmental forest region while only taking the area actually covered within each region into consideration; data generated by this new method overrule the data series published in the year 2000 version of the present report).

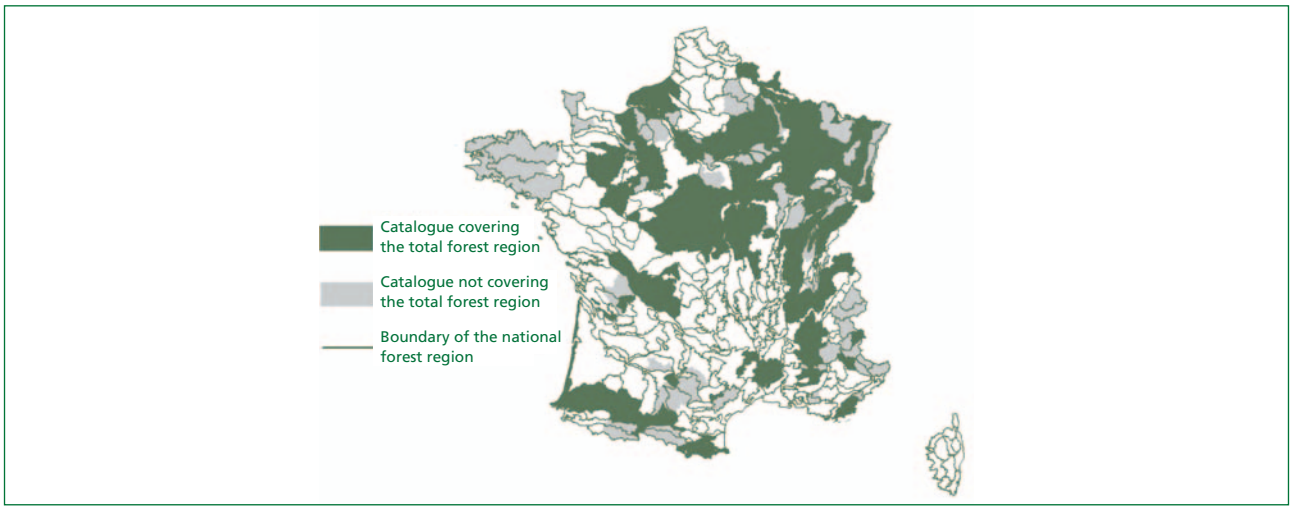
These practical guides (attractive presentation, small size, simple and detailed scientific concepts) can provide forest managers with access to enhanced knowledge on natural production factors concerning their forests, thus facilitating decision making on the best species to plant in their forest stands. These guides are the only reference documents available for some regions when no catalogue of forest sites has been drawn up (Maps 14 and 15).

Since 1992, the Inventaire forestier national (IFN) has been recording ecological and floristic field data. In 2002, IFN was tasked by the French

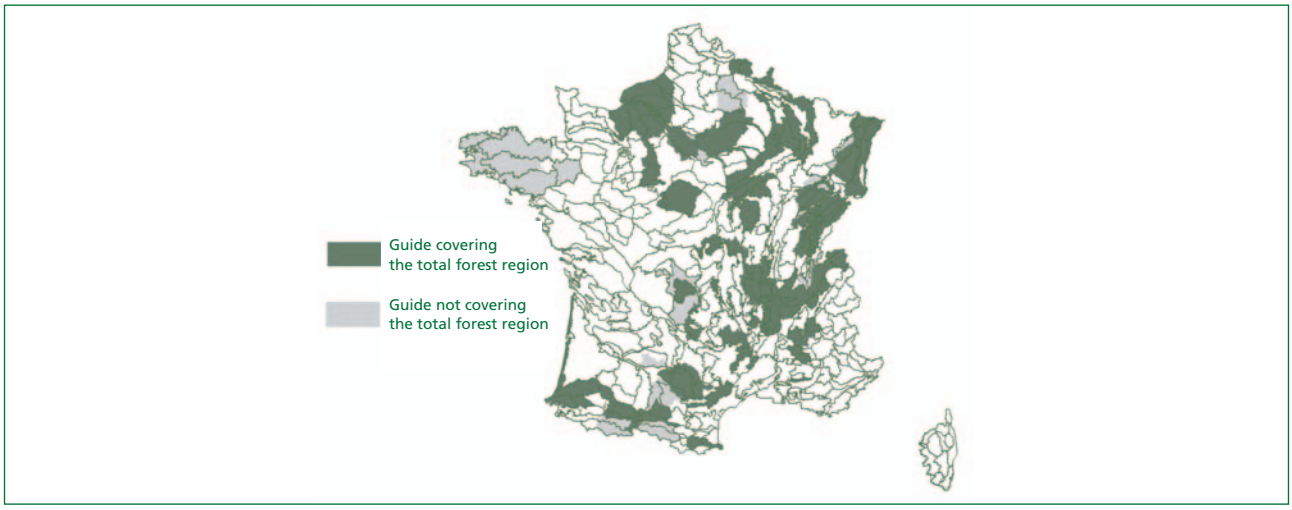
Forestry Ministry to permanently oversee, provide expertise and operational coordination in the field of forest site classification. Areas actually covered by a descriptive record of forest sites were thus recalculated and refined on national forest region and departmental forest region scales. Data generated by this more accurate method overrule the data series published in the year 2000 edition of the present document. The method was used to determine the status of the situation on 01/01/2000, while taking the newly published guides into consideration, which are the only documents likely to be used on a daily basis by public and private forest managers.

Half of the forest area in France, i.e. more than 7 million ha, is currently covered by a catalogue of forest sites (20% increase in 5 years), while slightly more than a third of the area is covered by a simple guide (64% increase over the same period). The guides are thus being published at a much faster pace than the catalogues, which is very encouraging with respect to applying sustainable management concepts in the field. This progress has been more substantial in regions with the harshest forest production conditions, i.e. mountain areas and the Mediterranean region.

Moreover, regions for which a forest site classification is available have a mean forest cover of 30%, which is higher than the national average. This trend indicates that–apart from the Landes de Gascogne region, for instance, for which no classification tool is available to date–the interest generated by the forest site catalogues is generally higher in the most forested regions. This clearly highlights the willingness of public and private managers to conduct ecological analyses as part of their everyday forest management activities.



Map 14: Catalogues of sites available per forest region - Situation 2005 (source: IFN)



Map 15: Simple species guides available per forest region - Situation 2005 (source: IFN)

Criterion 4

Maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems

INDICATOR 4.1

Area of forest and other wooded land, classified by number of tree species occurring and by forest type

Forest stands available for wood supply (excluding poplar plantations)

Forest type	Number of tree species or tree species groups per plot	1989		1994		1999		2004		1994-2004
		area (K ha)	% total area	area (K ha)	% total area	area (K ha)	% total area	area (K ha)	% total area	annual variation rate
Broadleaved	1	1,845	22.0%	1,773	21.1%	1,725	20.3%	1,672	19.3%	-0.6%
	2	2,534	30.2%	2,470	29.4%	2,436	28.6%	2,474	28.5%	0.0%
	3	2,045	24.4%	2,091	24.9%	2,126	25.0%	2,209	25.5%	0.6%
	4 and +	1,959	23.4%	2,079	24.7%	2,223	26.1%	2,320	26.7%	1.1%
Total broadleaved		**8,383**	**100.0%**	**8,413**	**100.0%**	**8,510**	**100.0%**	**8,675**	**100.0%**	**0.3%**
Conifers	1	2,099	56.6%	2,054	55.1%	1,997	53.5%	1,952	52.0%	-0.5%
	2	967	26.1%	974	26.1%	980	26.3%	1,013	27.0%	0.4%
	3	432	11.7%	464	12.5%	488	13.1%	504	13.4%	0.8%
	4 and +	208	5.6%	235	6.3%	266	7.1%	287	7.6%	2.0%
Total conifers		**3,706**	**100.0%**	**3,726**	**100.0%**	**3,731**	**100.0%**	**3,756**	**100.0%**	**0.1%**
Mixed	1	0	0.0%	0	0.0%	0	0.0%	0	0.0%	
	2	419	36.3%	398	34.1%	392	32.2%	402	31.6%	0.1%
	3	387	33.5%	394	33.7%	402	33.0%	423	33.2%	0.7%
	4 and +	348	30.1%	377	32.3%	423	34.7%	450	35.3%	1.8%
Total mixed		**1,154**	**100.0%**	**1,168**	**100.0%**	**1,217**	**100.0%**	**1,275**	**100.0%**	**0.9%**
All types	1	3,956	29.9%	3,833	28.8%	3,728	27.7%	3,627	26.5%	-0.6%
	2	3,910	29.5%	3,834	28.8%	3,803	28.3%	3,885	28.3%	0.1%
	3	2,864	21.6%	2,949	22.2%	3,016	22.4%	3,137	22.9%	0.6%
	4 and +	2,514	19.0%	2,691	20.2%	2,911	21.6%	3,057	22.3%	1.3%
Total all types		**13,244**	**100.0%**	**13,307**	**100.0%**	**13,458**	**100.0%**	**13,706**	**100.0%**	**0.3%**
Mean number of tree species or tree species groups	Broadleaved	2.63		2.68		2.73		2.77		0.3%
	Conifers	1.69		1.73		1.77		1.80		0.4%
	Mixed	3.10		3.18		3.26		3.30		0.4%
	All types	**2.40**		**2.46**		**2.51**		**2.54**		**0.3%**

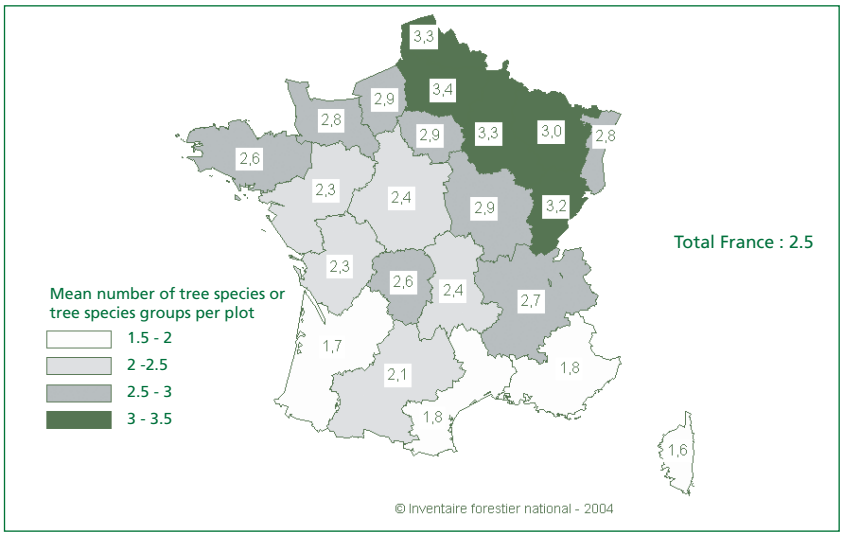
(Source: IFN, except for poplar plantations, criterion only for inventoried forests available for wood supply and not unstocked, based on the number of tree species or tree species groups observed within a 25 m radius around each sampling point; relative to Appendix 6, sessile, pedunculate and pubescent oaks were grouped, as were fruit trees (code 23) and wild service tree, so as to be able to make unbiased comparisons over time)

⇨*Note : data presented for this indicator are based on tree species or groups of tree species monitored by the Inventaire forestier national within a 25 m radius around a sampling point. This is thus an intra-stand diversity assessment approach. The coding of tree species used in the dendrometric surveys provides for species clustering (cf. Appendix 6), corresponding to a simplification measurement (ash, maple, etc.) or to an identification problem (sessile, pedunculate and pubescent oak). This provision leads to a significant underestimation of the number of tree species but the data presented for the different mentioned dates are still comparable.*

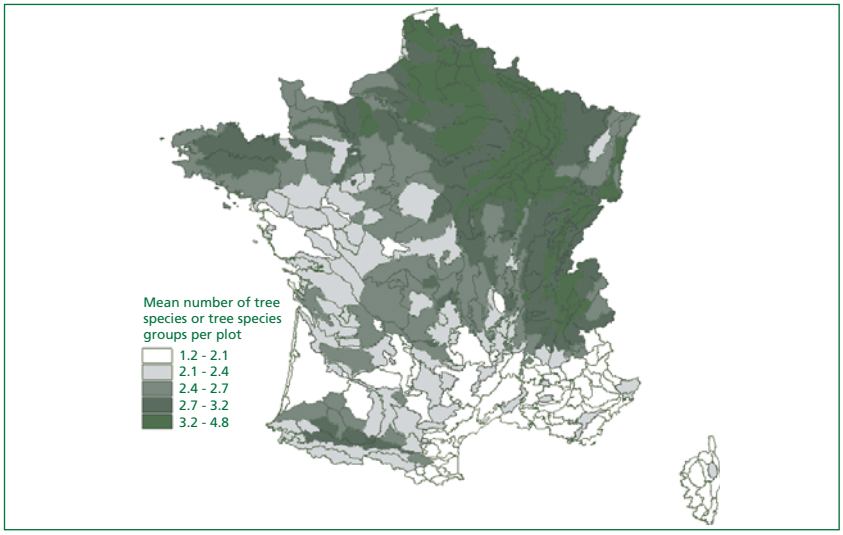
Commentary: nearly three-quarters of the French forest area consists of stands containing two or more tree species. Mixed stands with three or more tree species now account for 45% of the total area. The trend noted between 1989 and 1999 has been confirmed, i.e. monospecific stands continue to decline (206,000 ha lost in 10 years) to the benefit of mixed stands. The greatest increase (37,000 ha/year) has been in mixed stands with four or more tree species.
Not surprisingly, mixed stands are the most diversified, with 68% of them containing three tree species or more. More than 50% of conifer stands, which often arise as a result of reforestation operations, are monospecific and seldom contain four tree species or more. The status of broadleaved stands is midway between these latter two stand types, with 52% of them containing three tree species or more.

This indicator can be summarised on the basis of the mean number of tree species per stand, which increased from 2.46 to 2.54 within 10 years throughout France. The distribution by forest type confirms the previous analysis, i.e. mixed stands currently contain 3.30 species on average, as compared to 2.77 for broadleaved stands and 1.80 for conifer stands.

The most diversified stands are found in northern and northeastern France, with a mean of 3 to 3.4 species (Map 16). The maximum number of tree species was noted in Picardie (3.4), Nord-Pas-de-Calais and Champagne-Ardenne (3.3)–more than 70% of stands in these three regions contain three or more tree species.
The lower intra-stand diversity noted in the Mediterranean region should be cautiously analysed because the tree species clustering carried out by the Inventaire forestier national (IFN) likely leads to underestimation of the prevailing diversity. Moreover, the survey scale used–20 ares around an inventory sampling point–could have a greater negative impact in this region. Finally, IFN's floristic data show that the Mediterranean area has one of the highest woody species diversity rates.



Map 16: Mean number of tree species or tree species groups per plot and administrative region (source: IFN, 2004)



Map 17: Mean number of tree species or tree species groups per plot and forest region (source: IFN, 2004)

n.b. the values shown for the Mediterranean region and mountainous zones are probably underestimated due to the assessment method used

Map 17 highlights some differences within administrative regions. The situation is homogeneous in the Mediterranean region but varied in Aquitaine, i.e. the low diversity of monospecific maritime pine stands on the Landes plateau contrasts with the richness of pedunculate oak stands on the Gascogne hillsides or the beech stands on the Pyrenees foothills. The same trend is noted in northeastern France, where oak and beech stands in Lorraine are more diversified than fir stands in Vosges or pine stands in northern Alsace.

Indicator 4.1 could be enhanced in future considering the reported difficulties encountered in the collection and interpretation of data for this indicator.

In addition, a Cemagref thesis research study on the impact of the tree species composition on floristic diversity is currently under way, and the results should help to assess the relevance of this indicator.

INDICATOR 4.1.1
Purity of main tree species stands in basal area

Forest stands available for wood supply (excluding poplar plantations)

Main tree species	Basal area for all tree species in stands in which the tree species predominates (m^2/ha)				Percentage of the main tree species relative to the basal area for all tree species (% purity)			
	1989	1994	1999	2004	1989	1994	1999	2004
sessile and pedunculate oak	18.5	19.6	20.8	21.4	63%	62%	62%	59%
beech	22.4	22.9	24.0	24.4	69%	68%	67%	67%
maritime pine	16.5	18.1	18.4	20.3	86%	87%	86%	87%
silver fir	28.1	28.4	30.3	31.3	76%	76%	75%	75%
common spruce	21.4	23.5	26.2	28.2	75%	77%	77%	78%
Scots pine	20.1	20.9	22.1	22.4	77%	76%	75%	74%
chestnut	20.8	21.2	23.0	23.1	80%	80%	79%	79%
hornbeam	16.6	17.1	19.2	19.8	57%	57%	56%	55%
pubescent oak	11.5	12.7	13.7	14.6	86%	86%	85%	83%
ash	18.5	18.9	18.9	18.9	48%	49%	49%	48%
Douglas fir	10.8	14.6	18.2	20.4	79%	82%	82%	81%
birch	13.0	13.4	14.0	14.6	59%	58%	58%	58%
Austrian pine	19.3	20.0	21.4	21.7	83%	82%	82%	82%
aspen	16.7	17.1	17.6	18.0	50%	49%	49%	46%
Corsican pine	17.1	19.6	20.7	21.0	82%	81%	82%	83%
false acacia	13.5	14.5	15.5	16.4	71%	73%	71%	71%
larch	20.2	20.1	19.9	22.9	79%	80%	79%	79%
large alder	19.5	19.7	20.4	21.9	75%	73%	74%	74%
large maple	17.3	18.2	18.1	19.9	43%	43%	45%	45%
cherry or wild cherry	13.4	13.6	13.2	13.8	42%	41%	40%	41%
holm oak	8.8	9.9	10.8	11.4	85%	86%	85%	84%
small maple	12.9	12.7	13.0	12.4	50%	49%	46%	47%
Aleppo pine	11.4	11.9	12.0	13.9	75%	75%	75%	72%
linden	20.9	21.0	22.1	22.8	49%	49%	46%	48%
other broadleaved	13.0	13.7	13.8	13.8	65%	64%	64%	63%
other conifers	14.2	17.6	20.5	21.9	80%	80%	80%	80%
Broadleaved*	**17.6**	**18.5**	**19.6**	**20.1**	**66%**	**66%**	**65%**	**64%**
Conifers*	**19.0**	**20.3**	**21.7**	**23.0**	**79%**	**79%**	**79%**	**79%**
All species*	**18.1**	**19.2**	**20.4**	**21.2**	**71%**	**71%**	**71%**	**70%**

* weighted mean

(Source: IFN, excluding poplar plantations, only for inventoried forest stands available for wood supply and for trees with a diameter greater than 7.5 cm at breast height (1.30 m))

⇨Note : the purity rate in basal area supplements the approach of § 4.1 by assessing the status of the main species in the stand; however, this is limited to trees measured by the Inventaire forestier national, i.e. over 7.5 cm diameter at breast height (1.30 m). Sessile and pedunculate oaks could not be distinguished since the different undetermined oak species were pooled.

Commentary: in French silviculture practice, priority is given to one or two key stand-forming tree species, accompanied by secondary tree species and/or understorey tree species, which explains why a high purity rate is maintained in terms of basal area (70%).

Conifer stands have the highest degree of purity (79%) as compared to broadleaved stands (64%), thus confirming previous results based on tree species numbers (§ 4.1).

Purity rates vary, however, depending on the species and the main regions involved–54% for beech in Champagne-Ardenne as compared to 80% in Midi-Pyrénées, 60% for maritime pine in the southeast as compared to 91% in Aquitaine, 62% for Scots pine in Alsace as compared to 86% in Languedoc-Roussillon. Silver fir and common spruce are not as variable, i.e. increasing from 70% and 76%, respectively, in Rhône-Alpes to 80% in Auvergne.
Stands of valuable broadleaved species and various preponderant broadleaved species have a low purity level, i.e. not above 50% for valuable broadleaved species (wild cherry, ash, and large maples) and 60% for various broadleaved species (birch, hornbeam, aspen, etc.).

The rise in stands containing several tree species noted in § 4.1 is reflected by a slight decrease in the purity rate in terms of basal area for many tree species. The purity rate increased mainly in reforestation species (Douglas fir, common spruce, Corsican pine).

INDICATOR 4.2

Area of regeneration within even-aged stands and uneven-aged stands, classified by regeneration type

Forest stands available for wood supply (excluding poplar plantations)

Type of regeneration	Regular stands	Irregular high forest and mixed coppice/high forest	Total	
	ha/year	ha/year	ha/year	%
Natural regeneration	13,500	10,800	**24,300**	**29.4%**
Artificial regeneration	27,000	6,900	**33,900**	**40.9%**
Coppice sprouting	24,600		**24,600**	**29.7%**
Total	**65,100**	**17,700**	**82,800**	**100.0%**

(Source: IFN, excluding poplar plantations, only for inventoried forest stands available for wood supply. For regenerations, the method used involved overlaying field plots of the previous inventory on the aerial photographs of the last inventory (1984-93 period); no comparison was possible with 1999 because the two data series were not available for three departments; cases of clearcutting awaiting regeneration for less than 5 years were classified as artificial regeneration for maritime pine stands in private forests in departments 33, 40 and 47. For coppice sprouting, the data were deduced from coppice ages at the last inventory because the previous method underestimated the sprouted area.)

⇨ *Note : the data in this table do not account for the extension of the forest area analysed in paragraph 1.1.*

Commentary: the area regenerated yearly is estimated at 83,000 ha, including 30% via coppice sprouting and 70% by natural or artificial regeneration.

When not considering coppices, 33% of regular stands are naturally regenerated as compared to 61% of irregular stands, which include irregular high forests and mixed coppice/high forest stands that are generally renewed naturally (regeneration or conversion into high forest).
More than 60% of the broadleaved stand area is naturally regenerated, mainly involving pedunculate oak (67%), beech (64%) and sessile oak (55%). Planting is the main regeneration strategy adopted for conifers, accounting for 70% of the area regenerated annually. Maritime pine is the main species used for reforestation, via plantation (and sowing) in 85% of the area regenerated with maritime pine, as compared to 52% for Scots pine.

Generally only silver fir (55%), Austrian pine (55%) and especially Aleppo pine (82%) are regenerated naturally.

2,000 ha of coppice are cut yearly in Rhône-Alpes, Aquitaine, Midi-Pyrénées, Poitou-Charentes and Provence-Alpes-Côte d'Azur regions. The main species involved are chestnut, pubescent oak and false acacia.

There is some uncertainty concerning data on natural and artificial regeneration because it is hard to determine the reasons underlying forest clearcuts on aerial photographs. The new inventory method should enable more reliable updates of these data on the basis of field surveys.

INDICATOR 4.3

Area of forest and other wooded land, classified by "undisturbed by man", semi-natural" or by "plantations", each by forest type

Forest stands (including poplar stands)

Extent of naturalness	Forest type	1989		1994		1999		2004		1994-2004
		x1,000 ha	%	x1,000 ha	%	x1,000 ha	%	x1,000 ha	%	annual variation rate
Undisturbed forests		***30***	***0.2%***	***30***	***0.2%***	***30***	***0.2%***	***30***	***0.2%***	
Semi-natural forests	Broadleaved	8,448	59.7%	8,581	59.6%	8,759	59.4%	8,901	59.0%	0.4%
	Conifers	2,276	16.1%	2,251	15.6%	2,242	15.2%	2,252	14.9%	0.0%
	Mixed	1,115	7.9%	1,153	8.0%	1,209	8.2%	1,262	8.4%	0.9%
	Unspecified	547	3.9%	577	4.0%	643	4.4%	755	5.0%	
total Semi-natural forests		**12,386**	**87.6%**	**12,562**	**87.3%**	**12,853**	**87.1%**	**13,170**	**87.2%**	**0.5%**
Plantations	Broadleaved	209	1.5%	210	1.5%	221	1.5%	240	1.6%	1.3%
	Conifers	1,465	10.4%	1,553	10.8%	1,604	10.9%	1,609	10.7%	0.4%
	Mixed	49	0.3%	39	0.3%	45	0.3%	49	0.3%	2.3%
total Plantations		**1,723**	**12.2%**	**1,802**	**12.5%**	**1,870**	**12.7%**	**1,898**	**12.6%**	**0.5%**
Total		**14,139**	**100.0%**	**14,394**	**100.0%**	**14,753**	**100.0%**	**15,098**	**100.0%**	**0.5%**

(Source: IFN for semi-natural forests and plantations, including poplar plantations, based on FAO definitions; estimations taken from the 1995 and 2000 editions of the present report for forests undisturbed by man—it was not possible to update these estimations or to classify them by forest type)

⇨*Note : the **undisturbed forest** area was assessed on the basis of estimations presented in the 1995 and 2000 versions of the present report, which in turn were based on 1994 data of the French Office national des forêts and the Inventaire forestier national (IFN). They were defined by the presence of high forest stands from time immemorial, consisting exclusively of local indigenous tree species, and in which there had been no human interventions for at least 50 years; the figure for private forests was estimated by applying the same ratio between undisturbed forests and forests not available for wood supply (estimated by IFN) as for state-owned forests, which could slightly overestimate this area–indeed, private forests are less represented in mountain regions where most "undisturbed" forests are found. It was not possible to update these data.*

***Plantations** were represented by:*

1) afforestations and reforestations within less than 40 years with acclimatized or exotic species (including Corsican pine grown outside of Corsica) treated as regular high forest;

2) afforestations and reforestations within less than 40 years with common spruce treated as regular high forest;

3) communal and private regular high forest stands of maritime pine in Landes, Gironde and Lot-et-Garonne departments. In compliance with the FAO definitions, plantations not intensively logged were classified as semi-natural forests (maritime pine stands in state-owned forest stands in the Landes range, etc.).

*Stands were only designated by IFN as derived from "afforestation" or "reforestation" when they were less than 40 years old–hence beyond this age stands could no longer be considered as being intensively logged, apart from maritime pine stands outside state-owned forests in the Landes range. **Semi-natural forests** were stands that did not qualify under the previous two definitions.*

Commentary: French metropolitan forests have been profoundly shaped by humans throughout history. Only 30,000 ha of forest area is estimated to have been undisturbed for at least 50 years–these stands are mainly located in mountain regions that are generally inaccessible. It is hard to accurately evaluate this area and the data therefore could not be updated.

Plantations represent 13% of the forest area, or 1.9 million ha (Figure 17), mostly conifer stands. Indigenous tree species, i.e. maritime pine and common spruce, largely predominate. Concerning introduced tree species, Douglas fir is the main reforestation species, followed by Austrian pine, Sitka spruce, American red oak and grand fir. The plantation area has increased since 1999, but at a slower pace than during previous years, i.e. +5,600 ha per year as compared to +13,600 between 1994 and 1999 (years for which data are available).

Semi-natural forests, as defined by FAO, represent 87% of the total forest area–the expansion of the forest area has mainly been to the benefit of these formations, which have increased by 60,000 ha per year over the last decade. Broadleaved species account for two-thirds of this area and most mixed stands are classified as semi-natural forests.

Forest naturalness is hard to assess. Recent studies conducted by the French Institut national de la recherche agronomique (INRA) highlighted that the "ancient forest" concept can be beneficially used to develop a complementary indicator. This indicator, which is based on the period during which the land has been forested, and not on the tree age or the stand structure, is designed to assess forest ecosystem function and diversity. These studies led to the identification of floristic associations typical of ancient forests.

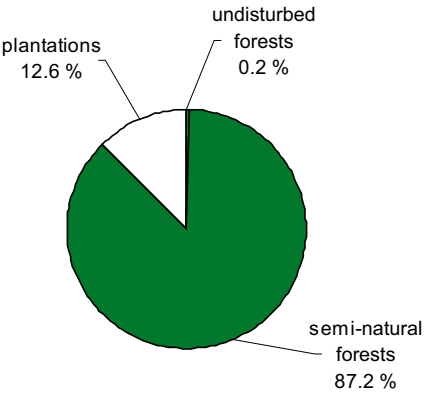


Figure 17: Forest area according to the extent of naturalness (source: MAP and IFN, 2004)

INDICATOR 4.3.1
Area of very old regular high forests forming specific habitats

Forest stands available for wood supply (excluding poplar plantations) - Regular high forests

Main tree species	age limit*	1989		1994		1999		2004	
		ha	% total area	ha	% total area	ha	% total area	ha	% total area
pedunculate oak	180 years	13,800	2.9%	14,900	2.5%	12,800	1.9%	10,300	1.5%
sessile oak	240 years	700	0.2%	900	0.2%	700	0.1%	400	0.1%
pubescent oak	150 years	3,800	2.5%	5,200	3.6%	6,800	4.3%	7,800	4.8%
holm oak**	200 years	1,800	12.6%	700	6.2%	700	5.9%	700	5.8%
cork oak	120 years	4,600	7.6%	4,200	7.2%	4,200	7.2%	5,100	9.9%
beech	180 years	30,700	4.9%	35,800	5.2%	29,000	3.9%	30,800	4.0%
chestnut	150 years	23,900	19.7%	17,200	15.0%	17,800	15.4%	16,500	13.6%
ash	120 years	4,600	6.8%	5,500	5.7%	6,900	5.1%	7,000	4.1%
large alder	70 years	3,500	25.3%	2,500	23.9%	2,200	23.1%	2,600	20.1%
aspen	70 years	1,600	17.0%	1,100	11.7%	1,400	15.9%	1,100	10.6%
birch	50 years	9,400	38.6%	10,500	54.1%	11,200	52.8%	15,000	56.4%
lowland fir	160 years	0	0.1%	0	0.1%	100	0.1%	0	0.1%
lowland spruce	160 years	0	0.0%	200	0.1%	200	0.1%	100	0.1%
mountain fir	200 years	11,200	3.4%	12,400	3.6%	11,800	3.4%	11,300	3.2%
mountain spruce	200 years	10,200	2.6%	9,400	2.3%	8,900	2.1%	9,900	2.4%
maritime pine	140 years	900	0.1%	800	0.1%	900	0.1%	1,400	0.1%
Scots pine	200 years	2,000	0.2%	1,500	0.2%	1,300	0.2%	1,200	0.1%
Corsican pine	200 years	1,900	2.4%	2,100	2.3%	2,000	1.8%	2,000	1.6%
mountain pine	150 years	7,400	15.5%	7,400	14.6%	7,400	15.0%	5,800	11.9%
larch	200 years	9,000	10.7%	8,700	10.4%	8,700	10.2%	10,700	11.5%
Total		**141,000**	**2.8%**	**141,000**	**2.7%**	**135,100**	**2.4%**	**139,800**	**2.4%**

* age limit greatly exceeding the admissible age for rotation of the concerned species

** area underestimated in 1994, 1999 and 2004 owing to the absence of a field inventory for certain formations in the Mediterranean region (garrigues and maquis woodland, holm oak coppices in Gard region)

(Source: IFN, excluding poplar plantations, based only on inventoried forest stands available for wood supply and having a regular high forest structure. The age limit estimation, carried out in collaboration with ONF and INRA, could, for a first approximation, be considered as a likely age of onset of physiological overmaturity or senescence phenomena under average conditions. The pedunculate oak forest area of 2004 was likely underestimated because this species could have been classified under the "undifferentiated oak" category when identification was in doubt.)

Commentary: stands in a phase of advanced maturity or even senescence contain specific habitats that are host to certain animal and plant species. However, the extent of these habitats based on the area of very old stands can be assessed only for regular high forests for which age data are available. The proposed table thus only concerns 49% of the forest area inventoried in France, while disregarding coppices-with-standards and selection high forests which may also contain this type of habitat. Furthermore, this "stand" approach does not account for individual trees sometimes grown by foresters for this purpose.

The area of very old regular high forest has remained relatively steady for 15 years, at around 140,000 ha, representing 2.4% of the total regular high forest area in the last inventory. The current situation varies greatly from species to species, ranging from 0.1% for sessile oak, maritime pine, Scots pine and lowland spruce, to 10-15% for aspen, larch, mountain pine and chestnut, and to as high as 56% for birch.

The overall stability noted is the result of contrasting trends for different species. Very old pubescent oak and birch high forest stands have increased significantly, likely due to the fact that coppice felling has been halted, especially in the Midi-Pyrénées region, and also for stands of ash and larch (in the southern Alps for this latter species). Conversely, very old chestnut, mountain pine and pedunculate oak high forests have substantially declined. This could be correlated with the disappearance of old sweet chestnut groves, especially in the Massif Central, and with the regeneration of some mature mountain pine stands in the southern Alps. For this latter species, it is also possible that some stands had been reclassified as IFN protection forests in the last inventory and were thus not assessed in any field surveys. The extent of decline of very old pedunculate oak stands was probably overestimated–part of these stands were classified as "undifferentiated oaks" in 2004 when there was doubt as to the species identifications, whereas the high forest area for "undifferentiated oaks" over 180 years old was estimated at 1,900 ha in 2004 (no stands were over 240 years old, so sessile oaks are thus excluded from this cautionary note).
The same trend was noted for very old holm oak stands whose decline could be explained by the fact that some formations in the Mediterranean region were not inventoried in 1994, 1999 and 2004.

This stability of very old regular high forests throughout France also confirms that the capitalisation observed in French forests does not concern these stand categories (cf. § 1.3).

INDICATOR 4.4

Area of forest and other wooded land dominated by introduced tree species

Forest tree species recorded	Number of broadleaved species	Number of conifer species	Total
indigenous	57	16	73
acclimatized	3	6	9
exotic	16	38	54
Total	**76**	**60**	**136**

(Source: J.C. Rameau (ENGREF): cf. list of forest tree species (or species groups for cultivated poplars and eucalyptus) presented in the Appendices)

Forest stands available for wood supply (excluding poplar plantations)

Main tree species	1989		1994		1999		2004		1994-2004
	K ha	%	K ha	%	K ha	%	K ha	%	Annual variation rate
indigenous	12,648	94.9%	12,724	94.2%	12,942	94.0%	13,117	93.7%	0.3%
acclimatized	582	4.4%	663	4.9%	696	5.1%	754	5.4%	1.3%
exotic	99	0.7%	118	0.9%	129	0.9%	126	0.9%	0.6%
Subtotal*	**13,329**	**100.0%**	**13,505**	**100.0%**	**13,768**	**100.0%**	**13,998**	**100.0%**	**0.4%**
unspecified	8		66		99		93		
Total*	**13,337**		**13,571**		**13,867**		**14,091**		**0.4%**

* including area estimated in non-inventoried formations in the Mediterranean region in 1994, 1999 and 2004

(Source: IFN, excluding poplar plantations, criterion only determined for forest stands available for wood supply for which the main tree species was established. Cf. list in Appendix 5)

Commentary: French forests have an exceptionally diversified range of tree species due to the variety of physical environments and climates, which in turn is linked with France's geographical location in Europe–at the crossroads of the Atlantic, continental and Mediterranean domains. Broadleaved species predominate in both number and area.

There is a high proportion of stands with an indigenous main tree species (93.7% - Figure 18). This percentage has decreased slightly over the last 10 years to the benefit of acclimatized tree species, which now account for 5.4% of the inventoried forest area. The indigenous tree species area has, however, increased in absolute value due to substantial natural afforestation–this increase involved 35,000 ha per year over the last 5 inventoried years as compared to 11,600 ha per year for acclimatized tree species. These latter species–mainly Douglas fir and Austrian pine–have a high natural regeneration potential.

Exotic tree species only cover 1% of the inventoried forest area, and this area has levelled off over the last 5 years. The main species involved are Sitka spruce, grand fir and cultivated poplar.

According to data of the Inventaire forestier national (IFN), indigenous tree species were involved in 60% of artificially afforested and reforested areas between the last two inventories. These rates were estimated at 34% for acclimatized tree species and 6% for exotic tree species, whereas they were estimated at 60%, 35% and 5%, respectively in 2000.

A few exotic or acclimatized tree species are now known to be invasive, i.e. box elder (Acer negundo), false acacia (Robinia pseudo-acacia) and black cherry (Prunus serotina) throughout metropolitan France and copal tree (Ailanthus altissima) in the Mediterranean and Atlantic regions. Box elder can modify the floristic species composition in relict alluvial forests. Invasion of calcareous or sandy grasslands by false acacia can induce a very marked retreat of the natural vegetation. Dense black cherry stands hamper regeneration of shade-intolerant tree species (oak, Scots pine), leading to a decline in vegetation diversity. Copal trees tend to uniformize landscapes and habitats.

Concerning these four tree species, IFN dendrometric surveys currently only make a distinction for false acacia, whose area has slightly decreased in the last 15 years and seems to have levelled off at around 130,000 ha (cf. § 1.1.4). However, the area naturally colonised by false acacia between the last two inventories (1984-96) was estimated at 1,900 ha, or 160 ha per year.

The results of IFN floristic surveys to record all species present will soon be available for the entire forest area of metropolitan France–this will enable analysis of variations in other species on the basis of species abundance-dominance coefficients.

A more detailed sampling will, however, be required to monitor invasive species in the most fragile environments.

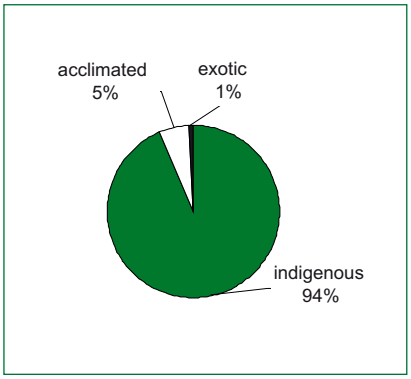


Figure 18: Forest area according to the extent of naturalness of the main species (source: IFN, 2004)

INDICATOR 4.5

Volume of standing and lying deadwood on forest and other wooded land, classified by forest type

Forest stands available for wood supply (excluding poplar plantations)

Forest type	Volume of wood from trees dead for less than 5 years									
	1989		1994		1999		2004		1994-2004	
	total	ratio to the inventoried area	total	ratio to the inventoried area	total	ratio to the inventoried area	total	ratio to the inventoried area	annual variation rate	
	x1,000 m³	m³/ha	x1,000 m³	m³/ha	x1,000 m³	m³/ha	x1,000 m³	m³/ha	total	per ha
Broadleaved	8,256	1.0	11,648	1.4	12,395	1.5	12,708	1.5	0.9%	0.6%
Conifers	5,292	1.4	7,567	2.0	7,934	2.1	7,448	2.0	-0.2%	-0.2%
Mixed	1,833	1.6	2,528	2.2	3,005	2.5	3,196	2.5	2.4%	1.5%
Total	**15,381**	**1.2**	**21,743**	**1.6**	**23,333**	**1.7**	**23,352**	**1.7**	**0.7%**	**0.4%**

(Source: IFN, excluding poplar plantations, only for not unstocked inventoried forest stands available for wood supply and only for wood from trees dead for less than 5 years when the inventory team surveyed the plot (dead trees and old or recent standard windfalls not yet removed). Exceptional windfalls were not taken into account.)

Commentary: deadwood is now known to be a key element in forest biodiversity conservation. It provides various microhabitats that are essential for the survival of many plant and animal species. It is also known that potential pest and disease risks for living trees can readily be controlled–only trees that are dying or have recently died could potentially, for a short period, still host secondary pests–this risk should be assessed according to the species, the pest insects and the size of their populations.

In metropolitan France, the volume of deadwood from trees that have died within the last 5 years continues to increase to the current level of 23.4 million m³, or 1.7 m³/ha, as compared to 1.2 m³/ha 15 years ago. These figures cannot be reliably compared with those of other European countries because of the calculation method used until now in France (cf. note).

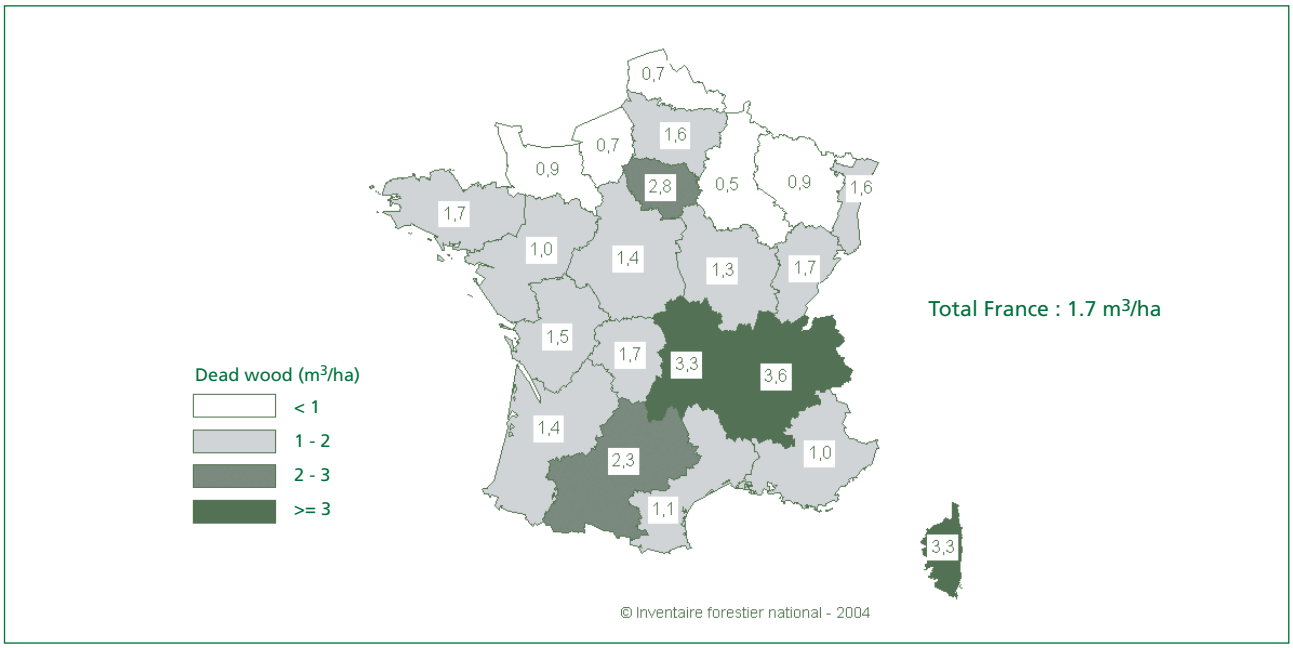
Mixed stands have the highest per-ha deadwood volume (2.5 m³/ha), ahead of conifer stands (2 m³/ha) and broadleaved stands (1.5 m³/ha). Mixed stands also showed the most marked increase in deadwood volume over the last 15 years.
Of the main tree species involved, chestnut has the highest total deadwood volume (17%), followed by Scots pine (13%), sessile and pedunculate oak (12%), common spruce (10%) and silver fir (9%). Broadleaved species predominate, with 54% of the total deadwood volume in metropolitan France.

The situation varies markedly from region to region, ranging from 0.5 m³/ha in Champagne-Ardenne to 3.6 m³/ha in Rhône-Alpes (Map 18). The lowest values were recorded in northern/northeastern France. The highest per-ha deadwood volumes occur in mountain regions, i.e. apart from Rhône-Alpes as already mentioned, Auvergne and Corsica both have a deadwood volume of 3.3 m³/ha. This could be mainly explained by the logging difficulties encountered in these three regions. Indeed, the deadwood volume in forest stands increases as the logging conditions get harsher–IFN data show that the per-ha volume rises from 1.3 m³/ha in easy logging conditions to 4.4 m³/ha in stands considered to be unavailable for wood supply and which thus have not been logged for a very long time. These results confirm the known relation between extensive forest management and the amount of deadwood present.

The relatively high value obtained for Ile-de-France seems to be associated with the unusually high mortality rate of Scots pine in Seine-et-Marne at the inventory date (1993).

⇨ *Note : the Inventaire forestier national only takes trees that have been dead for less than 5 years into account when the field team surveys the plot. This seriously underestimates the total volume of deadwood in forest stands–an IFN study showed that, in Haut-Rhin department, accounting for virtually all deadwood could boost the first estimation by fivefold. This 5-year limit was initially chosen on the basis of 5-year net increment calculations. Studies are under way to supplement this evaluation, but meanwhile this limit is taken into account in the current data analysis.*
Moreover, only standard mortality–excluding exceptional windfalls as in 1999–was considered in order to avoid spatial and temporal bias in the comparisons. The extent of exceptional windfalls recorded by IFN is directly linked with the inventory date in each department.
Finally, the results are higher than those presented in the 1995 and 2000 editions of this report because recent standard windfalls (1-2 years) were not taken into account in the previous analyses.

Most forest managers, especially of state-owned forests, recognise the importance of conserving deadwood in forests. The Office national des forêts has already published a series of recommendations on this topic, within the framework of a set of guidelines on taking biodiversity into account in forest management plans and practices– these are currently being revised on the basis of up-to-date bibliographical data recently summarised by Cemagref.
The increase in forest deadwood recorded by IFN seems to reflect an improvement in the situation, but it is still hard to distinguish between the impact of extensive forest management–especially in mountain regions–and that of silvicultural practices which promote deadwood preservation.



Map 18: Volume of deadwood from trees that have died within the last 5 years, apart from exceptional windfalls, per administrative region (source: IFN, 2004)

INDICATOR 4.6

Area managed for conservation and utilisation of forest tree genetic resources (*in situ* and *ex situ* gene conservation) and area managed for seed production

Forest tree seed and stand production

Selected or tested seed stands

	broadleaved	conifers	total
number	773	933	**1,706**
area (ha)	22,455	36,912	**59,367**

Qualified or tested seed orchards

	broadleaved	conifers	total
number	1	13	**14**
area (ha)	1	321	**322**

Tested clones (classified in the tested category)

cultivars	poplars	wild cherry	total
number	44	8	**52**

(Source: Cemagref, 2004)

Commentary: the main French forest species are governed by regulations set down in an EU Council Directive on the marketing of forest reproductive material. One aim of this directive is the genetic improvement of forest stands by prohibiting the use of seeds or plants derived from stands considered to be of poor genetic quality. Following signature of this new EU directive in December 1999, the French forest code texts concerning these regulations were fully updated. The new regulations became effective in October 2003 after the adoption of a new system of redistribution of regions of origin.

The objectives of the new regulations are wide ranging:

- to broaden the regulation scope, especially by increasing the number of species controlled. Besides poplar cultivars which are only propagated vegetatively, the regulations now apply to 41 species that can be generatively propagated using seeds that are harvested in authorised seed stands and seed orchards in France. These 41 species include 18 conifers and 23 broadleaved species, and 32 of them are indigenous species;
- to enhance monitoring of the forest reproductive material identity from seed harvest to plant dissemination. Seed lots are now certified at harvest with a Master Certificate, which replaces the former Certificate of Provenance;
- to set up four marketing categories, including "identified", "selected", "qualified" and "tested" (cf. Box 6). There were previously only two categories, i.e. "selected" and "controlled", and this latter was subsequently renamed "tested";
- to better account for new varieties from genetic improvement programmes.

A project was undertaken to redefine the regions of provenance in order to facilitate implementation of the new "identified" category. This initiative was conducted by Cemagref, in collaboration with scientists and professional partners, focusing on 39 species for which there is an indigenous resource (or not) in France and which could generate harvests classified under the "identified" or "selected" categories. These regions of provenance were determined on the basis of the species' stand size, distribution and diversity, as assessed through tests, biochemical analysis or environmental variation patterns. The number of regions of provenance ranges from 1 to 19 depending on the species .

It was thus necessary to update the list of recommended provenance according to regions in which the material is to be used. The new region of provenance system became operational on 1 July 2002 for the certification of harvests in the "selected" category (green label).

Box 6: Marketing categories for forest seeds and plants

The **geographical origin** is the only information available for materials classified as **identified**. These are harvested in a seed source, i.e. a set of trees of undetermined size, located in a known harvest zone, corresponding to a single region of origin. There is **no preselection** of these resources.

Selected material is from stands chosen mainly on the basis of **phenotypic traits** (vigour, tree shape, disease resistance). Most trees in these stands must be true-to-type.

Material classified under the **qualified** category is **artificial**, contrary to that from most selected stands. This material is produced in seed orchards (plantations of family clones or parental stock) set up specifically to produce seeds of superior genetic quality. To this end, the raw material components previously undergo **individual phenotypic selection** in the forest or under test conditions on the basis of criteria such as vigour, tree shape, disease resistance or wood quality.

The highest amount of information is available for **tested** material. The superiority of this material, relative to one or several reference materials for the species, is demonstrated through **comparative tests or component assessments** with respect to at least one trait of silvicultural interest. Stands, seed orchards and clones that have been the focus of comparative provenance or clonal tests qualify under this category.

National genetic resource conservation programme

Species	Natural populations conserved *in situ*		*Ex situ* conservation plantations		*Ex situ* conserved collections
	number	area	number	area	
Wild service tree	*under discussion*				
Sessile oak	20	2,593 ha			
Service tree					140 clones
Walnut					90 clones
Beech	27	3,875 ha			
Wild cherry	*under discussion*		2	4 ha	332 clones
Elm species	*in preparation*				426 clones
Black poplar	12 (currently being selected)				367 clones
Common spruce	*in preparation*				
Silver fir	22	3 506 ha	4	28 ha	
Maritime pine	*in preparation*				

(Source: Cemagref, INRA and ONF; 2004)

Commentary: following the first Ministerial Conference on the Protection of Forests in Europe (Strasbourg, 1990), France pledged to implement a conservation policy for forest genetic resources. The French Forestry Ministry thus subsequently set down the main national policy guidelines in this area–in line with the strategy it has been following since 1986. Priority was given to *in situ* conservation of forest genetic resources, as recommended in Resolution 2 of the Strasbourg conference.

A national body was set up, i.e. the Commission des Ressources Génétiques Forestières, to ensure that the national forest genetic resource conservation policy is harmoniously implemented. This commitee is responsible for defining how the policy should be implemented, so a national network for the management and conservation of genetic resources of the main forest species was set up. This national network is organised by species and combines *in situ* and *ex situ* methods. It currently concerns 11 species and covers:

- *in situ* conservation stands already set up for beech, silver fir and sessile oak, in preparation for maritime pine, common spruce, black poplar and European white elm, and under discussion for wild cherry and wild service tree

- *ex situ* conservation plantations set up for wild cherry and silver fir

- *ex situ* collections of clones maintained in clone plots or via cryoconservation for elms, black poplar, service tree, walnut and wild cherry

France also participates in EUFORGEN (European Forest Genetic Resources Programme), a cooperative programme that is geared towards promoting the exchange of information and experience on forest genetic resource conservation, and it focuses especially on ensuring consistency in the work undertaken at the species level.

This programme is based on networks for each species or group of species: conifers, stand-forming broadleaved species (including Mediterranean oak), scattered broadleaved species (including black poplar). Since 1 January 2005 (beginning of Phase III), the EUFORGEN programme also includes a multisector "forest management" network. France is actively involved in these different networks.

INDICATOR 4.7

Landscape-level spatial pattern of forest cover

Area per forest range size class

Forest stands (including poplar plantations)

area class	1999				2004			
	number of forest units	mean area mapped per forest unit (ha)	total mapped area x1,000 ha	%	number of forest units	mean area mapped per forest unit (ha)	total mapped area x1,000 ha	%
4-25 ha	42,308	10	431	2.8%	45,230	10	449	2.8%
25-50 ha	7,827	35	275	1.8%	7,962	35	280	1.8%
50-100 ha	4,766	70	332	2.1%	4,743	70	331	2.1%
100-500 ha	4,908	209	1,028	6.6%	4,876	208	1,014	6.3%
500-1,000 ha	787	698	549	3.5%	801	701	561	3.5%
1,000-5,000 ha	646	2,096	1,354	8.6%	645	2,080	1,341	8.4%
5,000-10,000 ha	99	6,906	684	4.4%	94	6,825	642	4.0%
over 10,000 ha	90	122,278	11,005	70.3%	92	123,960	11,404	71.2%
Total	**61,431**	**255**	**15,659**	**100.0%**	**64,443**	**249**	**16,023**	**100.0%**

(Source: IFN 1999 and 2004, for all forests (including poplar stands) of over 4 ha, based on the IFN cartographic database, considering that a 200 m break does not interrupt the continuity of a forest unit. The monitored areas are higher than those derived from the statistical data (14,753 thousand ha for 1999 and 15 098 thousand ha for 2004) because they were calculated on the basis of cartographic analyses conducted before application of the afforestation rate - cf. Appendix 4.)

Commentary: fragmentation of forest area is an important factor in evaluating the capacity of forest ranges to host certain animals and plants. It can also serve as a tool for analysing the migratory potential of some species under the effect of climate change.

The sensitivity of species to habitat fragmentation depends especially on their mobility and the size of their territories, which can range from a few cm^2 to several thousands of km^2.
Cartographic data of the Inventaire forestier national (IFN) are not sufficiently accurate to be able to assess very small forest units. The proposed method thus mainly concerns large animals.
Some animal species, like red deer and bears, need to be completely peaceful in their refuge habitats deep within large forests, while other species, such as roe deer and certain birds of prey, seek varied terrain and–at least during some periods of their lifecycle–they prefer forest edges and small forest stands. It has been estimated that a break of 200 m would not interrupt the continuity of a forest unit. This option attempts to account for the mobile behaviour of some animals and their circulation between forest units linked by forest or subforest corridors. It should ultimately be enhanced by taking potential impassable barriers (highways without special animal crossings, rivers, etc.) into account, but it already represents a preliminary approach to the spatial distribution of forest units and associated changes.

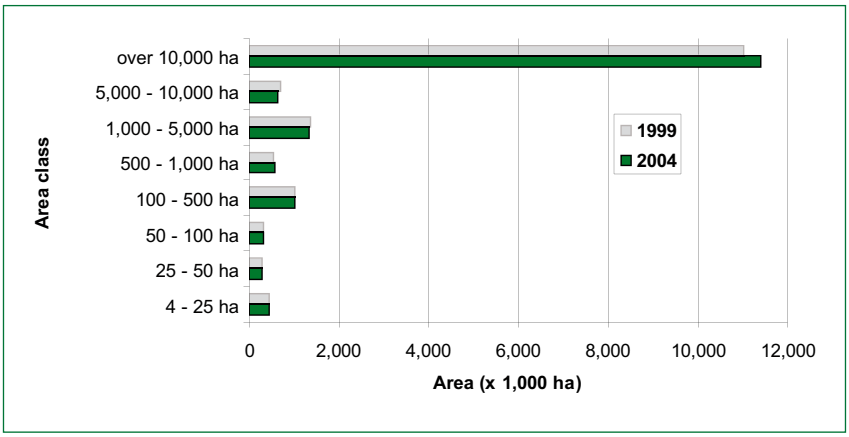


Figure 19: Forest area (including poplar stands) per forest range area in 1999 and 2004 (source: IFN)

On this basis, in the last inventory, IFN recorded more than 64,400 forest units larger than 4 ha, as compared to 61,400 in the previous inventory 5 years earlier–the mean forest unit area dropped from 255 to 249 ha, which seems to be evidence of acute fragmentation. However, this analysis was difficult due to the extension of the forest area, which could lead to a series of small forest stands or the fusion of

much larger units. Moreover, non-extension related flows between area classes have not been documented–the results obtained are due to both urban extension and forest canopy closure phenomena, which vary from region to region.
The proportion of small forest units of 4-100 ha is still quite small, accounting for 7% of the forest area, or slightly more than 1 million ha. This proportion varies substantially between regions, ranging from 1-2% in the Mediterranean region to more than 25% in Bretagne and Nord-Pas-de-Calais (cf. Appendix 11).
Units larger than 10,000 ha account for more than 70% of the forest area (Figure 19).
Here again, this share can range from less than 10% in Bretagne and Nord-Pas-de-Calais to more than 95% in the Mediterranean region. These large forest ranges can also conceal highly contrasting situations because of the sampling method used–they can be large forest areas with few gaps (Landes massif), or a series of many small neighbouring stands (western Massif Central), or ranges consisting mainly of open forests (southern Massif Central).
The current situation reflects the landholding structure and the heritage from the history of the last centuries. It is hard to interpret the fragmentation of the national forest area because of the high diversity between regions. In many cases, increased fragmentation can threaten certain plant and animal species, while in others the opening of different sized clearings in very compact forest units can benefit some species.

INDICATOR 4.7.1
Per-ha length of forest edges

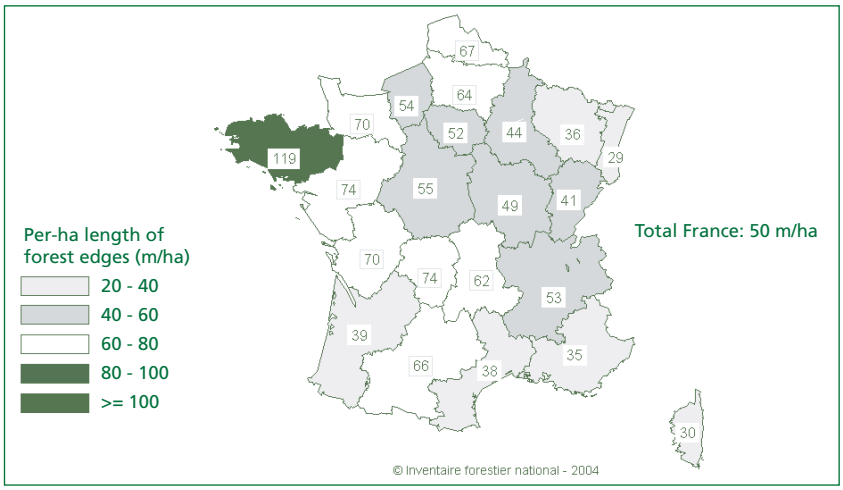
Forest stands (including poplar plantations) and other wooded lands

Category	per-ha length of forest edges (m/ha)		Annual variation rate
	1999	2004	1999-2004
Forests	49.0	50.3	0.5%
Other wooded lands*	55.5	63.2	2.8%
Total	**41.7**	**43.1**	**0.6%**

* FAO's "other wooded lands" correspond to IFN's "heathlands"

(Source: IFN, 1999 and 2004 for all forest stands (including poplar plantations) and heathlands of more than 4 ha according to the cartographic database)

Commentary: fragmentation of forest area can also be assessed by the per-ha length of forest range edges. Contrary to Indicator 4.7, by this approach, each forest range of more than 4 ha mapped by the Inventaire forestier national (IFN) is considered separately, without any buffer zone along its edges.



Map 19: Mean per-ha length of edges between forest stands and non-forest areas per administrative region (source: IFN, 2004)

The length of the "forest/non-forest" edge is currently estimated at 50.3 m/ha. This length has been increasing over the last 5 years, thus confirming the results of Indicator 4.7, while there has been a slight increase in fragmentation of the metropolitan forest. The length of the heathland edge (FAO's "other wooded lands" classification) has also been increasing, but at a faster pace–the extension of forest area, mainly due to natural afforestation of heathland and fallows, could lead to a substantial increase in small forest stands, which in turn also cause heathland fragmentation. This seems to indicate that the increase in the number of small stands noted in § 4.7 is mainly due to the extension of forest area.
The level of forest range fragmentation varies considerably between regions (Map 19): Bretagne has by far the highest fragmentation rate in France, whereas there is little fragmentation of forests in the Mediterranean, Aquitaine and Alsace-Lorraine regions.
A detailed analysis by 20 x 20 km area was undertaken by the Office national des forêts (ONF). The results revealed a close correlation between the percentage forest cover and the length of the forest/non-forest edge per forested ha. This per-ha length, relative to the total area of France, is maximal at 50% forest cover.

INDICATOR 4.7.2
Per-ha length of forest edges by IFN national stand types

Forest stands (including poplar plantations)

National stand type	per-ha forest edge length (m/ha)		annual variation rate
	1999	2004	1999-2004
Pure broadleaved high forest	78.0	79.6	0.4%
Pure conifer high forest	59.3	62.1	1.0%
Mixed high forest	89.2	98.4	2.1%
Mixed coppice-predominantly broadleaved high forest	84.2	88.3	1.0%
Mixed coppice-predominantly conifer high forest	89.5	99.6	2.3%
Coppice	77.0	83.2	1.7%
Open production forest	84.6	95.6	2.7%
Non-forest poplar plantation	140.7	143.3	0.4%

(Source: IFN, 1999 and 2004 for all forest stands of over 4 ha according to the cartographic database)

Commentary: the per-ha length of forest edges by stand type provides a preliminary assessment of French forest landscape diversity. Here the edge is defined as the limit between a type of forest stand and another type of stand or a non-forest landuse (heathland, agriculture, urbanisation, etc.). National stand types delineated by the Inventaire forestier national (IFN), based mainly on the stand structure and composition, were used for this purpose.

The high results obtained for cultivated poplar plantations could be simply explained by the small size of plots planted with poplar. The most fragmented stand types are thus mixed coppice-conifer high forests, mixed high forests and open forests. These three stand types are currently being fragmented most quickly. This increase could undoubtedly be partially explained by the extension of forest area, as already pointed out in § 4.7.1. Indeed, open forests represent the first stage in the heathland-closed forest conversion process, and mixed stands have had the greatest increase in area as compared to pure broadleaved and conifer stands (cf. § 1.1). The most widespread stand units are pure conifer high forests, i.e. mainly maritime pine in the Landes massif.

The national data are hard to interpret, as also noted in Indicator 4.7. A more in-depth regional analysis would be required using departmental IFN stand types, which are more detailed than national stand types–these latter types can conceal substantial landscape diversity since very different broadleaved and conifer species are pooled together. This problem is sometimes also noted within the same type of departmental stand which can contain trees at many different development stages.

INDICATOR 4.7.3
Intensive cuts and clear cuts

Forest stands available for wood supply (excluding poplar plantations)

Type of cut	Broadleaved stands	Conifer stands	Total	
	ha/year	ha/year	ha/year	%
Clearcut awaiting regeneration for over 5 years	1,600	1,800	3,400	3.6%
Final cut with natural regeneration*	24,300	15,200	39,500	41.4%
Clearcut followed by plantation	11,000	16,900	27,900	29.2%
Cutting of alternate strips	500	500	1,000	1.0%
Cutting of the overstorey	2,100	1,500	3,600	3.8%
Cutting of over 50% of the overstorey	13,900	6,100	20,000	21.0%
total	**53,400**	**42,000**	**95,400**	**100.0%**
including departments after the 1999 storms	10,000	3,600	13,600	14.3%
Deforestation	9,100	4,700	13,800	
including departments after the 1999 storms	1,900	600	2,500	18.1%

* including clearcuts awaiting regeneration for less than 5 years

(Source: IFN, excluding poplar plantations, only for inventoried forest stands available for wood supply and for the period between the last two inventories (1984-93); the method used involved overlaying the field plots of the prior inventory on the aerial photographs of the last inventory; a comparison with the 1999 situation was not possible because the two data series were not available for three departments.)

Commentary: there is high public awareness in France on the issue of clearcutting and intensive cutting in forest stands. The Inventaire forestier national (IFN) estimated that 95,400 ha per year of forest was cut between the last two inventories, or 0.7% of the total forest area (0.6% in broadleaved stands and 0.9% in conifer stands). The main species concerned are maritime pine, sessile and pedunculate oak, beech and Scots pine. The 1999 storms were only partially accounted for considering the inventory dates, but these events affected some 15 departments in which clearcutting and intensive cutting was recorded in 13,600 ha of forest.

Significant regional differences were noted: the highest cutting rates concerned regions where maritime pine silviculture plantations predominate (Aquitaine 1.3%, Poitou-Charentes 1.3% and Pays de la Loire 1.2%). This is followed by regions with a strong forestry tradition (Lorraine 0.9%, Alsace 0.8%), Normandie (0.9%) and regions in which there has been recent forestry development (Limousin 0.8%). Ile-de-France, where there is high public access to forests, and the Mediterranean region, where forests are generally managed extensively, were found to have the lowest cutting rates, i.e. 0.4%.

Forest management cuts are part of the normal forest renewal process. The first three cutting categories listed on the table can have a serious visual impact, depending on the extent of these cuts and their location. A map of sensitive landscape units is thus provided for public forest management plans, thus substantially limiting this impact. It is not yet possible to assess the effects of this measure in public forests because the update of IFN data on the extent of cuts is not yet available.

INDICATOR 4.8

Number of threatened forest species, classified according to IUCN Red List categories in relation to total number of forest species

	species living in a strictly forest-type habitat or often present in a forest environment	species with mixed behaviour living in both forests and open environments	total
vascular plants outside of the Mediterranean region			
number of species	271	435	**706**
endangered	1	3	**4**
vulnerable	3	5	**8**
rare	0	2	**2**
total threatened	4	10	**14**
% threatened species	1%	2%	**2%**
mammals			
number of species	39	34	**73**
endangered	2	1	**3**
vulnerable	10	1	**11**
rare	2	2	**4**
total threatened	14	4	**18**
% threatened species	36%	12%	**25%**
birds			
number of species	55	65	**120**
endangered	0	1	**1**
vulnerable	2	5	**7**
rare	4	4	**8**
total threatened	6	10	**16**
% threatened species	11%	15%	**13%**
reptiles			
number of species	0	11	**11**
endangered	0	0	**0**
vulnerable	0	1	**1**
rare	0	1	**1**
total threatened	0	2	**2**
% threatened species	0%	18%	**18%**
amphibians			
number of species	4	9	**13**
endangered	0	0	**0**
vulnerable	0	5	**5**
rare	0	0	**0**
total threatened	0	5	**5**
% threatened species	0%	56%	**38%**

(Source: Muséum national d'histoire naturelle, working document 2000; the references used are the "Livre rouge de la flore menacée de France, Vol. 1, 1995" for vascular plants; the "Livre rouge de la faune menacée de France, 1994" for fauna, except for birds; the danger levels for birds have been updated and are based on a new book "Oiseaux menacés et à surveiller en France, SEOF/LPO, 1999" – cf. list in the Appendix. The forestry status of some species was modified as compared to the 2000 edition concerning Indicators for Mammals and Amphibians.)

Commentary: assigning a forest species status is complicated since many species live both in forest areas and different highly varied environments where they seek similar living conditions. Many of them actually live in fringe areas, in plant structures and formations at the forest interface or in changing forest areas: forest pre-mantles, clearings, felled areas, etc.

A global approach to land management, rather than strict forest management measures, is thus required to ensure the protection of most threatened species. Moreover, forest species with the highest populations are invertebrates, lower plants (lichens, bryophytes) and micro-organisms, for which no accurate information is available. Finally, it is not currently possible, based on available data, to assess the threatened species rate amongst vascular plants in the Mediterranean region.

The following are some of the threatened species that inhabit forest areas or mixed forest environments: for mammals, lynx, brown bears and some bat species; for amphibians, the fire-belly toad, the European green tree frog and various newts; and for birds, the three-toed woodpecker and the black stork.

The need for a European policy to preserve biodiversity is now acknowledged. The European directives "Birds" (1979) and "Habitats, Fauna, Flora" (1992) have led to setting up of the "Natura 2000" network, which should soon be completed. This European ecological network is intended to preserve biodiversity in the EU by maintaining or restoring natural habitats and habitats of species of fauna and flora of community importance. The habitat registers currently being drawn up by the French Ministry of Ecology and Sustainable Development, under the aegis of the Muséum national d'histoire naturelle, will specify the ecological requirements and management recommendations for each type of habitat.

Concerning forest management as such, the recent publication of the first two volumes of the document "Gestion forestière et diversité biologique" will now enable forest managers to take biodiversity into better account in their day-to-day practices. This document, which was written for educational purposes by experts from the Ecole nationale du génie rural des eaux et forêts, the Office national des forêts and the Institut pour le développement forestier, specifically examines forest habitats and associated habitats (mosaic habitats in forest environments or dynamically linked habitats) and, in addition to descriptions of how to recognise species, puts forward a series of recommendations on management methods that promote biodiversity preservation.

⇨*Note: three categories are generally used to classify threatened species:*
- category 1: Species living in a strictly forest-type habitat or species commonly present in a forest environment. Note that the fauna usually concerned are arboreal species and/or species requiring considerable tree cover: forest, but also sometimes parks, plantations, orchards, etc.
- category 2: Species with mixed behaviour, with a home range divided more or less equally between forest and open environments (grassland, heathland, marshes). This category includes species of fauna seeking or tolerating tree cover of over 10%.
- category 3: Plant species occasionally found in a forest environment but usually observed in an open environment. Animal species from non-forest environments that may still be found in environments on the fringe of forest areas, especially most aquatic species which become arboreal during the breeding season (e.g. grey heron).

Only the first two categories are regarded here as "forest species" .
The groups included in the above table are thus as follows:

***Flora**: plant species capable of developing in a forest environment were selected on the basis of the first two volumes of the Flore forestière française (Rameau et al., 1989 and 1993) in addition to other works. This list therefore does not include Mediterranean species, a great number of which are listed in the Livre Rouge. The likely result is an underestimation of the percentage of threatened species. Non-vascular plants are not included. The selection of forest species, involving about 13,000 species of bryophytes and 5,000 species of lichens, would require a long-term programme by a team of experts. Furthermore, no national red book is currently available for these groups.*

***Mammals**: aquatic species were not included when the presence of a riparian environment is not essential to them, even though they can sometimes commonly be observed in forest ponds, streams or ditches (e.g. Neomys fodiens, Ondatra zibethicus). They are however included when they especially seek riversides with tree cover (e.g. Mustela lutreola, Castor fiber). Two species (Rattus rattus and Mus musculus) are included because they live wild in forest environments in the Mediterranean region (not because they may occupy buildings in forests).*

***Birds**: only nesting birds are included; migratory and wintering birds are omitted. While category 1 of the species living in a strictly forest-type habitat is relatively well defined, the same cannot be said of the other categories. As explained above, aquatic species which become arboreal during the breeding season (e.g. grey heron) were shifted to category 3 and hence are not included in this table. In contrast, species that occupy bushy environments, preforest areas and heathland are included in category 2 (e.g. warblers, shrikes, etc.).*

***Reptiles**: aquatic (or semi-aquatic) species are not included as none of them seek riparian environments, even though they can be observed in forest ponds, streams or drains (e.g. Natrix natrix).*

***Amphibians**: species which do not absolutely require a riparian environment were excluded, although they are sometimes commonly observed in forest ponds, streams or drains (e.g. Rana kl. esculenta). However, amphibians are included when the presence of riverside tree cover (or in the vicinity for seasonally migrating species) is especially sought (e.g. Triturus marmoratus).*

INDICATOR 4.9

Area of forest and other wooded land protected to conserve biodiversity, landscapes and specific natural elements, according to MCPFE Assessment Guidelines

MCPFE protection class		Type of protected area	2001 area (ha)	2004 area (ha)			2004
			Forests	Forests	Heathlands*	Total	Proportion of protected forests
1	**Biodiversity protection**						
1.1	**No active intervention**	Strict biological reserves	1,300	4,300		**4,300**	0.03%
		Strict nature reserves	4,000	4,000	4,000	**8,000**	0.02%
Subtotal 1.1			**5,300**	**8,300**	**4,000**	**12,300**	**0.05%**
1.2	**Minimal intervention**	National parks: central areas	**94,600**	**94,600**	**125,600**	**220,200**	**0.6%**
1.3	**Conservation via active management**	Nature reserves, excluding strict nature reserves	57,500	53,200	25,200	**78,400**	0.3%
		Voluntary nature reserves		8,700	4,000	**12,700**	0.1%
		Managed biological reserves	17,400	22,100		**22,100**	0.1%
Subtotal 1.3			**74,900**	**84,000**	**29,200**	**113,200**	**0.5%**
Subtotal 1 (after deletion of overlapping areas)			**174,800**	**186,900**	**158,800**	**345,700**	**1.2%**
2	**Protection of landscapes and specific natural elements**						
		National parks: peripheral areas	403,800	403,800	287,500	**691,300**	2.5%
		Regional natural parks	2,547,400	2,724,400	378,500	**3,102,900**	17.0%
		Biotope protection prefectoral orders	62,300	55,200	11,500	**66,700**	0.3%
		Alluvial protection forests	6,200	6,200		**6,200**	0.04%
		Periurban protection forests	10,600	44,600		**44,600**	0.3%
		Conservation of coastal and lacustrine shoreline areas	8,900	10,200	18,800	**29,000**	0.1%
		National hunting and wildlife reserves	17,000	17,100	4,900	**22,000**	0.1%
Subtotal 2 (after deletion of overlapping areas)			**2,984,300**	**3,170,500**	**689,500**	**3,859,900**	**19.8%**
Total (after deletion of overlapping areas)			**3,159,100**	**3,297,400**	**835,100**	**4,132,500**	**20.6%**

* "other wooded lands" according to FAO

(Source: MNHN 1997 to 2003 and IFN 2001 and 2004 by intersection of IFN "forest" and "heathland" maps (4 ha resolution) with MNHN digitised edges of protected areas, except for those mentioned hereafter; ONF 2000 and 2003 for managed and strict biological reserves; DGFAR 1/01/2002 and 1/01/2005 for protection forests. MCPFE categories 1.1, 1.2, 1.3 and 2 respectively correspond to IUCN categories I, II, IV and V. Totals and subtotals were calculated after deletion of overlapping areas for the cartographic data. The proportions of protected forest area were calculated relative to the areas evaluated cartographically by IFN in 2004, i.e. 16,023 thousand ha.)

Commentary: the use of geographical information systems has substantially improved the estimation of protected forest areas and other wooded lands since the 2000 edition of the present report. Cartographic data of the Inventaire forestier national (IFN) can thus now be intersected with the digitised protected area edge data supplied by the Museum national d'histoire naturelle, after deletion of overlapping areas. This map analysis was already carried out for the World Wildlife Fund (WWF) in 2001, followed by an update in 2004 through the integration of other wooded lands (IFN heathlands). Due to the lack of available digital data, only strict and managed biological reserves and protection forests, as specified in the forestry code, could not be intersected with the IFN data. The Natura 2000 network was dealt with separately (cf. infra)–the proposed sites of community importance had not yet been certified and the designated special protection areas overlapped different protection classes.

In metropolitan forests, biodiversity is highly protected in an area of 187,000 ha, or 1.2% of the forest area (categories I, II and IV of the World Conservation Union - IUCN). These protected areas occur in the centre of national parks, nature reserves, and strict and managed biological reserves located in public forests. This very low protected area rate in comparison to rates in Scandinavian countries and North America, could be historically explained by the landholding structure and the high population density in France, which have made it difficult to form large-scale strict biological reserves. Scientific discussions are still ongoing concerning the best solution that should be adopted to preserve forest biodiversity–imitation of natural disturbance regimes, maintenance of natural forest structuring elements during cutting operations (large trees, deadwood, etc.) or setting up of strict biological reserves–these three possibilities are not mutually exclusive.

The Office national des forêts (ONF) initiated a programme to form a network of strict biological reserves covering a broad range of forest ecosystems. The area of these reserves, although still relatively small (4,300 ha), has sharply increased in recent years. This network consists of reserves with a unit area of around 50 ha in lowland regions and 100 ha in mountain regions. In late 2005, it will be enhanced by the creation of a large-scale strict biological reserve of 2,600 ha in Chizé forest and supported by the current national hunting and wildlife reserve (area not taken into account in the table).

Moreover, it is estimated that the "protection of landscapes and specific natural elements" concerns 3.2 million ha of metropolitan forests, or 20% of the forest area. This classification corresponds to IUCN category V (inhabited protected areas). These areas consist mainly of regional natural parks (PNR) and zones on the periphery of the six national parks. The marked increase in these protected areas (+186,000 ha) could mainly be due to the creation of the Monts d'Ardèche PNR in April 2001. There are now 42 regional natural parks in metropolitan France. The last PNR parks founded could not be taken into account in the proposed estimation, i.e. Narbonnaise (Mediterranean region), Pyrénées catalanes, Millevaches (Limousin) and Oise-Pays de France PNRs.

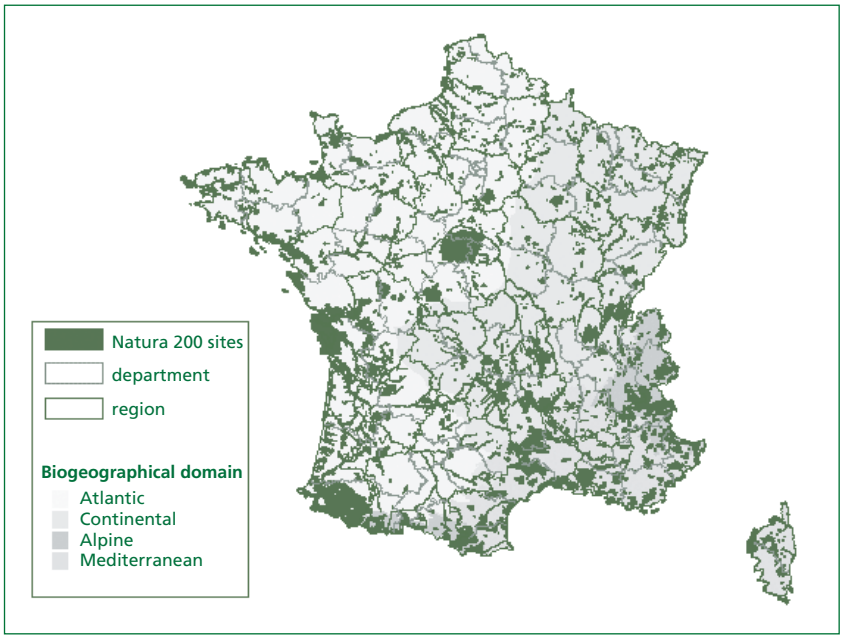
Finally, there are also other protection statuses in France, including the landuse planning classification "woodlands to be preserved". This status prohibits any change in classification or landuse strategy that could jeopardise woodland conservation, protection or creation.

Natura 2000

EU directive	Site classifications	Landuse	Land area (ha)
"Birds"	Special protection areas (certified)	forests heathlands* non-forested	221,300 192,700 325,400
		Total	**739,400**
"Habitats"	Sites of community importance (proposed)	forests	**ND**
"Birds" and "Habitats"	All Natura 2000 sites (proposed or certified)	forests	**1,418,500**

* "other wooded lands" according to FAO

(Source: MNHN 2003 and IFN 2004 for Special protection areas by intersection of IFN "forest" and "heathland" maps (4 ha resolution) with MNHN digitised protected area edge data; IFEN 2004 for all sites after deletion of overlapping areas.)



Map 20: Location of Natura 2000 sites
(sites of community importance and special protection areas – source: MEDD, 2004)

Commentary: the Natura 2000 network was set up to foster biodiversity conservation throughout the European Union. The aim is to maintain or rehabilitate natural habitats and habitats of flora and wildlife species of community importance so as to ensure their conservation. It consists of sites that have been specially designated by each Member State in application of the so-called EU "Birds" and "Habitats" directives of 1979 and 1992.

France has currently designated 201 special protection areas and proposed a classification of 1,226 sites of community importance in compliance with these two directives, representing a total area (terrestrial and marine) of a 4.8 million ha (Map 20). This network should be enhanced, especially in compliance with the "Birds" directive, via new designations by mid-2006. The forest area now represents around a third of the total area, i.e. 1,418,000 ha.

The site management conditions are defined in "objective documents" that specify measures required to ensure species and habitat conservation. These measures are implemented through contracts drawn up by the state with different suppliers (farmers, forest owners, forest managers, etc.).

INDICATOR 4.9.1
Deer population densities per 100 ha

	Head number per 100 ha of forest		
	1993-94	1997-98	2002-03
mean red deer density	0.33	0.53	0.70
mean roe deer density	5.98	7.95	10.10

(Source: réseau cervidés-sanglier ONCFS-FNC, based on a population estimation method involving allocation of hunting plans. Considering the head number in terms of the per-ha forest area is less and less relevant for roe deer since this animal now inhabits a broad range of environments, i.e. bluffs, large-scale grasslands, etc. Concerning red deer, the area actually colonised is much lower when considered in terms of the total forest area.)

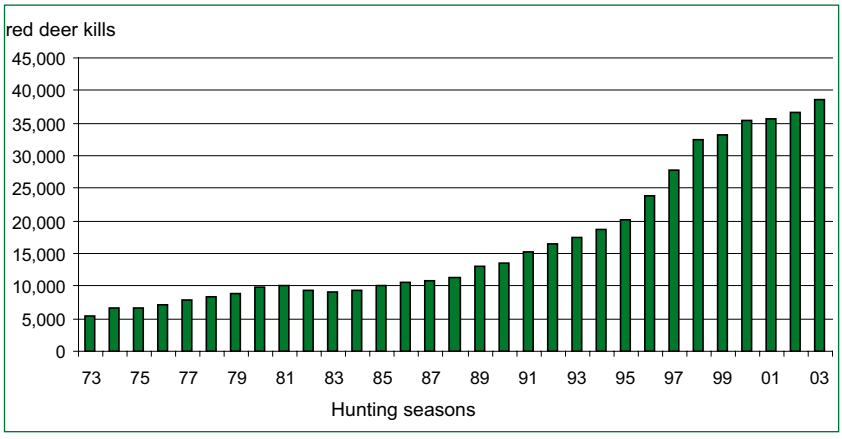


Figure 20: Variations in annual red deer kills from 1973 to 2003
(source: réseau cervidés-sanglier ONCFS-FNC)

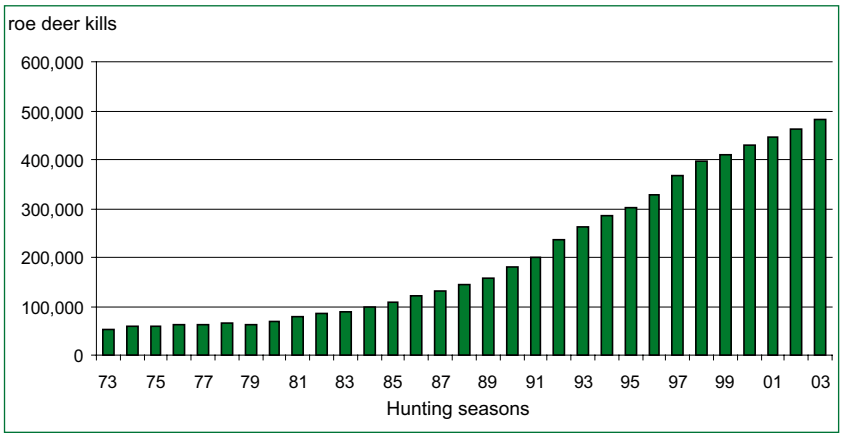


Figure 21: Variations in annual roe deer kills from 1973 to 2003
(source : réseau cervidés-sanglier ONCFS-FNC)

Commentary: big game is a key component of forest ecosystems. It is hard to accurately assess the deer population density in forests, but the numbers can still be roughly evaluated via hunting plans allocated each hunting season by the Office national de la chasse et de la faune sauvage (ONCFS).

The mean red deer population density increased by a third over the last 5 years to reach the current level of 0.70 head per 100 ha of forest. However, the exponential increase in red deer numbers noted since the early 1970s on the basis of kill patterns seems to have slowed considerably since 1998 (Figure 20).

The mean roe deer population density per 100 ha of forest is a less relevant indicator because these animals inhabit a broad range of environments (bluffs, large grasslands, etc.). However, populations are clearly increasing, including in forests. Patterns noted according to hunting plans allocated since 1973 highlight an exponential increase in roe deer numbers until 1989, followed by a relatively linear increase (Figure 21).

Public authorities are concerned about the current deer population density in forests, especially since complaints are being lodged by forest owners and managers concerning deer damage in their forests (cf. § 2.4.1), and also since this situation could lead to local declines in biodiversity.

Criterion 5

Maintenance and appropriate enhancement of protective functions in forest management (notably soil and water)

INDICATOR 5.1

Area of forest and other wooded land designated to prevent soil erosion, to preserve water resources, or to maintain other forest ecosystem functions, part of MCPFE Class "Protective Functions"

Physical protection (soil and water) in public forests

Objective	state-owned forests* (ha)			other public forests governed by forest regulations (ha)			total public forests (ha)			annual variation rate
	1994	1999	2004	1994	1999	2004	1994	1999	2004	1994-2004
priority physical protection	79,500	84,300	87,000	106,100	139,500	153,000	185,600	223,800	240,000	2.6%
secondary physical protection (protection & wood supply)	201,500	201,700	212,000	405,400	445,700	488,000	606,900	647,400	700,000	1.4%
total	**281,000**	**286,000**	**299,000**	**511,500**	**585,200**	**641,000**	**792,500**	**871,200**	**940,000**	**1.7%**

* including state-owned forests allocated to various ministries

(Source: ONF, for all wooded land governed by forest regulations; the percentage of wooded land in the total area for 2004 was applied to the total areas for 1994 and 1999.)

Commentary: public forests, whose key function is to protect the physical environment, now cover an area of 240,000 ha, two-thirds of which is found on non-state-owned property. These are mainly mountain and coastal forests. This area has increased by around 55,000 ha in 10 years, currently accounting for 6% of the total wooded area within public forests. Only the wooded area was considered in the table, with the total protection area (wooded and non-wooded) currently being 380,000 ha. These forests also have a partial role in the protection of infrastructures and inhabitants against natural hazards, but it is impossible to differentiate these different functions– data presented in Indicator 5.1 thus partially overlap those of Indicator 5.2, for which no detailed data is available.
Public forests also include 700,000 ha that serve a dual role as a source of wood supply while providing physical protection.

The French government has been rehabilitating mountain land since 1860. Under this policy it has been acquiring highly degraded areas and subsequently reforesting and developing them in order to boost their protective role. The Office national des forêts has set up mountain landscape rehabilitation services (RTMs) in 11 departments located in mountainous regions (Alps and Pyrenees). These RTMs conduct prevention activities in all public forests. They also provide support for local communities (expertise, work planning, technical assistance) and public security authorities.

A major programme to stabilise coastal dunes was also undertaken by the state in the 19th century, through afforestation, plant cover and civil engineering works. This large coastal area is currently managed by the Office national des forêts and includes 380 km of coastal dunes and 120 km of rocky coast.

Coastal environments are subject to very rapid natural dynamics (erosion, vegetation successions, etc.) and to considerable human pressure (urbanisation, tourism, etc.). Their management is no longer solely focused on dune protection, it also includes biodiversity and landscape protection initiatives.
Since 1975, the Conservatoire de l'espace littoral et des rivages lacustres has been actively acquiring highly threatened coastal sites.

Drinking and mineral water quality protection (all properties)

	Forest area within protection zones
drinking water reservoirs	around 200,000 ha
commercial mineral water springs	around 600,000 ha
total	**around 800,000 ha**

(Source: DRAF and DDAF 1994 estimate, with extrapolation of the extended drinking water reservoir protection zones on a prorata basis with wooded areas for the missing regions (except Rhône-Alpes, which is an exception due to the extent of its mineral water spring protection zones). The 2004 update is not available.)

Commentary: around 200,000 ha of forest are found in drinking water reservoir protection zones that are clearly delineated in the landscape and have special easements.
Moreover, almost 600,000 ha of forest are located within mineral water spring protection zones and thus have a specific role in water quality protection, without any special forest management requirements.

INDICATOR 5.2

Area of forest and other wooded land designated to protect infrastructure and managed natural resources against natural hazards, part of MCPFE Class "Protective Functions"

Commentary: as noted in § 5.1, the proportion of forests designated for the protection of infrastructures and managed natural resources is currently unknown. These forests are partially accounted for in Indicator 5.1 since erosion control, especially in mountain regions, also provides protection for infrastructures and inhabitants against potential floods and landslides, etc.

Since 1995, the French Ministry of the Environment has been drawing up predictable natural hazard prevention plans (PPR). Under these PPRs, natural hazard zones are mapped and regulations are enforced for all existing and future urbanism, construction and management initiatives. Prevention, protection and safety measures to be taken by inhabitants and territorial communities are also drawn up. Although flooding is the most prevalent natural hazard in France, PPRs can take all potential hazards into account, including landslides, avalanches, earthquakes, forest fires, etc.

On 31 March 2003, PPRs were approved for 3,775 urban and rural districts, including 80% for flood hazards. The overall aim is to have 5,000 PPRs set up by 2005 for the most exposed French districts.

In addition, the French Ministry of the Environment is coordinating the development of mountain hazard databases along with permanent avalanche monitoring systems.

Criterion 6

Maintenance of other socioeconomic functions and conditions

INDICATOR 6.1

Number of forest holdings, classified by ownership categories and size classes

Public forests

size (ha)	state-owned forests			other public forests governed by forest regulations			total public forests			
	number*	total area		number	total area		number*	total area		mean area
		ha	%		ha	%		ha	%	ha
0 - 1	13	10	0.0%	70	40	0.0%	83	50	0.0%	0.6
1 - 10	25	130	0.0%	1,561	8,700	0.3%	1,586	8,830	0.2%	5.6
10 - 25	43	800	0.0%	2,198	37,500	1.4%	2,241	38,300	0.8%	17.1
25 - 100	177	9,900	0.5%	5,068	284,100	10.3%	5,245	294,000	6.4%	56.1
100 - 500	466	130,500	7.1%	5,370	1,187,900	43.2%	5,836	1,318,400	28.8%	225.9
500 - 10,000	744	1,446,000	79.2%	1,223	1,229,300	44.7%	1,967	2,675,200	58.5%	1,360.0
10,000 and over	16	238,100	13.0%	0	0	0.0%	16	238,100	5.2%	14,881.3
Total	**1,484**	**1,825,440**	**100.0%**	**15,490**	**2,747,540**	**100.0%**	**16,974**	**4,572,880**	**100.0%**	**269.4**

* number of forests for state-owned forests; number of common owners for other public forests

(Source: ONF 2004 for public forests, based on the land register, which concerns all wooded and unwooded land governed by forest regulations. In this table, state-owned forests include forests assigned to different ministries.)

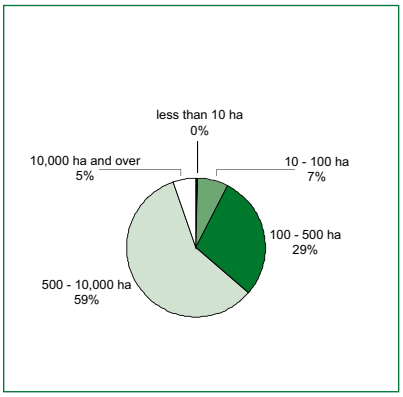


Figure 22: Public forest area by size class (source: ONF, 2004)

Commentary: the Office national des forêts (ONF) currently manages nearly 17,000 different forest units, including 15,490 that are owned by local authorities.
The mean unit size varies markedly according to the public forest category, i.e. estimated at 1,200 ha for state-owned forests but only 180 ha for community forests. More than 90% of the state-owned forest area is thus occupied by units of over 500 ha, while most other public forests (55%) contain units of less than 500 ha (Figure 22).
State-owned forests include 16 very large forest ranges of more than 10,000 ha (13% of the area), with the largest being the Orléans state-owned forest, which is almost 35,000 ha.

Small units of less than 100 ha account for only 7.4% of the public forest area but represent over half of all the units managed by ONF.

Private forests

size (ha)	1976-83					1999				
	number of owners (x 1,000)		area			number of owners (x1,000)		area		
			total (x1,000 ha)	%	mean (ha)			total (x1,000 ha)	%	mean (ha)
0 -1	2,360	64.2%	773	7.9%	0.3	2,361	67.8%	745	7.0%	0.3
1 - 10	1,165	31.7%	3,188	32.7%	2.7	934	26.8%	2,975	28.0%	3.2
10 - 25	100	2.7%	1,464	15.0%	14.6	120	3.4%	1,761	16.6%	14.7
25 - 100	42	1.1%	1,905	19.6%	45.4	58	1.7%	2,641	24.9%	45.5
100 and over	9	0.2%	2,410	24.7%	267.8	11	0.3%	2,498	23.5%	227.1
total or mean	**3,676**	**100.0%**	**9,740**	**100.0%**	**2.6**	**3,484**	**100.0%**	**10,620**	**100.0%**	**3.0**

(Sources: SCEES and land register of the Direction Générale des Impôts; 1976-83: survey on silviculture economic structures (SCEES/ESSES); 1999: survey on private forest property structures for properties of 1 ha and over (SCEES) and based on the land register for properties of less than 1 ha.)

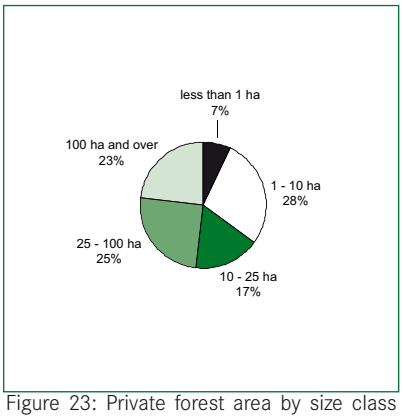


Figure 23: Private forest area by size class (source: SCEES, 1999)

⇨Note : the 0-1 ha class results are not comparable because the 1976-83 data are based on the Teruti survey whereas the 1999 data are based on the land register, because no elements were available from the 1999 SCEES survey. Moreover, the 1976-83 SCEES/ESSES survey was based on sampling points from the Teruti survey in which the owners were identified, thus explaining why the total area is underestimated (9.7 million ha as compared to 10.4 million ha surveyed).

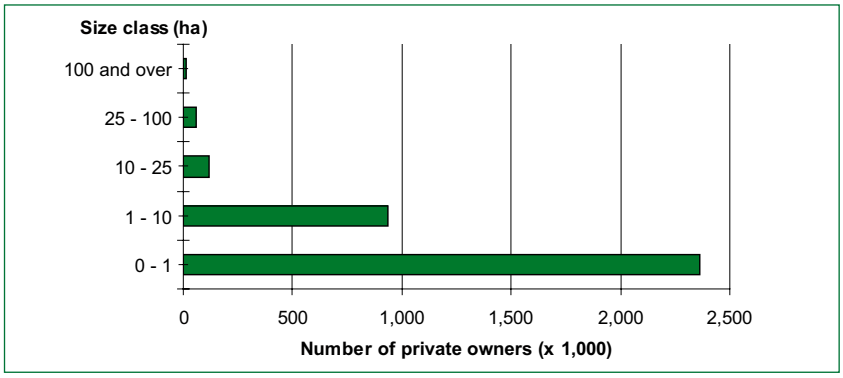


Figure 24: Number of private forest owners by property size class (source: SCEES, 1999)

Commentary: more than half of the private forest area (52%) consists of units of less than 25 ha (Figure 23). This proportion has decreased slightly since the 1976-83 survey in response to initiatives undertaken to promote private forest ownership consolidation. The mean size of private forest properties is now estimated at 3 ha, whereas it was 2.6 ha 20 years ago. The number of private owners is still very high (3.5 million), i.e. by far the highest rate in Europe, much ahead of Poland (844,000) and Italy (816,000) according to data from the TBFRA 2000 survey of UNECE/FAO. Very small forest units of less than 1 ha are owned by 2.4 million private owners, or more than two-thirds of all private forest owners in France (Figure 24).

A survey conducted by the Service central des enquêtes et études statistiques (SCEES) in 1999 on forest properties of over 1 ha revealed the legal status of private forest owners. Individual forest owners are the most numerous, i.e. 96% of the total for around 83% of the area. They are represented by individuals, communal matrimonial estates, joint- and co-owners. There are not many legal entities (4%), but they account for more than 17% of the area. Their units are quite large, i.e. 43 ha on average. These include forest management groups that own the largest units (mean 110 ha).

Land parcelling is a major private forest management problem, especially to generate commercial wood supplies. The French ministry for forests thus introduced a fiscal incentive to encourage investment in forests, with the aim of fostering land restructuring upon the initiative of owners and preventing the breakup of family forest management groups.
In addition to these land initiatives, which are long and difficult to implement, consolidation of owners with respect to wood supply is also being promoted. These are classified as "joint forest management and logging organisations", which have sufficient economic and technical clout to consolidate private forest property management, especially with respect to small properties. These bodies– cooperatives and owners' associations-qualify for public subsidisation.

All forest properties

size (ha)	ownership category	number* (x1,000)		area		
				total (x1,000 ha)	%	mean (ha)
0 -1	public	ε	ε	ε	ε	-
	private	2,361	67.4%	745	4.9%	0.3
	total	**2,361**	**67.4%**	**745**	**4.9%**	**0.3**
1 - 10	public	2	0.0%	9	0.1%	5.6
	private	934	26.7%	2,975	19.6%	3.2
	total	**936**	**26.7%**	**2,984**	**19.6%**	**3.2**
10 - 25	public	2	0.1%	38	0.3%	17.1
	private	120	3.4%	1,761	11.6%	14.7
	total	**122**	**3.5%**	**1,799**	**11.8%**	**14.7**
25 - 100	public	5	0.1%	294	1.9%	56.1
	private	58	1.7%	2,641	17.4%	45.5
	total	**63**	**1.8%**	**2,935**	**19.3%**	**46.4**
100 and over	public	8	0.2%	4,232	27.9%	541.2
	private	11	0.3%	2,498	16.4%	227.1
	total	**19**	**0.5%**	**6,730**	**44.3%**	**357.6**
total or mean	public	17	0.5%	4,573	30.1%	269.4
	private	3,484	99.5%	10,620	69.9%	3.0
	total	**3,501**	**100.0%**	**15,193**	**100.0%**	**4.3**

* number of owners for private forests and non-state-owned public forests; number of forests for state-owned forests

(Source: ONF 2004 for public forests, based on the land register for all wooded and unwooded land governed by forest regulations; SCEES 1999 (survey on private forest property structures) for private properties of 1 ha and over and the land register of the Direction Générale des Impôts 1999 for private properties of less than 1 ha. The 2004 update is not available for private forests.)

Commentary: private forests account for 70% of the metropolitan forest land area, and 74% when just considering the actually wooded area. The "all forest properties" results are thus marked by the high land parcelling in private forests– the mean unit size is only 4.3 ha for all metropolitan forests.

When the state is considered, along with the 11,000 forest-owning communities and 69,000 private owners of more than 25 ha, then around 80,000 decision-makers control two-thirds of the metropolitan forest area.

INDICATOR 6.2

Contribution of forestry and manufacturing of wood and paper products to gross domestic product

Activity sector	Added value excl. of VAT (million € 2001)		Sources
	1997	2001	
silviculture	2,326	2,435	1
logging	453	491	2
sawing, planing	741	1,005	2
other mechanised woodworking	2,433	2,640	3
total furniture making	*3,850*	*4,004*	4
including wooden furniture making	2,359	2,553	4
pulp, paper, cardboard	5,491	5,880	5
Total	**13,803**	**15,003**	
GDP France	1,308,755	1,475,600	6
Added value France	1,164,826	1,322,400	6
% GDP France	**1.05%**	**1.02%**	
% added value France	**1.18%**	**1.13%**	

(Sources: 1 INSEE, economic silviculture and logging accounts for 1997 and 2001, deduction for logging according to the sources presented in 2; 2 EAE-SCEES partial and overall assessment based on the 1997 EPEI; EAE-SCEES and DGI-BIC for 2001 (Agreste n° 130/2005); 3 Enterprises with over 20 employees, EAE-SESSI; enterprises with less than 20 employees, EPEI 1997 and DGI-BIC 2001 ("Le bois en chiffres 2004"); 4 Enterprises with over 20 employees, EAE-SESSI according to sorting by SESSI for wooden furniture making; enterprises with less than 20 employees, EPEI 1997 and DGI-BIC 2001; 5 Enterprises with over 20 employees, EAE-SESSI; enterprises with less than 20 employees, EPEI 1997 and DGI-BIC 2001; 6 INSEE, "Les comptes de la nation en 2002" publication.)

⇨ *Note : the added value of enterprises of less than 20 employees was estimated in 1997 on the basis of a survey of small commercial enterprises that INSEE (EPEI) conducts every 4 years. As this method was not considered satisfactory, it was replaced in 2001 by a new estimation based on fiscal declarations of business profits (BIC) to the Direction générale des Impôts. This will make it possible in future to develop an annual dataset. This methodological change complicates comparisons between the 1997 and 2001 datasets.*

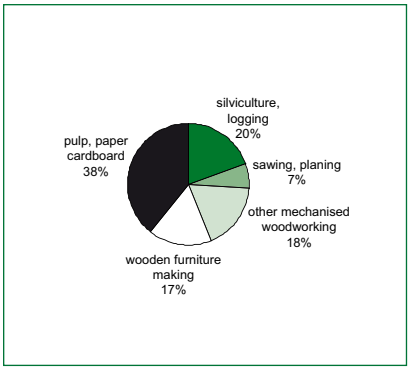


Figure 25: Added value (exclusive of VAT) per activity sector in 2001 (sources: cf. Table 6.2)

Commentary: the forest-wood sector, strictly speaking, includes the silviculture and logging sectors, and the timber and paper industries (woodworking, including sawmills, wooden furniture making and the paper industry). This currently generates an added value estimated at €15 billion per year, or 1.13% of the total added value for France. The pulp, paper and cardboard production sector predominates and accounts for around 40% of the added value (Figure 25). Silviculture-logging accounts for 20% of the total, woodworking 25% and wooden furniture making 17%.

Comparisons cannot be made with the 1997 data since the calculation method was modified for most sectors (cf. note). The silviculture sector alone represents 16% of the total added value of the forest-wood sector.

There are 5,800 logging companies, a third of which also run a sawmill. The sector is becoming increasingly concentrated from year to year, and the production from small companies logging less than 500 m³ per year is marginal. Conversely, the largest enterprises, which individually produce more than 20,000 m³ per year, account for two-thirds of the total production volume.

The timber and paper industry consists of three main sectors: woodworking (including sawmills), wooden furniture making and the paper industry. Each of these sectors has its own specific characteristics, which differ between sectors. Except for the pulp and paper industry and the wood-based panel industry, which are highly capitalistic and globalised, the other sectors are generally more dispersed and their performance varies substantially.

Wood sawing and planing activities have increased considerably in recent years, mainly due to an upswing in the building industry that started in 1997. This sector still consists of many small units but the trend is now towards corporate concentration, i.e. there are currently 2,400 small units as compared to 6,800 in 1970. Sawmills, whose output is more than 8,000 m³ per year, is the top activity in this sector. Two-thirds of sawmills are also involved in logging.

Mechanised woodworking, excluding sawmills, mainly involves wood-based panel making, framework, joinery and wooden package manufacturing.

The French wood-based panel industry ranks second in Europe behind Germany. It is a highly concentrated sector consisting of a small number of mainly medium-sized companies. The framework and joinery sector is, however, very dispersed, with two-thirds of the companies having less than 50 employees. Wooden package making companies are also quite dispersed, with 77% of the total number of companies involved in craftwork.

Wooden furniture making represents an important share of the general furniture manufacturing industry. This industry has begun growing again after a long recession, and most companies have less than 50 employees.

The French pulp and paper industry ranks 9th worldwide and 4th in Europe. Its overall production capacity increased by 25% during the 1992-2002 period and continued increasing in 2003.

INDICATOR 6.3

Net revenue of forest enterprises

Activity sector	Mixed income (million € 2002)		
	2000	2001	2002
Silviculture	1,107	857	832
Logging	1,094	964	819
Total	**2,201**	**1,821**	**1,651**

(Source: INSEE; LEF/IFEN, "Les comptes de la forêt - Enjeux et méthodes - 2005"; mixed income is the sum of the added value and production subsidies after deduction of employee compensation, taxes and fixed capital consumption)

⇨*Note : the available dataset was considered too small for calculation of the annual variation rate.*

Commentary: forest enterprise mixed income was estimated at €1.7 billion in 2002, shared equally between the silviculture and logging sectors. The marked decrease between 2000 and 2002 was mainly due to the impact of the 1999 storms. The high volume of wood logged in 2000, and to a lesser extent in 2001, generated surplus added value, but this was not maintained in 2002. In addition, the 1999 storms also had an impact on timber prices (cf. § 3.2).

INDICATOR 6.4

Total expenditures for long-term sustainable services from forests

Long-term sustainable services		amount (million € 2003)					annual variation rate
		1999	2000	2001	2002	2003	1999-2003
Forest fire protection	Prevention	30.3	30.7	31.1	32.8	27.4	-2.5%
	Control	75.4	76.8	83.0	95.6	179.0	24.1%
Subtotal Forest fire protection		**105.8**	**107.5**	**114.1**	**128.4**	**206.4**	**18.2%**
Mountain landscape rehabilitation		8.6	11.2	6.6	18.3	16.3	17.3%
Coastal dune protection		0.5	0.0	0.9	1.2	1.2	25.4%
Total		**114.9**	**118.7**	**121.6**	**147.8**	**223.9**	**18.2%**

(Source: French Ministry of the Interior for forest fire control; DGFAR for forest fire prevention, mountain landscape rehabilitation and coastal dune protection. Funding by agreement with ONF's RTM service is included in the amount noted.)

Commentary: the main long-term sustainable services from metropolitan forests are forest fire protection (prevention and control), mountain land rehabilitation and coastal dune protection. Total expenditures for these services in 2003 are estimated at €224 million. These expenditures have been steadily increasing since 1999, and sharply rose in 2003 as a result of the many forest fires that occurred during the summer drought-heat wave period (cf. § 2.4): forest fire control expenditures incurred by the French Ministry of the Interior thus reached €179 million, excluding those incurred by the departmental fire emergency services.
Expenditures for mountain land rehabilitation and coastal dune protection also increased, especially in recent years, but that allocated to forest fire protection takes by far the greatest share, even in average years.

Forest fire prevention policies are implemented by the French ministry for forests, in conjunction with other ministries representing the interior, the environment and equipment, territorial communities and forest owners. These policies focus on four issues:

- hazard forecasting
- forest fire monitoring for quick intervention
- equipment, development and maintenance of forest areas
- public awareness and professional training

Mountain landscape rehabilitation (RTM) and coastal dune protection operations are undertaken by the Office national des forêts (ONF) for the French ministry for forests.
RTM activities of ONF concern:

- active protection: torrent control, snow stabilisation on steep slopes, drainage of waterlogged soils
- close protection to complement active protection: containment or deviation of dangerous material flows (torrential lava, avalanches, rockslides).

ONF is also involved in various mountain hazard prevention operations for the French ministry for the environment: management of databases on mountain hazards, permanent avalanche monitoring in partnership with Cemagref, and drawing up hazard prevention guidelines, etc.

In addition, ONF stabilises and maintains dunes on the edges of state-owned forests by planting vegetation, installing windbreaks, safety fences and walking paths. Most of these operations are focused on dunes along the Atlantic coast.

ONF outlined initiatives to be implemented on the basis of three key objectives: controlling erosion in the dune environment and preserving or enhancing its biodiversity, providing public access without disturbing natural balances, and renewing forest stands essential for the management of coastal areas.

INDICATOR 6.5

Number of persons employed and labour input in the forest sector, classified by gender and age group, education and job characteristics

Activity sector	Number of persons employed (full-time equivalents)			Annual variation rate 1993-2001	Source
	1993	1997	2001*		
silviculture	13,300	13,700	13,000	-0.3%	1
logging	11,700	10,300	10,600	-1.2%	2
sawing, planing	20,100	21,900	24,700	ND	3
other mechanised woodworking	61,000	61,300	66,700	ND	4
total furniture making	*122,400*	*102,500*	*114,100*	ND	4
including wooden furniture making	69,200	66,500	72,700	ND	4
pulp, paper, cardboard	101,100	97,800	100,000	ND	4
total	**276,400**	**271,500**	**287,700**	**ND**	
total employed labour force (x 1000)	22,200	22,400	23,800	0.9%	5
% of total employed labour force	1.25%	1.21%	1.21%	ND	

* 2000 for silviculture and logging

(Sources: **1** Mutualité Sociale Agricole + ONF civil servants + forestry administration + forestry experts (CNIEFB members), without taking silviculturist forest owners' labour input into account. **2** Mutualité Sociale Agricole, data published in "Statistiques Forestières" of SCEES. **3** Enterprises with over 20 employees, EAE-SCEES; enterprises with less than 20 employees: EPEI-INSEE for 1993 and 1997, DGI-BIC for 2001; NAF 700 codes: 201A. **4** Enterprises with over 20 employees, EAE-SESSI; enterprises with less than 20 employees: EPEI-INSEE for 1993 and 1997, DGI-BIC for 2001; NAF 700 codes: 201B, 202Z, 203Z, 204Z, 205A, 205C (other mechanised woodworking) or NES114 grouping: F31; 361A to 361M (furniture making; for EAE data sorted by SESSI so as to only consider wood-using enterprises; NES114 grouping: C41); 211A, 211C (pulp, paper and cardboard manufacturing; NES114 grouping: F32); 212A to 212L (paper industry; NES114 grouping: F33); 2001 data are from Agreste n°130/2005. **5** INSEE.)

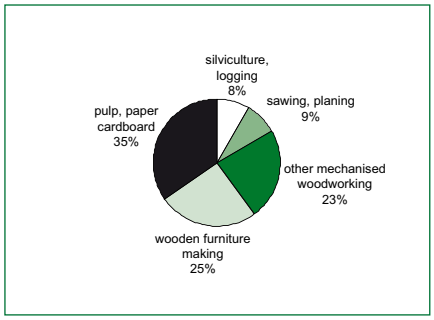


Figure 26 : Persons employed per activity sector in 2001 (sources: cf. Table 6.5)

Commentary: the forest-wood sector, strictly speaking (silviculture, logging, timber and paper industries), employs around 288,000 full-time equivalents, or 1.2% of the total employed labour force. The distribution per sector (Figure 26) clearly shows that the paper sector predominates, with 35% of the workforce, followed by woodworking (32%), wooden furniture making (25%) and silviculture-logging (8%). However, as noted above, taking the work carried out by silviculturist forest owners into account (estimated at 49,000 full-time equivalents by SCEES in 1999) would increase the share of the silviculture-logging sector to 22% of the total, i.e. 337,000 full-time equivalents.

In addition, according to a study carried out by the Association forêt-cellulose (AFOCEL) and Serge Lochu Consultants in 1998, 235,000 jobs have been indirectly induced by the forest-wood sector, especially in the construction, intermediate goods, energy and financial sectors.

The employed labour force involved in the forest-wood sector has been declining in a trend-setting way for several decades. For the 1993-2001 period, around 1,400 jobs have been lost in the silviculture and logging sectors. It is hard to analyse the trend in the timber and paper industries over this period because of the change in calculation method introduced in 2001 (cf. note). However, the decline seems to be ongoing, especially considering the enterprise concentration that is under way in the paper and wood-based panel sectors.

Small commercial enterprises with less than 20 employees have a considerable economic weight in the timber and paper industries, representing 23% of the total workforce, and as high as 35% if the paper sector is excluded. This sector is distributed throughout France and serves as an important social anchor in rural areas.

Personnel recruitment is still, however, a major concern of small company managers, i.e. around two-thirds of them declared that they had encountered problems in hiring staff. These problems seem to be linked with the shortage of qualified labour and with the unattractive public image of woodworking professions. It would be essential to seriously focus on providing young people with professional training, while boosting their awareness on the sector and associated occupations.

⇨*Note : a number of problems were encountered in evaluating the employed labour force involved in the forest-wood sector. First, work accomplished in the silviculture sector is especially hard to quantify because forest owners carry out much of the work themselves, and this is not accurately monitored by regular statistical surveys. However, the last survey of the Service central des enquêtes et études statistiques (SCEES) in 1999 on the private forest property structure enabled an estimate of silviculturist forest owner labour input at 11 million days per year, or 49,000 full-time equivalents. When salaried jobs are cumulated, the silviculture sector represents around 62,000 jobs. Secondly, the national statistical system is based on activity and service nomenclature, but the materials used are not always considered separately. The share of wood in furniture making is thus estimated using wood coefficients that can change from year to year, so these estimations should be considered with caution. Finally, in the timber and paper industries, the workforce in enterprises of less than 20 employees was estimated in 1997 on the basis of a survey of small commercial enterprises that INSEE (EPEI) conducts every 4 years. As this method was not considered satisfactory, it was replaced in 2001 by a new estimation based on fiscal declarations of business profits (BIC) to the Direction générale des Impôts. This will make it possible in future to develop an annual dataset. This methodological change complicates comparisons between the 1997 and 2001 datasets concerning the timber and paper industries.*

INDICATOR 6.6

Frequency of occupational accidents and occupational diseases in forestry

Forestry employees

		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	annual variation rate 1992-2002
Number of work hours (x 1,000)		65,771	61,926	58,618	61,173	60,512	59,120	55,043	53,365	57,685	53,580	50,854	-2.5%
Occupational accidents with loss of time													
Number	**total**	**6,712**	**5,843**	**5,816**	**6,105**	**6,049**	**5,748**	**6,019**	**5,520**	**5,530**	**5,460**	**4,655**	**-3.6%**
	fatal	12	25	12	14	18	13	13	15	20	19	9	-2.8%
	non-fatal	6,700	5,818	5,804	6,091	6,031	5,735	6,006	5,505	5,510	5,441	4,646	-3.6%
Frequency rate	**total**	**102.1**	**94.4**	**99.2**	**99.8**	**100.0**	**97.2**	**109.4**	**103.4**	**95.9**	**101.9**	**91.5**	**-1.1%**
	fatal	0.18	0.40	0.20	0.23	0.30	0.22	0.24	0.28	0.35	0.35	0.18	-0.3%
	non-fatal	101.9	94.0	99.0	99.6	99.7	97.0	109.1	103.2	95.5	101.5	91.4	-1.1%
Occupational diseases with loss of time													
Number of cases	**total**	**25**	**26**	**34**	**33**	**52**	**63**	**64**	**84**	**86**	**130**	**127**	**17.6%**

(Source: MSA, only for employees; the "forestry works" sector concerns silviculture, resin tapping, logging, fixed sawmills and associated office staff; the accident frequency rate represents the number of accidents with loss of time per million declared work hours. Concerning occupational diseases, it is not relevant to relate the number of diseases to the number of work hours because times between the hazard exposure and recognition of the occupational disease can be quite long. Moreover, the allowance for these diseases varies markedly depending on the type of disease and the geographical location of the patient, so this is more an administrative follow-up indicator.)

Commentary: after a marked decrease from 1979 to 1988, the occupational accident frequency rate in the forestry sector levelled off until 2001, with a slight improvement beginning in 2002 (Figure 27).
The trends varied in the different subsectors. Logging is traditionally the worst subsector for accidents, with a rate of around 120, even in 2002. This rate sharply rose between 1988 and 1999, but has been declining since year 2000. Silviculture has ranked second in terms of occupational accident frequency since 1992, but this rank is now shared by the sawmill subsector, whose rate increased from 1994 to 2001. Finally, there was a substantial improvement in all subsectors in 2002.
The 1999 storms did not lead to a general increase in the occupational accident frequency rate in 2000 and 2001, but the proportion of fatal accidents markedly increased for these 2 years (0.35).

The spectacular increase in occupational diseases noted is generally linked to periarticular diseases, which were first taken into account in 1984. The Mutualité sociale agricole (MSA) proposed two explanations for this phenomenon, without giving the relative proportion of each factor:
- first, the modification in working conditions (work compartmentalisation, faster working pace, hiring of unqualified employees, etc.)
- secondly, employees more systematically declare their health problems, thus suggesting that this is mainly an "administrative follow-up" indicator of occupational diseases.

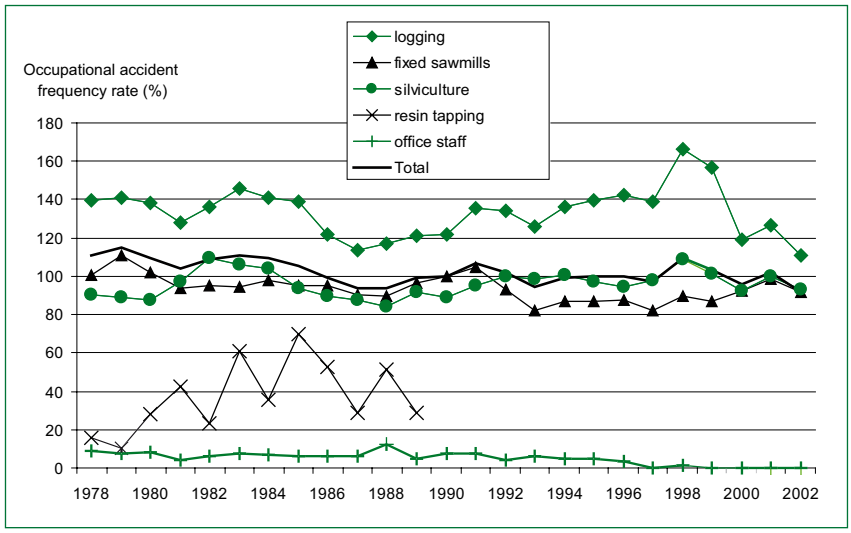


Figure 27: Variations in the frequency of occupational accidents for forestry employees (source: MSA)

INDICATOR 6.7

Per-capita consumption of wood and products derived from wood

Apparent consumption of wood and wood-derived products	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	annual variation rate 1993-2002
total (x 1,000 m³ roundwood equivalents)	62,274	62,181	63,749	59,090	61,055	68,405	69,102	80,135	69,445	63,805	0.3%
per capita (m³ roundwood equivalents per capita)	1.09	1.08	1.10	1.02	1.05	1.17	1.18	1.36	1.18	1.08	-0.1%

(Source: SCEES for the estimation of apparent consumption excluding self-consumption; INSEE/general population census; IFN for the self-consumption assessment, estimated at 14,418 thousand m³/year from 1993 to 1997 and 18,396 thousand m³/year from 1998 to 2002 - cf. paragraph 3.1)

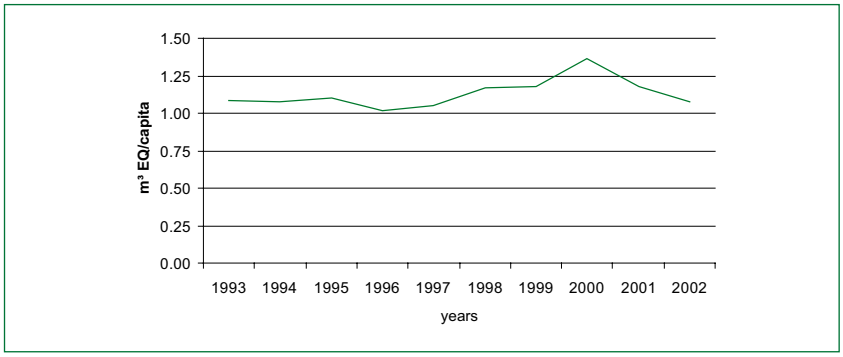


Figure 28: Variations in per-capita apparent consumption of wood and wood-derived products from 1993 to 2002 (sources: SCEES, INSEE and IFN)

⇨Note : the apparent consumption of wood and wood-derived products is defined as the sum of rough timber removals and the import/export balance for raw timber and wood-derived products.
- marketed removals was directly evaluated in m³ by the SCEES annual branch survey (cf. § 3.2).
- self-consumption was estimated by IFN on the basis of inventory comparisons and also expressed in m³. For consistency with § 3.1, values used in this paragraph were copied for the 1993-97 and 1998-2002 periods, i.e. 14,418 and 18,396 thousand m³, respectively; without more accurate data, self-consumption is thus considered as steady within these two periods (self-consumption is undoubtedly under-estimated for the "post-storm" years 2000 and 2001). The new inventory method (now annual) should enable regular updates of this evaluation.
- SCEES assessed French imports and exports of raw timber and, apart from a few exceptions (mainly furniture and prefabricated housing elements), of all products derived from raw timber. Volumes of these processed products were converted, using technical coefficients, into "roundwood equivalents", i.e. into raw timber volumes required to manufacture them, and added to imported or exported volumes of corresponding raw timber categories.

Commentary: France ranks 9th in the world for the consumption of wood and wood-derived products. Consumption in metropolitan France was estimated at 64 million m³ roundwood equivalents (EQ) in 2002, or 1.08 m³ EQ per capita (Figure 28). Construction timber takes the largest share with 37% of the total consumption, while industrial wood represents 31% and fuelwood 32% (29% just for fuelwood self-consumption).
The increase recorded in 1998 and 1999, and boosted in 2000 by the 1999 storms, was not confirmed in the 2002 results, likely due to a consumption whiplash effect of the storms– construction timber consumption dropped from 24.9 million m³ EQ in 1999 to 23.4 in 2002; similarly, industrial wood consumption slumped from 23.4 million m³ EQ in 1999 to 19.7 in 2002. A prime objective of the French wood sector is to promote wood materials and wood-derived products. This is mainly being done through two organisations in the construction and furniture manufacturing sectors, i.e. the Comité national de développement du bois (CNDB) and the Centre technique du bois et de l'ameublement (CTBA).
CNDB is an association of the main concerned professional groups and unions which is striving to capture new markets while protecting traditional wood outlets in the face of heavy competition. It has undertaken various initiatives aimed at revitalizing and promoting wood-use in construction projects. This primarily involves boosting stakeholder awareness, regional networking of wood construction specialists, participation in media events on this topic, etc. Wood use is also being promoted through the journal "Séquence Bois", the publication and dissemination of technical factsheets and manuals, and public awareness campaigns on the comparative advantages (especially ecological) of wood products.
CTBA focuses especially on technological development, market adaptation and enhancement of the quality of products generated by the timber, paper and furniture industries. It conducts targeted research, fosters product standardisation, develops tools and new products.

These two organisations are key players in the process set down in the "construction timber-environment" framework agreement, which recognises that carbon storage in wood products is essential for controlling the greenhouse effect. This agreement aims to boost wood use in construction by 10-12.5% before 2010.

Moreover, fuelwood use is especially being promoted by the Agence de l'environnement et de la maîtrise de l'énergie (cf. § 6.9).

INDICATOR 6.8

Imports and exports of wood and products derived from wood

	quantities (million m³ roundwood equivalents)										annual variation rate
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	1993-2002
exports	23.5	22.3	21.7	23.7	25.7	26.1	28.4	33.4	33.4	34.6	4.4%
imports	39.0	35.1	35.0	35.1	37.4	40.6	43.1	49.3	44.6	44.6	1.5%

(Source: SCEES/wood product balance. This accounts for imports and exports of rough timber and, apart from a few exceptions (mainly furniture and prefabricated house construction components), all rough timber-derived products. The volumes of these processed products were converted, using technical coefficients, to roundwood equivalents, i.e. rough timber volumes required to manufacture these products)

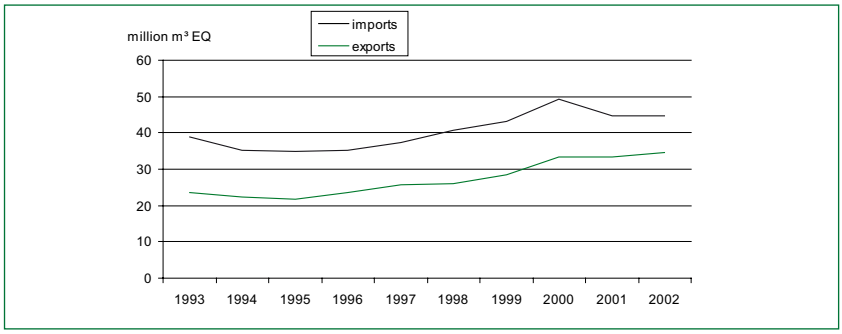


Figure 29: Variations in imported and exported volumes from 1993 to 2002 (source: SCEES)

Commentary: in 2002, imports of wood and wood-derived products involved 45 million m³ roundwood equivalents (EQ), while exports represented 35 million m³ EQ.
The respective shares of construction timber (16-17%) and industrial wood (83%) were the same in both categories.
Volume exports increased at a faster pace than imports, thus reducing the differential, but a value analysis highlighted a deterioration in the trade deficit (cf. infra).

Trade balance trends

	value (million € 2003)											annual variation rate
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	1993-2003
exports	4,412	5,356	6,143	5,693	6,167	7,371	7,653	8,852	8,368	8,216	7,928	6.0%
imports	6,229	7,810	8,909	8,227	8,854	10,183	10,633	12,697	11,932	11,547	11,181	6.0%
Balance	**-1,817**	**-2,454**	**-2,766**	**-2,534**	**-2,687**	**-2,812**	**-2,980**	**-3,845**	**-3,564**	**-3,331**	**-3,253**	**-6.0%**

(Source: SCEES/foreign trade of wood and wood-derived products; transaction amounts are expressed in CIF values (cost, insurance and freight) for imports, and in FOB values (free on board) for exports; the nomenclature adopted is the 8-figure combined nomenclature used by all EU countries)

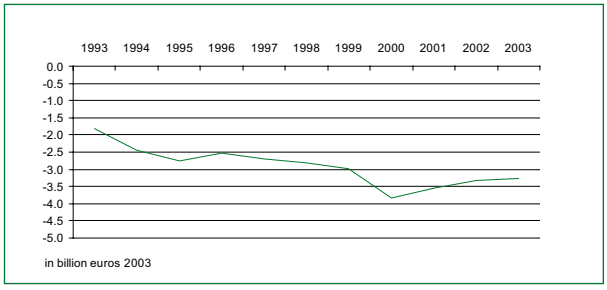


Figure 30: Trade balance trends from 1993 to 2003 (source: SCEES)

Commentary: France had a negative foreign trade balance of €3.3 billion for the entire wood sector in 2003. Import and export patterns in terms of value have increased at the same pace since 1993, thus deteriorating the deficit by 6% per year.

However, the trend has been improving since 2001 (Figure 30).
For many years, three sectors have accounted for most of this deficit but recent trends in these sectors differ markedly:
- for wooden furniture and chairs: the trade balance deterioration is ongoing
- for woodpulp and used papers: after a substantial deterioration in 2000, the balance has been improving since 2001, but remains negative
- for paper-cardboard: the balance is still negative but has been improving considerably since 1999.

The sawnwood sector had a modest impact with respect to the overall deficit until 1999, but the situation has been deteriorating, especially for sawn softwood. The main surplus sectors are wood-based panels (particle- and fibre-board) and plywood, whose balance improved in 2003, and rough hardwood and softwood timber (logs and pulpwood). The trade balance of the wooden veneer sector was positive until the downturn in 2001, after which it became negative.
A detailed analysis of the trade balance revealed that the deficit deterioration noted in 2000 was mainly a consequence of the sharp rise in prices of woodpulp and used paper.
The 1999 storms prompted a marked improvement in the rough timber trade balance in 2000, with a 50% increase in temperate rough hardwood timber, and an almost twofold greater increase in rough softwood timber. In parallel, the balance deteriorated for sawn softwood and hardwood–sawnwood imports increased by 20% while exports rose by only 12%. The surge in available timber induced by the storms clearly did not enable French sawmills to substantially boost their production capacity. The extent of disruption caused by the 1999 storms is becoming more obvious every year.

INDICATOR 6.9

Share of wood energy in total energy consumption, classified by origin of wood

Wood and wood-waste energy consumption	2001 KTOE	2002 KTOE	2003** KTOE	Variation 2001-03
households*	7,571	6,708	7,175	-10.2%
collective residential and service sector*	130	144	153	38.5%
electricity and industrial heating	1,572	1,603	1,634	8.0%
heating for agricultural use	40	40	40	0.0%
total	**9,313**	**8,495**	**9,002**	**-6.6%**
Household share in total wood energy consumption	**81.3%**	**79.0%**	**79.7%**	**-3.9%**
Total primary energy consumption*	266,900	266,300	271,700	3.6%
Share of wood energy in total primary energy consumption	**3.5%**	**3.2%**	**3.3%**	**-9.8%**
Total renewable primary energy consumption	19,378	17,711	18,214	-11.7%
Share of wood energy in total renewable primary energy consumption	**48.1%**	**48.0%**	**49.4%**	**5.8%**

* without climatic correction
** provisional

(Source: Observatoire de l'énergie; June 2005 update; data expressed in millions of tonnes of oil equivalent (MTOE) after conversion of gigawatthours into KTOE using the 0.086 electric energy coefficient. These data concern metropolitan France and the overseas departments (DOM).)

⇨*Note : wood and wood waste used for energy production encompasses a broad range of woody materials derived from silviculture and industrial processing: wood chips and sawdust generated by the timber and paper industries, black liquor generated by pulp and paper industries. Wood charcoal and peat were not recorded.*
The presented data are from studies undertaken by the Centre d'études et de recherches économiques sur l'énergie (CEREN), supplemented with data from the Agence de l'environnement et de la maîtrise de l'énergie (ADEME) concerning collective and industrial heating plants installed since 1994 within the framework of fuelwood programmes. In 2003, fuelwood consumption was thus estimated at 40 million m³, with 25 million m³ derived from forests. This latter figure is higher than the estimation of the Inventaire forestier national mentioned in § 3.1 (18.4 million m³), mainly because of the period assessed by IFN (1984-96) and the forest stands considered.

Commentary: fuelwood consumption in France was estimated at 9 million tonnes of oil equivalent (MTOE) in 2003. It represents 3.3% of the total primary energy consumption. This proportion rises to almost 50% of the total renewable primary energy consumption.
Household consumption, represented by domestic heating, accounts for a major share of the total consumption, at more than 7 MTOE (80%), with industrial consumption taking the lowest share (18%).

Overall fuelwood consumption remained steady at around 10 MTOE from 1990 to 1996 and has been hovering around 9 MTOE since 1997. This recent stagnation concerns household consumption, while consumption has been rising in industrial, collective residential and service sectors.

This was apparently a result of the reduction in wood consumed by traditional heating appliances (reduction in the number of wood-fired stoves and ranges), partially offset by an increase in wood used in inserts in association with alternative energy sources.
The promotion of renewable energy is a key focus in EU energy orientations, which are especially aimed at doubling renewable energy use before 2010. The French energy law of July 2005 aims to fulfil the same objectives. Hence, by 2010, the goal is:

- to meet 10% of energy needs via renewable energy sources
- to increase renewable heat production by 50%. This would result in a consumption rate of 12-13 MTOE, thus utilising an additional 12-16 million m^3 of wood.

To ensure sustainability of the fuelwood sector, full insight is required on the extent of available resources, their cost-effective extraction, supply structuring and technical and environmental enhancement of energy generation.

The Agence de l'environnement et de la maîtrise de l'énergie (ADEME) is addressing the main challenges through successive fuelwood programmes. The first one began in 1994, in 11 regions, and contributed to the development of collective wood-fuelled heating. The second, which spans the 2000-2006 period, concerns the entire country, and has a much broader scope, i.e. promoting collective and individual wood-fuelled heating, developing industrial fuelwood use (e.g. to produce heat for drying, electricity cogeneration), improving heating plant and electricity cogenerator energy output by 10%, thus leading to the creation of 1,000-2,000 direct jobs.

In this setting, ADEME sponsored a national study in 2002 to develop a method for estimating wood chip supplies from forests. Available resources were assessed by the Inventaire forestier national (IFN) and the technical-economic alternatives were evaluated by the SOLAGRO association. This study revealed that considerable unused wood chip supplies from logging waste are available. Further analyses are under way to determine the actual usable quantity of wood chips available at a competitive price relative to other energy sources, without being detrimental to other wood uses.

INDICATOR 6.10

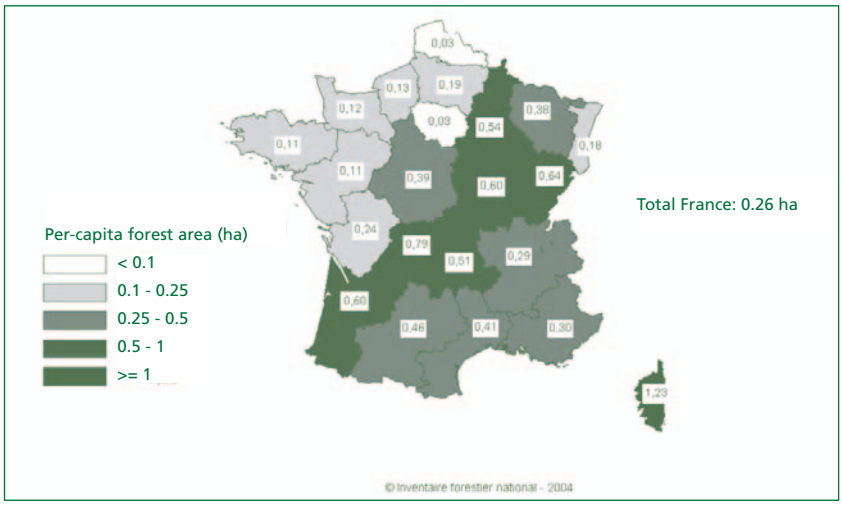
Area of forest and other wooded land where public has a right of access for recreational purposes and indication of intensity of use

Total per-capita forest area

	1993	1998	2003	Annual variation rate 1993-2003
population (x1,000 inhabitants)	57,369	58,299	59,635*	0.4%
forest area, including poplar plantations (x1,000 ha)	14,811	15,220	15,408	0.4%
per-capita forest area (ha)	0.26	0.26	0.26	0.0%

* provisional

(Source: SCEES/Teruti and INSEE/general population census, estimations on 1st January of the year; the data concern metropolitan France.)



Map 21: Per-capita forest area by administrative region in 2003 (sources: SCEES and INSEE)

Commentary: the per-capita forest area has remained steady for 10 years because the forest has generally been expanding at the same pace as the population. France, with 0.26 ha of forest per inhabitant, is slightly below the mean for Europe (0.30 ha/capita according to the TBFRA 2000 survey of UNECE/FAO), but ranks midway between Germany (0.13), Italy (0.17) and Poland (0.23) on one side, and Spain (0.34) and Austria (0.47) on the other, but far behind the Scandinavian countries (Finland 4.25; Sweden 3.07; Norway 1.97).
The situation varies in different French regions because of differences in percentage forest cover and population densities (Map 21). Corsica has the highest per-capita forest area (1.23 ha). Regions with a ratio of more than 0.5 ha/capita are located along a diagonal line running from southwestern to northeastern France, excluding Lorraine and Alsace. The lowest ratios occur in western and northern regions and Ile-de-France (0.03).

This first approach to the "forest supply" should be improved by including a property parameter because there is no public access to some private forests. Moreover, the distance between the population and the closest forest is a key factor with respect to accessibility. Forest access is also, and to an increasing extent, governed by different, and sometimes competing, forest uses, especially on weekends (hunting, hiking, etc.)–a rigorous spatiotemporal understanding of activity sharing in forests could enhanced the notion of public access to forests.

Public forests

ownership category	forest area devoted mainly to public access (ha)			Annual variation rate
	1994	1999	2004	1994-2004
state-owned forests	17,300	26,700	24,000	3.3%
other public forests governed by forest regulations	19,900	27,800	29,000	3.8%
Total public forests	**37,200**	**54,500**	**53,000**	**3.6%**

(Source: ONF, management plan datasets on public access while only considering the wooded area; the share of wooded area in the total area in 2004 was applied to the total areas of 1994 and 1999)

Commentary: the public forest area devoted in priority to public recreation has considerably increased in the last 10 years, thus reflecting a strong growth in demand. These formations, which are mainly located around large urban areas or famous tourist sites, are specially equipped and managed, in order to offset potential ecological problems arising as a result of overuse.

However, this assessment does not provide a suitable representation of the real situation–many public forests that are mainly managed for wood supply actually provide a high level public accommodation service. The slight reduction in public hosting areas in state-owned forests in the last 5 years is therefore not an indication that there has been a decline in public visits.

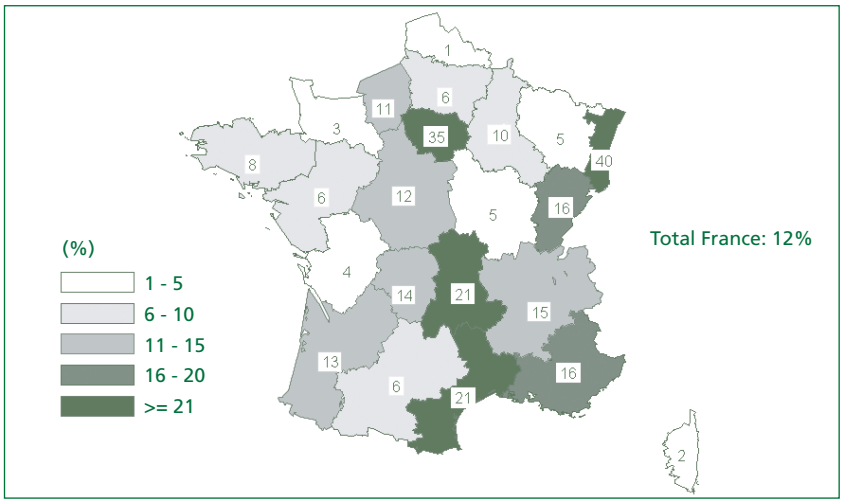
In addition to 700 public recreational areas equipped with wooden furniture, the Office national des forêts (ONF) has installed a considerable amount of equipment to meet the recreational demand in state-owned forests, especially:
- 11,000 km of hiking trails
- 8,000 km of cycling trails
- 9,000 km of horseback riding trails
- 500 km of cross-country ski trails

Social expectations of French people concerning the forest are complex and ever-changing. This situation prompted ONF, in partnership with scientific organisations, to undertake a large-scale assessment on social demand relative to forests. This work is aimed at clearly identifying and analysing expectations so that forest management can ultimately be tailored to meet these needs. A preliminary assessment, carried out in partnership with Cemagref, Bordeaux, showed that public expectations extended far beyond the recreational aspect of forests and could not be solely fulfilled by installing equipment associated with public accommodation. In 2004, a national survey on different images of forests in the public eye, conducted by ONF and the Université de Caen, concluded that the forest's role as a "heritage to pass on to future generations" is the top concern of French people (87%). Other projects are also planned, including surveys with detailed open-ended interviews and a PhD thesis on the social demand, based on case studies.
This work should ultimately result in the founding of an observatory on social expectations.

Public use of private forests of over 1 ha

	Number of owners (x 1,000)	Forest area (x 1,000 ha)
Total	1,118	9,848
including %		
providing free public access to their forests	86%	72%
where the forest is visited by the public	75%	84%
- low public use	51%	46%
- medium public use	19%	25%
- high to very high public use	5%	12%
considering the public causes no annoyance	87%	67%
tolerating picking of small products	88%	78%

(Source: SCEES, 1999, survey on private forest property structures; only forests of over 1 ha were monitored)



Map 22: Private forest areas with high to very high public use per administrative region (source: SCEES, 1999)

Commentary: according to a survey of the Service central des enquêtes et études statistiques (SCEES) conducted in 1999, most owners of private forests of over 1 ha (86%) declare that they provide free access to their forests, i.e. 72% of the total forest area. Prohibited access is usually enforced by legal entities, as displayed by warning signs (21% of areas) or by physical barriers (7%).

A very large proportion of private forests is actually used by the public (84%), but the visiting rate is only high to very high in 12% of the area and limited to 5% of owners. The results vary from region to region (Map 22)–the most visited private forests are located around large urban centres (Ile-de-France) or in regions where tourism is high (Alsace, Languedoc-Roussillon, Auvergne, Provence-Alpes-Côte d'Azur).

Finally, according to the same survey, many private owners consider that the public does not cause any annoyance and they tolerate picking of mushrooms, berries and other small products in their forests.

Number of visits in forests

Public activities	Total number of household visits (x 1,000,000)	Mean number of visitors per household (units)	Total number of individual visits (x 1,000,000)	Proportion of visits of 2 h or more (%)	Number of visits per person and per year (units/pers./year)
Walking	287	2.5	716	72%	12.5
Sports	51	2.1	109	65%	1.9
Animal walking	44	1.6	69	30%	1.2
Picking	21	2.5	51	88%	0.9
Hunting	10	1.7	18	74%	0.3
Fauna/flora	9	1.5	14	82%	0.2
Firewood	7	1.4	10	83%	0.2
Other activities	12	1.9	23	99%	0.4
Total	**441**	**2.3**	**1,010**	**70%**	**17.7**

(Source: LEF ENGREF/INRA, 2002. Survey on visiting patterns in French forests. "Other activities" includes graphic arts and photography, geology, forest maintenance, etc.)

Commentary: according to a survey conducted in 2002 in a sample of 2,575 French households representative of telephone subscribers, and concerning the year 2001 (Laboratoire d'économie forestière ENGREF/INRA, Nancy), 56% of French households had visited a forest at least once in 2001. There were a total of 441 million visits, two-thirds of which involved walks. Each household was composed of 2.3 members on average, which means there was a total of a billion visits by French people in 2001. Walking is most often associated with picking, usually in family groups, more than nature watching, rural activities (hunting, firewood collecting) or walking a dog. Excluding the time it takes to reach the forest (mainly by car, bicycle or on foot), the visiting time is often over 2 h, and 2.5 h on average. Recreational activities in the forest are thus extremely important for French people, who pay around €2 billion per year just to gain access to forests by car.

INDICATOR 6.10.1
Population distribution by per-capita forest area segment within a 50 km radius

per-capita forest area within a 50 km radius	population concerned (%)	proportion of public forest in the total forest area (%)
less than 0.01 ha	3.1%	53.8%
0.01-0.02 ha	19.2%	38.6%
0.02-0.05 ha	6.1%	24.9%
0.05- 0.1 ha	14.2%	18.6%
0.1- 0.2 ha	16.4%	26.4%
0.2-0.5 ha	28.8%	28.4%
0.5-1 ha	8.9%	25.2%
1-2 ha	2.4%	24.3%
2-5 ha	0.8%	28.3%
more than 5 ha	ε	54.2%
Total	**100%**	**26.5%**

(Source: ONF, IFN 1998, IGN, INSEE/general population census 1999; ONF assessment)

Commentary: the overall per-capita forest area ratio can be broken down by considering the population distribution by section of forest area within a 50 km radius. This breakdown highlights marked differences in situation, with a ratio of 1 to 500 from one extreme to the other (range 0.01 to 5 ha). More than 20% of French inhabitants have access to only 200 m^2 of forest within a 50 km radius around their homes. Conversely, 12% of inhabitants have access to more than 0.5 ha, or more than 5,000 m^2.
The proportion of public forests is much higher in zones where the per-capita forest area is low, e.g. within the green belt in the Paris region.

INDICATOR 6.10.2
Proportion of forest area by per-capita forest area segment within a 50 km radius

per-capita forest area within a 50 km radius	total forest area (%)
less than 0.01 ha	0.04%
0.01-0.02 ha	0.9%
0.02-0.05 ha	1.2%
0.05-0.1 ha	3.1%
0.1-0.2 ha	7.9%
0.2-0.5 ha	33.4%
0.5-1 ha	27.2%
1-2 ha	17.1%
2-5 ha	9.0%
more than 5 ha	0.1%
Total	**100%**

(Source: ONF, IFN 1998, IGN, INSEE/general population census 1999; ONF assessment)

Commentary: the distribution of French forests by per-capita forest area class within a 50 km radius provides an indication of the impact of human use on the natural environment.
More than half of the forest area is located in zones where the per-capita forest area within a 50 km radius is over 0.5 ha–the human impact is higher on 13% of the area for which this ratio is under 0.2 ha.

INDICATOR 6.11

Number of sites within forest and other wooded land designated as having cultural or spiritual values

Type of site	Number	Observations	Source
classified sites with wooded areas	275	with a total area of around 74,000 ha	1
arboretums with public access	87		2
biosphere reserves	6	Pays de Fontainebleau, Vosges du Nord, Cévennes, Mont Ventoux, Lubéron, Vallée du Fango	3
World Heritage sites	2	Vallée de la Loire (Domaine de Chambord); Scandola nature reserve in Corsica (maquis)	3
unusual trees in public forests	2,000	with 264 of national interest	4
unusual stands in public forests	200		4

(Source: **1** MEDD 2004, according to a database on classified sites. Sites were classified on the basis of five criteria: scenic, historical, legendary, artistic or scientific. Some sites were classified on the basis of several criteria. **2** ENGREF Arboretum National des Barres 2005. **3** UNESCO 2005; the Chambord site, classified since 1981, was included in the "Vallée de la Loire" site in 2000; maquis (other wooded lands according to FAO) covers part of the Scandola reserve. **4** ONF 2004)

Commentary: the forest has an important cultural and symbolic status in the French imagination. This is reflected in the main images that the forest brings to mind for people, as a "heritage to pass down to future generations" and a "nature reservoir", as revealed in a survey undertaken by the Office national des forêts and the Université de Caen in 2004.
Forest areas with a high cultural and symbolic value include sites that are classified as being partially wooded, arboretums with public access, biosphere reserves, World Heritage sites and unusual trees and stands.

✓ Classified sites are legally designated as sites whose conservation or preservation is of public interest from an artistic, historical, scientific, legendary or scenic standpoint. All forestry work that could modify the state or aspect of a classified site requires an authorisation from the minister responsible for these sites.
Around 275 sites are classified as being partially wooded, representing a total area of 74,000 ha. Two-thirds of them are classified with respect to all of the criteria mentioned above, with 20% considered as being "scenic". Most of them are located in Ile-de-France (21%), Bretagne (13%), Pays de la Loire (12%), in the Centre region (11%) and Provence-Alpes-Côte d'Azur (8%).

✓ French arboretums are relatively untapped biological heritage resources. They contain very high diversity (taxa and individual plants), rare species (endangered, vulnerable or symbolic) and very unique ecosystems. There is public access to 87 of these arboretums (cf. list in Appendix 10).
A French public arboretum network was set up with the aim of ensuring the sustainable management of this heritage. This network includes 10 arboretums managed by the Ecole nationale du génie rural des eaux et forêts (ENGREF), the Institut national de la recherche agronomique (INRA), the Office national des forêts (ONF), the Museum national d'histoire naturelle (MNHN) and the Université Paris-Sud.

✓ The United Nations Educational, Scientific and Cultural Organization (UNESCO) launched a scientific programme entitled Man and the Biosphere (MAB) in 1974, with the aim of gaining further insight into the relationship between man and the environment. Within the framework of this programme, UNESCO developed the "biosphere reserve" concept–sites where natural resource-friendly human developments are showcased and applied. There are currently 440 biosphere reserves worldwide, located in 97 different countries. France has 10 reserves, 7 of which are in metropolitan France. Six of these metropolitan reserves are forested, i.e. the biosphere reserves of Pays de Fontainebleau, Vosges du Nord, Cévennes, Mont Ventoux, Lubéron and Vallée du Fango in Corsica.

✓ The UNESCO World Heritage Convention was adopted in 1972. Its aim is to globally promote the identification, protection and preservation of cultural and natural heritage considered as having an outstanding value for humanity. Natural heritage sites have an outstanding universal value from scientific, conservation or natural beauty standpoints.
There are 30 World Heritage sites in France, two of which contain forests, or "other wooded lands" according to FAO. These are the Domaine de Chambord, which has been classified since 1981 and included in the Vallée de la Loire site since 2000 and, secondly, the Scandola nature reserve in Corsica, which is a remarkable example of Mediterranean maquis landscape.
In 2006, France should submit a request for classification of the Causses and Cévennes area as a World Heritage site–it covers a 639,000 ha area and contains many forests and other wooded lands.

✓ In 1996, the Office national des forêts (ONF) undertook an inventory of unusual trees in public forests. They were defined according to dendrological (size, age), aesthetic (stem shape, foliation, roots) or cultural (historical, religious, ethnographic value) criteria. These trees are generally not legally protected but they are taken into account in forest management plans.
ONF thus conducted local inventories with regional and national harmonization and four interest levels. Around 2,000 trees and tree groups were classified as unusual, 264 of which were considered as being of national interest. In addition, 200 unusual stands were recorded.

Conclusion

The present analysis of the 56 proposed indicators reviewed the progress and problems encountered in applying sustainable management strategies in French forests. The broad range of topics covered under the six criteria set down in the Helsinki Conference clearly highlights the complexity of situations encountered and the need for a global approach to sustainable forest management. This regularly improved and updated set of indicators should provide an effective monitoring tool for the national forest programme which is currently being drawn up.

This study was also an opportunity to field test the feasibility of the quantitative indicators adopted at the Vienna Conference in 2003. It was possible to assemble data on all but one of the 35 proposed indicators. Some drawbacks were noted concerning a few indicators (growing stock on other wooded lands, deadwood volume, etc.). However, as substantial and broad ranging data are available in France, most of the indicators proposed at the Vienna Conference could be addressed, and these were supplemented with around 20 other new indicators.

The data presented here–in addition to those from the Inventaire forestier national (IFN)–were supplied by 33 different organisations, administrations and associations. The main problems concerned methodological issues, the absence of certain data and information recovery. The change in IFN's inventory method in 2005 should overcome some of these problems.

Many research studies on sustainable management indicators are currently under way in France, especially within the framework of a forest diversity action plan, which will enhance this analysis through the inclusion of standard biodiversity. In 2006, a study on this topic is to be assigned to the Ecosystèmes Forestiers (ECOFOR) public interest group, which aims at promoting French forestry research synergy. This work should give rise to new simple, relevant and easy to assess biodiversity indicators.

This indicator assessment also provided an opportunity to continue the sustainable forest management debate with all national and international stakeholders

ACRONYMS, SYMBOLS AND ABBREVIATIONS

Acronyms

ADEME	Agence de l'Environnement et de la Maîtrise de l'Energie
AFOCEL	Association Forêt-Cellulose
ANB	Arboretum National des Barres
BIC	Bénéfices Industriels et Commerciaux
CATAENAT	Charge Acide Totale d'origine Atmosphérique dans les Ecosystèmes NATurels Terrestres
CEMAGREF	Institut de Recherche pour l'Ingénierie de l'Agriculture et de l'Environnement Ex Centre National du Machinisme Agricole, du Génie Rural des Eaux et des Forêts
CEREN	Centre d'Etude et de Recherche Economique sur l'Energie
CITEPA	Centre Interprofessionnel Technique d'Etudes de la Pollution Atmosphérique
CNDB	Comité National de Développement du Bois
CNIEFB	Compagnie Nationale des Ingénieurs et Experts Forestiers et des experts en Bois
CNPPF	Centre National Professionnel de la Propriété Forestière
COPACEL	Confédération française de l'industrie des Papiers, Cartons et Celluloses
CRPF	Centre Régional de la Propriété Forestière
CTBA	Centre Technique du Bois et de l'Ameublement
DDAF	Direction Départementale de l'Agriculture et de la Forêt
DGFAR	Direction Générale de la Forêt et des Affaires Rurales
DGI	Direction Générale des Impôts
DOM	Département d'Outre-Mer
DRAF	Direction Régionale de l'Agriculture et de la Forêt
DSF	Département Santé des Forêts
EAB	Enquête Annuelle de Branche
EAE	Enquête Annuelle d'Entreprise
ECOFOR	ECOsystèmes FORestiers public interest group
ENGREF	Ecole Nationale du Génie Rural, des Eaux et des Forêts
EPEI	Enquête sur les Petites Entreprises Industrielles
ESSES	Enquête Statistique sur les Structures Economiques de la Sylviculture
EUROSTAT	Statistical Office of the European Communities
FAO	Food and Agriculture Organization of the United Nations
FNC	Fédération Nationale des Chasseurs
FNPC	Fédération Nationale des Producteurs de Champignons
FNSPFS	Fédération Nationale des Syndicats de Propriétaires Forestiers Sylviculteurs
FSA	Fédération des Syndicats d'Apiculteurs
FSC	Forest Stewardship Council
GDP	gross domestic product

IDF	Institut pour le Développement Forestier
IEFC	Institut Européen de la Forêt Cultivée
IFEN	Institut Français de l'Environnement
IFN	Inventaire Forestier National (French national forest inventory)
IGN	Institut Géographique National
INRA	Institut National de la Recherche Agronomique
INSEE	Institut National de la Statistique et des Etudes Economiques
ISFM	sustainable forest management indicator
IUCN	World Conservation Union
LEF/ENGREF	Laboratoire d'Economie Forestière de l'ENGREF
LERFOB	Laboratoire d'Etudes des Ressources Forêt-Bois
LPO	Ligue pour la Protection des Oiseaux
LULUCF	land-use, land-use change and forestry
MAB	Man and Biosphere
MAP	Ministère de l'Agriculture et de la Pêche
MCPFE	Ministerial Conference on the Protection of Forests in Europe
MEDD	Ministère de l'Ecologie et du Développement Durable
MNHN	Muséum National d'Histoire Naturelle
MSA	Mutualité Sociale Agricole
NAF	Nomenclature d'Activités Française
NES	Nomenclature Economique de Synthèse
ODARC	Office de Développement Agricole et Rural de la Corse
OE	Observatoire de l'Energie
ONCFS	Office National de la Chasse et de la Faune Sauvage
ONF	Office National des Forêts
ONIPPAM	Office National Interprofessionnel des Plantes à Parfum, aromatiques et Médicinales
PACA	Provence Alpes Côte d'Azur
PEFC	Program for the Endorsement of Forest Certification schemes
PNR	Parc Naturel Régional
RENECOFOR	Réseau National de suivi à long terme des Ecosystèmes Forestiers
RMQS	Réseau de Mesure de la Qualité des Sols
RTM	Restauration des Terrains en Montagne
SCEES	Service Central des Enquêtes et Etudes Statistiques
SEOF	Société d'Etudes Ornithologiques de France
SESSI	Service des Etudes et des Statistiques Industrielles
SNM	Service des Nouvelles du Marché
SPA	special protection area (Birds directive)

SRFB	Service Régional de la Forêt et du Bois
TBFRA	Temperate and Boreal Forest Resource Assessment
TERUTI	Enquête annuelle sur l'Utilisation du Territoire (SCEES)
UNECE	United Nations Economic Commission for Europe
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
WWF	World Wildlife Fund

Symbols and Abbreviations

§	paragraph
>	more than
µg	microgramme
C	carbon
cm^2	square centimeter
cm	centimeter
CO_2	carbon dioxide
EQ	roundwood equivalent
F	franc
g	gramme
ha	hectare
Keq	kg-equivalent
kg	kilogramme
km	kilometer
KTOE	kilotonne of oil equivalent
l	liter
m	meter
m^2	square meter
m^3	cubic meter
mg	milligramme
mm	millimeter
MTOE	megatonne of oil equivalent
NA	not available
NH_3	ammoniac
NH_4	ammonium
NMVOC	non-methane volatile organic compound
NO_3	nitrate
NO_x	nitrogen oxide
p	part
p.	page
PVC	polyvinylchloride
SO_2	sulfur dioxide
t	tonne
VAT	value added tax
ε	very low quantity

Boxes

Maps

List of boxes, maps and figures

Figures

WEBSITES QUERIED

Agence de l'environnement et de la maîtrise de l'énergie	www.ademe.fr
Agreste, la statistique agricole	www.agreste.agriculture.gouv.fr
Association Forêt-Cellulose	www.afocel.fr
Centre technique interprofessionnel d'études de la pollution atmosphérique	www.citepa.org
Comité national pour le développement du bois	www.bois-construction.org
Confédération française de l'industrie des papiers, cartons et celluloses	www.copacel.fr
Direction générale de l'énergie et des matières premières	www.industrie.gouv.fr/energie
ECOsystèmes FORestiers public interest group	www.gip-ecofor.org
Fédération nationale des communes forestières de France	www.fncofor.fr
Food and Agriculture Organization of the United Nations – Forestry	www.fao.org/forestry
Forest Stewardship Council	www.fsc.org
Institut de recherche pour l'ingénierie de l'agriculture et de l'environnement	www.cemagref.fr
Institut français de l'environnement	www.ifen.fr
Institut national de la statistique et des études économiques	www.insee.fr
Inventaire forestier national	www.ifn.fr
L'actualité du bois et de la forêt	www.boisforet-info.com
Man and the Biosphere – France (UNESCO)	www.mab-france.org
Ministère de l'agriculture et de la pêche	www.agriculture.gouv.fr
Ministère de l'écologie et du développement durable	www.ecologie.gouv.fr
Ministerial Conference on the Protection of Forests in Europe	www.mcpfe.org
Mutualité sociale agricole	www.msa.fr
Observatoire de la forêt méditerranéenne	www.ofme.org
Office national de la chasse et de la faune sauvage	www.oncfs.gouv.fr
Office national des forêts	www.onf.fr
Office national interprofessionnel des plantes à parfum, aromatiques et médicinales	www.onippam.fr
Program for the endorsement of forest certification schemes	
- PEFC International	www.pefc.org
- PEFC France	www.pefc-france.org
Service des études et des statistiques industrielles (SESSI)	www.industrie.gouv/sessi
Service des nouvelles du marché	www.snm.agriculture.gouv.fr
Statistical Office of the European Communities (EUROSTAT)	europa.eu.int/comm/eurostat
United Nations Economic Commission for Europe	www.unece.org
World Conservation Union – French Committee	www.uicn.fr
World Heritage Committee (UNESCO)	www.whc.unesco.org
World Wildlife Fund – France	www.wwf.fr

REFERENCES

General references

Buttoud G., 2003, *La forêt, un espace aux utilités multiples*, La documentation Française, 143 p.

FAO, 2002, *Evaluation des ressources forestières mondiales 2000. Rapport principal*, Etude FAO forêts n°140, Organisation des Nations-Unies pour l'alimentation et l'agriculture, 466 p.

FAO, 2005, *Situation des forêts du monde*, Organisation des Nations-Unies pour l'alimentation et l'agriculture, 153 p.

Forestry Commission, United Kingdom, 2002, *UK indicators of sustainable forestry*, 104 p.

Gadant J. (dir.), 1991, *L'atlas des forêts de France*, Jean-Pierre de Monza, 240 p.

MCPFE Liaison Unit Vienna, 2003, *Improved pan-european indicators for sustainable forest management*, Fourth ministerial conference on the protection of forests in Europe, Vienna, 45 p.

MCPFE Liaison Unit Vienna, UNECE/FAO, 2003, *State of Europe's Forests 2003*, Fourth ministerial conference on the protection of forests in Europe, Vienna, 126 p.

Ministère de l'agriculture et de la pêche, 1995, *Les indicateurs de gestion durable des forêts françaises*, DERF, 49 p.

Ministère de l'agriculture et de la pêche, Inventaire forestier national, 2000, *Les indicateurs de gestion durable des forêts françaises*, Edition 2000, DERF, 129 p.

Ministère de l'agriculture et de la pêche, 2000, *La forêt et les industries du bois 2000*, Agreste GraphAgri, DERF, 157 p.

Ministère de l'agriculture, de l'alimentation, de la pêche et des affaires rurales, 2002, *Structure de la propriété forestière privée en 1999*, Agreste Chiffres et Données Agriculture, n° 144, DAF, 94 p.

Ministère de l'agriculture, de l'alimentation, de la pêche et des affaires rurales, 2004, *Rapport national volontaire pour la cinquième session du Forum des Nations-Unies sur les forêts*, DGFAR, 54 p.

Ministry of Agriculture and Forestry, Finland, 2001, *The State of Forestry in Finland 2000, Criteria and Indicators for Sustainable Forest Management in Finland*, Publications 5al/2000, 102 p.

Ministère de l'écologie et du développement durable, Institut français de l'environnement, 2002, *Les comptes économiques de l'environnement en 2000*, 164 p.

Office fédéral de l'environnement, des forêts et du paysage, 1997, *Critères et indicateurs de la gestion durable des forêts suisses*, 80 p.

Office national des forêts, 2004, *Rapport de développement durable. Gestion 2003*, 102 p.

Office national des forêts, 2005, *Rapport de développement durable. Gestion 2004*, 90 p.

Peyron J.-L., Tabourel S., Niedzwiedz A., 2005, *Les comptes de la forêt : enjeux et méthodes*, Laboratoire d'économie forestière-Engref, INRA, Ifen, 85 p.

UNECE/FAO, 2000, *Forest resources of Europe, CIS, North America, Australia, Japan and New Zealand*, Commission économique des Nations-Unies pour l'Europe, Organisation des Nations-Unies pour l'alimentation et l'agriculture, 445 p.

Criterion 1: Maintenance and appropriate enhancement of forest resources and their contribution to global carbon cycles

Lousteau D. (coord.), 2004, *Séquestration de carbone dans les grands écosystèmes forestiers en France. Quantification, spatialisation, vulnérabilité et impacts de différents scénarios climatiques et sylvicoles*, Rapport final du projet «CARBOFOR», Programme GICC 2001 «Gestion et Impacts du Changement Climatique», Convention Gip Ecofor n°3/2001, Cestas, 136 p.

Cinotti B., 1996, Evolution des surfaces boisées en France : proposition de reconstitution depuis le début du XIXè siècle, *Revue Forestière Française*, XLVIII n°6, p. 547-562

Centre Interprofessionnel Technique d'Etudes de la Pollution Atmosphérique, 2003, *Inventaire des émissions de gaz à effet de serre en France, au titre de la Convention cadre des Nations-Unies sur les changements climatiques. Rapport d'inventaire national*, 307 p.

Dupouey J.-L., Pignard G., 2001, Quelques problèmes posés par l'évaluation des stocks et flux de carbone forestiers au niveau national, *Revue Forestière Française*, LIII n°3-4, p. 294-300

Dupouey J.-L., Pignard G., Badeau V., Thimonier A., Dhôte J.F., Nepveu G., Bergès L., Augusto L., Belkacem S., Nys C., 1999, Stocks et flux de carbone dans les forêts françaises, *Comptes rendus de l'Académie d'agriculture de France, Bilan et gestion des gaz à effet de serre dans l'espace rural*, vol. 85, n°6, p. 293-310

Inventaire forestier national, 2005, *La forêt française : un puits de carbone*, IF n°7, 8 p.

Ministère de l'agriculture, de l'alimentation, de la pêche et des affaires rurales, 2004, *L'utilisation du territoire en 2003. Nouvelle série 1992 à 2003*, Agreste Chiffres et Données Agriculture, n° 157, DAF, 83 p.

Rivière E., 1999, *Evaluation des puits de CO2 suivant la nouvelle méthode préconisée par le GIEC*, Centre Interprofessionnel Technique d'Etudes de la Pollution Atmosphérique, 40 p.

Criterion 2: Maintenance of forest ecosystem health and vitality

Badeau V., 1998, *Caractérisation écologique du réseau européen de suivi des dommages forestiers. Bilan des opérations de terrain et premiers résultats*. Les cahiers du DSF 5-1998, Ministère de l'agriculture et de la pêche, DERF, Paris, 221 p.

Hamard J.P., Ballon P., 2005, Dégâts de cervidés en forêt : résultats d'un observatoire national, *Forêt-entreprise*, n°161, p. 17-22

Inventaire forestier national, 2003, *2003, année marquée par les incendies*, IF n°1, 8 p.

Inventaire forestier national, 2003, *Les tempêtes de décembre 1999 : bilan national et enseignements*, IF n°2, 8 p.

Legay M., Martin H., Quiñones-Nadler C., Gonin P., 2004, L'observatoire national des dynamiques de la végétation après tempête, *Rendez-vous techniques n°3*, Office national des forêts, p. 7-10

Ministère de l'agriculture, de l'alimentation, de la pêche et des affaires rurales, 2003, *Prévention des incendies de forêt*, Dossier de presse, DGFAR, 15 p.

Nageleisen L.-M., 2005, *Quelques indicateurs de la santé des forêts françaises (1989 – 2004)*, La santé des forêts [France] en 2004, Ministère de l'agriculture, de l'alimentation, de la pêche et de la ruralité, DGFAR, Paris, 3 p.

Peiffer M., Badeau V., 2002, Propriétés des sols forestiers français : quelques résultats complémentaires à l'inventaire systématique (16 km x 16 km), *Les Cahiers du DSF*, 1-2002, La santé des forêts [France] en 2000 et 2001, Ministère de l'agriculture et de la pêche, DERF, Paris, p. 84-88.

Pignard G., Thivolle-Cazat A., Hamza N., 2004, *Disponibilité en bois résineux en France. Réévaluation après les tempêtes de 1999*, Inventaire forestier national, 427 p.

Renaud J.-P., Nageleisen L.-M., 2005, *Les résultats 2004 du réseau européen de suivi des dommages forestiers*, La santé des forêts [France] en 2004, Ministère de l'agriculture, de l'alimentation, de la pêche et de la ruralité, DGFAR, Paris, 21 p.

Ulrich E., 2005, *Renecofor. 13è bilan annuel. Année 2004*, Office national des forêts, 23 p.

Criterion 3: Maintenance and encouragement of productive functions of forests (wood and non-wood)

Association Forêt-Cellulose, 2002, *Etude prospective de la ressource en peuplier sur l'ensemble de la France de 2002 à 2020, Rapport final*, Ministère de l'agriculture, de l'alimentation, de la pêche et des affaires rurales, DGFAR, 56 p.

Inventaire forestier national, 2004, *La typologie des stations forestières*, IF n°4, 8 p.

Office national interprofessionnel des plantes à parfum, aromatiques et médicinales, 1997, *Rapport annuel*, 211 p.

Pignard G., 1994, *Estimation des prélèvements de bois dans la forêt française. Approche forestière de l'autoconsommation*, Inventaire forestier national, 92 p.

Pignard G., 2000, *Analyse de l'évolution de la productivité des forêts françaises au cours des 25 dernières années à partir des données de l'Inventaire forestier national*, Inventaire forestier national, Gip Ecofor, 51 p.

REFERENCES

Criterion 4: Maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems

Dunoyer J.-L., Michon J.-M., 2004, Les espaces naturels protégés en France, état des lieux, *Rendez-vous techniques n°5, Office national des forêts*, p. 20-21

Dupouey J.-L., Sciama D., Koerner W., Dambrine E., Rameau J.-C., 2002, La végétation des forêts anciennes, *Revue Forestière Française*, LIV n°6, p. 521-532

Gosselin M., Laroussinie O. (Eds), 2004, Biodiversité et Gestion Forestière : *connaître pour préserver. Synthèse bibliographique*, Antony, Co-édition Gip Ecofor - Cemagref Editions, Collection Etudes du Cemagref - Série gestion des territoires n°20, 320 p.

Inventaire forestier national, 2004, *La diversité floristique de la forêt française*, IF n°3, 8 p.

Ministère de l'agriculture et de la pêche, 1997, *Les forêts de protection en France*, DERF, 28 p. + annexes

Muller S. (coord.), 2004, *Plantes invasives en France,* Muséum national d'Histoire naturelle, Patrimoines naturels 62, Paris, 168 p.

Rameau J.-C., Gauberville C., Drapier N., 2000, *Gestion forestière et diversité biologique. Identification et gestion intégrée des habitats et espèces d'intérêt communautaire*, Institut pour le développement forestier, Paris, 119 p.

Rameau J.-C., Mansion D., Dumé G., 1989, *Flore forestière française*, guide écologique illustré, Tome 1, Plaines et collines, Institut pour le développement forestier, 1 784 p.

Rameau J.-C., Mansion D., Dumé G., 1993, *Flore forestière française*, guide écologique illustré, Tome 2, Montagne, Institut pour le développement forestier, 2 421 p.

Vallauri D., André J., Blondel J., 2003, Le bois mort, une lacune des forêts gérées, *Revue Forestière Française*, LV n°2, p. 3-16

Vallauri D. (coord.), *Livre blanc sur la protection des forêts naturelles en France. Forêts métropolitaines*, Tec & Doc Lavoisier, Paris, 261 p.

Vallauri D., André J., Dodelin B., Eynard-Machet R., Rambaud D. (coord.), 2005, *Bois mort et à cavités, une clé pour des forêts vivantes*, Tec & Doc Lavoisier, Paris, 404 p.

Vallauri D., Poncet L., 2002, *La protection des forêts en France*. Indicateurs 2002, WWF-France, Paris, 100 p. + annexes

Criterion 5: Maintenance and appropriate enhancement of protective functions in forest management (notably soil and water)

Office national des forêts, 1990, *Forêts et risques naturels en montagne*, 28 p.

Criterion 6: Maintenance of other socioeconomic functions and conditions

Association Forêt-Cellulose, Serge Lochu consultant, 2001, *L'emploi dans la filière bois. Quantification et évolution*, Ministère de l'Agriculture et de la Pêche, DERF, 156 p.

Breman P., Jaillet C., 2004, La prise en compte du paysage dans les sites inscrits et classés : autorisations ponctuelles ou globale pour répondre aux obligations légales ?, *Rendez-vous techniques n°5*, Office national des forêts, p. 55-56

Caisse centrale de la Mutualité sociale agricole, Observatoire des risques professionnels, 2001, *Le risque d'accident des salariés agricoles 1978-1999*, 114 p.

Cibien C., Brézard J.-M., 2004, Les réserves de biosphère : territoires d'expérimentation du développement durable pour l'homme et la nature, *Rendez-vous techniques n°5*, Office national des forêts, p. 42-45

Cinotti B., 2003, Récolte de bois en France en 2001 : le difficile héritage de Lothar et Martin, *Revue Forestière Française*, LV n°4, p. 347-357

Deuffic P., Granet A.-M., Lewis N., 2004, Forêt et société : une union durable, 1960-2003 : évolution de la demande sociale face à la forêt, *Rendez-vous techniques n°5*, Office national des forêts, p. 10-14

Institut national de la statistique et des études économiques, 2003, *Rapport sur les comptes de la Nation 2002*, Insee Résultats, Economie, n°9, 45 p.

Inventaire forestier national, 2005, *Bois-énergie : les forêts ont de la ressource*, IF n°9, 8 p.

Ministère de l'agriculture, de l'alimentation, de la pêche et de la ruralité, 2005, *Exploitations forestières et scieries. Enquête annuelle d'entreprise et sources fiscales*, Agreste Chiffres et Données Agroalimentaire, n° 130, DAF, 42 p.

Ministère de l'agriculture et de la pêche, 2001 à 2005, *Filière bois et dérivés*, Agreste Conjoncture Commerce extérieur bois et dérivés, DAF, n°1/2001 à n°1/2005, 35 p.

Ministère de l'économie, des finances et de l'industrie, 2004, *Le bois en chiffres*, Production industrielle (hors série) Chiffres clés, DGITIP, 29 p.

Peyron J.-L., Harou P., Niedzwiedz A., Stenger A., 2002, *National survey on demand for recreation in French forests*, Laboratoire d'économie forestière-Engref, Institut national de la recherche agronomique, Eurostat, 85 p.

Appendices

APPENDIX 1

List and origins of quantitative SFM indicators in 2005

Topic	N°	Full indicator	Origin
C1: Maintenance and appropriate enhancement of forest resources and their contribution to global carbon cycles			
Forest area	1.1	Area of forest and other wooded land, classified by forest type and by availability for wood supply	MCPFE Vienna
	1.1.1	Forest area gains and losses	ISFM 2000
	1.1.2	Forest area by biogeographical area and elevation class	ISFM 2000
	1.1.3	Forest area by IFN forest structure	ISFM 2000
	1.1.4	Forest area by main tree species	ISFM 2000
Growing stock	1.2	Growing stock on forest and other wooded land, classified by forest type and by availability for wood supply	MCPFE Vienna
	1.2.1	Growing stock by IFN forest structure	ISFM 2000
	1.2.2	Growing stock by tree species	ISFM 2000
Age structure and/or diameter distribution	1.3	Age structure and/or diameter distribution of forest and other wooded land, classified by forest type and by availability for wood supply	MCPFE Vienna
Carbon stock	1.4	Carbon stock of woody biomass and of soils on forest and other wooded land	MCPFE Vienna
	1.4.1	Annual carbon emission levels	ISFM 2000
C2: Maintenance of forest ecosystem health and vitality			
Deposition of air pollutants	2.1	Deposition of air pollutants on forest and other wooded land, classified by N, S and base cations	MCPFE Vienna
	2.1.1	Atmospheric pollutant emission patterns	ISFM 2000
Soil condition	2.2	Chemical soil properties (pH, CEC, C/N, organic C, base saturation) on forest and other wooded land related to soil acidity and eutrophication, classified by main soil types	MCPFE Vienna
Defoliation	2.3	Defoliation of one or more main tree species on forest and other wooded land in each of the defoliation classes: "moderate", "severe" and "dead"	MCPFE Vienna
Forest damage	2.4	Forest and other wooded land with damage, classified by primary damaging agents (abiotic, biotic and human induced) and by forest type	MCPFE Vienna
	2.4.1	Regenerations protected from damage by large ungulates	ISFM 2000
C 3: Maintenance and encouragement of productive functions of forests (wood and non-wood)			
Increment and fellings	3.1	Balance between net annual increment and annual fellings of wood on forest available for wood supply	MCPFE Vienna
	3.1.1	Forest accessibility	ISFM 2000
Roundwood	3.2	Value and quantity of marketed roundwood	MCPFE Vienna
	3.2.1	Cellulose fibre recycling; effective use of derivative products	ISFM 2000
	3.2.2	Marketing wood felled in certified forests	new
Non-wood goods	3.3	Value and quantity of marketed non-wood goods from forest and other wooded land	MCPFE Vienna
Services	3.4	Value of marketed services on forest and other wooded land	MCPFE Vienna
Forests under management plans	3.5	Proportion of forest and other wooded land under a management plan or equivalent	MCPFE Vienna
	3.5.1	Forest area covered by a catalogue of stations and area covered by a simple species guide	ISFM 2000 + suppl.

Topic	N°	Full indicator	Origin
C4: Maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems			
Tree species composition	4.1	Area of forest and other wooded land, classified by number of tree species occurring and by forest type	MCPFE Vienna
	4.1.1	Purity of main species stands in basal area	ISFM 2000
Regeneration	4.2	Area of regeneration within even-aged stands and uneven-aged stands, classified by regeneration type	MCPFE Vienna
Naturalness	4.3	Area of forest and other wooded land, classified by "undisturbed by man", "semi-natural" or by "plantations", each by forest type	MCPFE Vienna
	4.3.1	Area of very old regular high forests forming specific habitats	ISFM 2000
Introduced tree species	4.4	Area of forest and other wooded land dominated by introduced tree species	MCPFE Vienna
Deadwood	4.5	Volume of standing and lying deadwood on forest and other wooded land, classified by forest type	MCPFE Vienna
Genetic resources	4.6	Area managed for conservation and utilisation of forest tree genetic resources (*in situ* and *ex situ* gene conservation) and area managed for seed production	MCPFE Vienna
Landscape pattern	4.7	Landscape-level spatial pattern of forest cover	MCPFE Vienna
	4.7.1	Per-ha length of forest edges	new
	4.7.2	Per-ha length of forest edges by IFN stand types (replaces fractionation by homogeneous vegetation unit)	ISFM 2000 modified
	4.7.3	Large-scale cuts and clear cuts	ISFM 2000
Threatened forest species	4.8	Number of threatened forest species, classified according to IUCN Red List categories in relation to total number of forest species	MCPFE Vienna
Protected forests	4.9	Area of forest and other wooded land protected to conserve biodiversity, landscapes and specific natural elements, according to MCPFE Assessment Guidelines	MCPFE Vienna
	4.9.1	Deer population densities per 100 ha	ISFM 2000
C5: Maintenance and appropriate enhancement of protective functions in forest management (notably soil and water)			
Protective forests – soil, water and other ecosystem functions	5.1	Area of forest and other wooded land designated to prevent soil erosion, to preserve water resources, or to maintain other forest ecosystem functions, part of MCPFE Class "Protective Functions"	MCPFE Vienna
Protective forests – infrastructure and managed natural resources	5.2	Area of forest and other wooded land designated to protect infrastructure and managed natural resources against natural hazards, part of MCPFE Class "Protective Functions"	MCPFE Vienna

APPENDIX 1

Topic	N°	Full indicator	Origin
C6: Maintenance of other socioeconomic functions and conditions			
Forest holdings	6.1	Number of forest holdings, classified by ownership categories and size classes	MCPFE Vienna
Contribution of forest sector to GDP	6.2	Contribution of forestry and manufacturing of wood and paper products to gross domestic product	MCPFE Vienna
Net revenue	6.3	Net revenue of forest enterprises	MCPFE Vienna
Expenditures for services	6.4	Total expenditures for long-term sustainable services from forests	MCPFE Vienna
Forest sector workforce	6.5	Number of persons employed and labour input in the forest sector, classified by gender and age group, education and job characteristics	MCPFE Vienna
Occupational safety and health	6.6	Frequency of occupational accidents and occupational diseases in forestry	MCPFE Vienna
Wood consumption	6.7	Per-capita consumption of wood and products derived from wood	MCPFE Vienna
Trade in wood	6.8	Imports and exports of wood and products derived from wood	MCPFE Vienna
Energy from wood resources	6.9	Share of wood energy in total energy consumption, classified by origin of wood	MCPFE Vienna
Accessibility for recreation	6.10	Area of forest and other wooded land where public has access for recreational purposes and indication of intensity of use	MCPFE Vienna
	6.10.1	Population distribution by per-capita forest area segment within a 50 km radius	ISFM 2000
	6.10.2	Proportion of forest area by per-capita forest area segment within a 50 km radius	ISFM 2000
Cultural and spiritual values	6.11	Number of sites within forest and other wooded land designated as having cultural or spiritual values	MCPFE Vienna

Legend:

ISFM 2000: Sustainable forest management indicator from the 2000 edition of this report and not listed by MCPFE

MCPFE: Ministerial Conference on the Protection of Forests in Europe

Inventory methods and definitions

1 Forest inventory methods

1.1 ***The SCEES Teruti survey*** (Service central des enquêtes et études statistiques du MAP) involves direct annual observation of the physical and functional occupation of many points located throughout metropolitan France.
The results presented in this document are based on the survey method used until 2004, which involves the determination of over 550,000 points generated from a sample of 15,579 aerial photographs taken by the Institut géographique national, which regularly monitors the entire mainland area. Each basic photograph consists of a grid with 36 points. The field survey team locates points to be monitored on the ground and every year determines the physical occupation and functional use for each of the 555,903 points.
Unlike the IFN survey, the Teruti survey covers the entire mainland area every year–thus paragraphs discussing overall changes in wooded land and tree-covered land outside of forests are based on these data.
The years used are 1993, 1998 and 2003, along with the 1997-2003 transition matrix.
In 2005, this survey was tailored to the European specifications of the "Lucas" survey, which EUROSTAT plans to launch in 2007. Hereafter it will be called the "Teruti-Lucas survey".

1.2 ***The Inventaire forestier national (IFN)*** draws up a permanent inventory of metropolitan forest resources by conducting–until 2004–field surveys in each department every 10-12 years. The method used involves a 3-phase statistical survey with stratification after the first phase. First, the outlines of vegetation types are defined on aerial photographs and then a grid of sampling points is applied, with each point also being photo-interpreted (1 point for 30-40 ha). The physical sampling points are drawn by lot after the sample is stratified (1 point for 140 ha)–these relate to productive forest formations, and a series of observations and measurements are made on their dendrometric, floristic and ecological features. Through this in-depth analysis, IFN can provide detailed and reliable data on French forests, particularly on their extent, volume and increment, broken down by different criteria: specific composition of stands, forest structure, accessibility, cover density, age and diameter classes, etc.
The national data presented in this document represent a sum of the departmental data available on the indicated dates: 1/01/1989, 1/01/1994, 1/01/1999 and 1/01/2004. The different departmental inventories are staggered over time, which means that they respectively relate to the following years: 1981, 1986, 1991 and 1996. This explains the slight discrepancy in the forest areas derived from the Teruti survey and those presented by IFN.
A new systematic annual inventory method was adopted in 2005. The next editions of the present report will thus present annual real data on area, volume, increment, etc., for all of France.

2 Definitions

2.1 ***Woodland and forests***

Woodland and forests according to the Teruti survey (physical headings 18-21)
Formations with an apparent forest tree cover of 10% or more or a density of at least 500 future shoots per ha with respect to young trees. The forest area must be over 50 ares.
The year's commercial clearcuts are regarded as "forests and woodland".

Forests (excluding poplar plantations) according to IFN
The term "forests (excluding poplar plantations)" used for IFN data in this document refers to all forest formations in the IFN definition, including thickets (cf. below), unlike Teruti. They consist of plant formations, made up mainly of trees and shrubs, which meet the conditions defining the wooded status:

- trees and shrubs must belong to the forest species featured on a limited list;
- trees and shrubs must have a forest shape, i.e. separate stem, relatively straight, branching only above a certain level (about 1.5 m), unless a different shape is the result of treatment to obtain a specific type of product (pollarding) or natural deformation (wind or snow) which does not inhibit normal use of the trees;
- the apparent forest tree cover eligible for inventory must be at least 10% of the ground area or, for young forest trees not eligible for inventory, the density must be at least 500 well spaced future shoots per ha;
- the stand must have a minimum area of 5 ares with a crown width of over 15 m.

APPENDIX 2

"Forests available for wood supply (excluding poplar plantations)" refers to forests whose principal function is the production of timber, apart from poplar plantations, and that are accessible to IFN's field survey teams. Among these, certain formations were not inventoried in the field for financial reasons. Certain findings thus only concern "inventoried forests available for wood supply". When poplar plantations are taken into account, the term "including poplar plantations" is added (cf. below).

2.2 ***Thickets***

Teruti survey (physical heading 22)

Forest formation (visible forest tree cover of over 10%) with an area of 5-50 ares, of any shape.

IFN

Forest formations according to IFN (cf. above) with an area of 5-50 ares and a crown width of over 15 m. This definition is more specific than that of the Teruti survey, so the area is much smaller, i.e. around 200,000 ha, or 1.3% of the total forest area. However, thickets were not distinguished from forests in the IFN data since thicket data was not recorded in some old inventories and since the actual proportion of IFN thickets was very small.

2.3 ***Poplar plantations***

Teruti survey: pure and combined poplar plantations (physical headings 24 and 25)

Pure poplar plantations (or plantations jointly cultivated with another type of agricultural crop) with a standing width of over 10 m and an area of 5 ares or more.

IFN: cultivated poplar plantations

Man-made stands consisting of cultivated poplar clones planted at regular intervals. There must be at least 100 poplars per ha (regularly distributed) of which 50 are still alive when the survey team arrives. These stands must also have at least three rows of poplars and a minimum area of 5 ares with a crown width of over 15 m and an interrow spacing of 10 m at most.
Cultivated poplar plantations are inventoried in the field only in the main producing departments.

2.4 ***Heathland, maquis and garrigues** (Teruti survey: physical heading 70) = **Other wooded lands according to FAO***

Formations generally covering large areas with forest cover representing less than 10% of the total area. Grass is the usual plant cover, but at least 25% of the wooded cover must consist of woody or semi-woody plants, such as ferns, heather, broom, gorse, etc. Maquis and garrigues are terms used to describe heathland in the Mediterranean region. In 1993, they were classified under the same physical heading as heathland (former physical heading 71).
Heathland, maquis and garrigues in the Teruti survey are considered as "other wooded lands" according to FAO.

2.5 ***Hedges** (Teruti survey: physical heading 72)*

Compact lines of trees or shrubs separating two sections or bordering one, sometimes functioning as windbreaks, 3-5 m wide (real vegetation coverage for bushy hedges or projection of the crown for wooded hedges). The hedge is monitored within a 15 m radius around the point in order to distinguish bushy hedges (absence of trees with crown) from wooded hedges (presence of trees with crown).

2.6 ***Scattered trees, including poplars** (Teruti survey: physical headings 23 and 26) (*

Forest formations of less than 5 ares, scattered trees (including fruit trees) and trees located in alignments other than hedges. The alignment concept is irrelevant for scattered poplars.

French National Forest Inventory (IFN): dates of field surveys to record data available on 1 January 1989, 1994, 1999 and 2004

Administrative region	Department		Dates of field surveys to record data available on 1 January			
			1989	1994	1999	2004
ALSACE	67	BAS-RHIN	1979	1989	1989	2002
	68	HAUT-RHIN	1978	1988	1988	1999
AQUITAINE	24	DORDOGNE	1982	1992	1992	1992
	33	GIRONDE	1977	1987	1987	1998
	40	LANDES	1978	1988	1988	1999
	47	LOT-ET-GARONNE	1979	1989	1989	2000
	64	PYRENEES-ATLANTIQUES	1985	1985	1995	1995
AUVERGNE	03	ALLIER	1987	1987	1987	2001
	15	CANTAL	1977	1989	1989	1989
	43	HAUTE-LOIRE	1979	1991	1991	2002
	63	PUY-DE-DOME	1976	1988	1988	1988
BASSE-NORMANDIE	14	CALVADOS	1987	1987	1987	2001
	50	MANCHE	1975	1987	1987	2001
	61	ORNE	1975	1988	1988	2001
BOURGOGNE	21	COTE-D'OR	1980	1990	1990	1990
	58	NIEVRE	1985	1985	1996	1996
	71	SAONE-ET-LOIRE	1980	1989	1989	1989
	89	YONNE	1986	1986	1986	1999
BRETAGNE	22	COTES-D'ARMOR	1981	1981	1995	1995
	29	FINISTERE	1981	1981	1996	1996
	35	ILLE-ET-VILAINE	1980	1980	1995	1995
	56	MORBIHAN	1980	1980	1998	1998
CENTRE	18	CHER	1986	1986	1986	1999
	28	EURE-ET-LOIR	1977	1992	1992	1992
	36	INDRE	1973	1988	1997	1997
	37	INDRE-ET-LOIRE	1985	1985	1985	1999
	41	LOIR-ET-CHER	1982	1982	1982	1998
	45	LOIRET	1979	1979	1992	1992
CHAMPAGNE-ARDENNE	08	ARDENNES	1987	1987	1987	1998
	10	AUBE	1983	1983	1994	1994
	51	MARNE	1986	1986	1986	1997
	52	HAUTE-MARNE	1985	1985	1997	1997
CORSE	2A	CORSE DU SUD	1977	1988	1988	1988
	2B	HAUTE-CORSE	1977	1988	1988	1988
FRANCHE-COMTE	25	DOUBS	1982	1982	1994	1994
	39	JURA	1980	1980	1992	1992
	70	HAUTE-SAONE	1984	1984	1996	1996
	90	TERRITOIRE DE BELFORT	1984	1984	1984	1996
HAUTE-NORMANDIE	27	EURE	1975	1988	1988	2003
	76	SEINE-MARITIME	1976	1989	1989	2002
ILE-DE-FRANCE	75	PARIS ET SA ZONE PERIPHERIQUE	1979	1979	1994	1994
	77	SEINE-ET-MARNE	1978	1978	1993	1993
LANGUEDOC-ROUSSILLON	11	AUDE	1978	1989	1989	1989
	30	GARD	1982	1982	1993	1993
	34	HERAULT	1983	1983	1997	1997
	48	LOZERE	1979	1979	1992	1992
	66	PYRENEES-ORIENTALES	1980	1991	1991	1991

APPENDIX 3

Administrative region	Department		Dates of field surveys to record data available on 1 January			
			1989	1994	1999	2004
LIMOUSIN	19	CORREZE	1980	1990	1990	2003
	23	CREUSE	1981	1991	1991	1991
	87	HAUTE-VIENNE	1981	1991	1991	1991
LORRAINE	54	MEURTHE-ET-MOSELLE	1980	1990	1990	1990
	55	MEUSE	1980	1980	1991	1991
	57	MOSELLE	1982	1982	1993	1993
	88	VOSGES	1981	1981	1992	1992
MIDI-PYRENEES	09	ARIEGE	1978	1990	1990	1990
	12	AVEYRON	1981	1981	1994	1994
	31	HAUTE-GARONNE	1975	1987	1987	2000
	32	GERS	1979	1989	1989	2001
	46	LOT	1980	1990	1990	2002
	65	HAUTES-PYRENEES	1974	1986	1997	1997
	81	TARN	1979	1992	1992	1992
	82	TARN-ET-GARONNE	1979	1989	1989	2001
NORD - PAS-DE-CALAIS	59	NORD	1986	1986	1986	2000
	62	PAS-DE-CALAIS	1986	1986	1986	2000
PAYS DE LA LOIRE	44	LOIRE-ATLANTIQUE	1985	1985	1985	2000
	49	MAINE-ET-LOIRE	1983	1983	1997	1997
	53	MAYENNE	1983	1983	1983	1999
	72	SARTHE	1984	1984	1984	1999
	85	VENDEE	1984	1984	1994	1994
PICARDIE	02	AISNE	1977	1991	1991	1991
	60	OISE	1976	1990	1990	2001
	80	SOMME	1976	1989	1989	2002
POITOU-CHARENTES	16	CHARENTE	1983	1983	1993	1993
	17	CHARENTE-MARITIME	1984	1984	1993	1993
	79	DEUX-SEVRES	1985	1985	1995	1995
	86	VIENNE	1986	1986	1996	1996
PROVENCE-ALPES-COTE D'AZUR	04	ALPES DE HAUTE-PROVENCE	1984	1984	1984	1999
	05	HAUTES-ALPES	1983	1983	1983	1997
	06	ALPES-MARITIMES	1985	1985	1985	2002
	13	BOUCHES-DU-RHONE	1977	1988	1988	1988
	83	VAR	1986	1986	1986	1999
	84	VAUCLUSE	1986	1986	1986	2001
RHONE-ALPES	01	AIN	1983	1983	1995	1995
	07	ARDECHE	1981	1981	1995	1995
	26	DROME	1982	1982	1996	1996
	38	ISERE	1984	1984	1997	1997
	42	LOIRE	1981	1981	1993	1993
	69	RHONE	1982	1982	1994	1994
	73	SAVOIE	1985	1985	1985	2000
	74	HAUTE-SAVOIE	1975	1987	1987	1998

Summary table of forest areas (in Kha)

The following table summarises the different forest areas referred to in this document.
The Service central des enquêtes et études statistiques (SCEES) presents forest areas for real years (1993, 1998, 2003).
Data of the Inventaire forestier national (IFN) available for 1 January 1989, 1994, 1999 and 2004 respectively correspond to the mean years 1981, 1986, 1991 and 1996 due to the method used until present.
Forest areas were also derived from cartographic analyses (prior to application of afforestation rates) or statistical analyses. Finally, as some forests were not surveyed in the field, data for some indicators could not be obtained for the entire forest area.
IFN adopted new systematic annual inventory method in 2005 in order to overcome these different problems.

SCEES/Teruti survey (real year)	**1993**	**1998**	**2003**
woodland and forest area (18-21)	14,592	14,985	15,168
poplar plantation area (24, 25)	219	235	240
Total woodland-forest-poplar plantation area (excl. thickets)	**14,811**	**15,220**	**15,408**

IFN - statistical data		**available on**	**01/01/1989**	**01/01/1994**	**01/01/1999**	**01/01/2004**
(mean field survey year)			(1981)	(1986)	(1991)	(1996)
IFN production forests	Not inventoried	By IFN choice	0	127	270	270
		Inaccessible	22	14	7	3
	Subtotal Not inventoried		**22**	**141**	**277**	**273**
	Inventoried	Unstocked	93	137	139	115
		Not unstocked	13,244	13,307	13,458	13,706
	Subtotal Inventoried		**13,337**	**13,444**	**13,597**	**13,821**
Subtotal IFN production forests			**13,359**	**13,585**	**13,874**	**14,094**
including forests available for wood supply according to FAO*			**13,337**	**13,571**	**13,867**	**14,091**
Other forests	Not inventoried		578	607	672	784
	Inventoried		0	0	0	0
Subtotal Other forests			**578**	**607**	**672**	**784**
All forests (excl. poplar plantations)	Not inventoried		600	748	949	1,057
	Inventoried		13,337	13,444	13,597	13,821
Subtotal All forests (excl. poplar plantations)			**13,937**	**14,192**	**14,546**	**14,878**
Poplar plantations	Not inventoried		52	49	56	68
	Inventoried		150	153	151	152
Subtotal poplar plantations			**202**	**202**	**207**	**220**
Total Forests and poplar plantations	Not inventoried		652	797	1,005	1,125
	Inventoried		13,487	13,597	13,748	13,973
Total All forests (including thickets) and poplar plantations			**14,139**	**14,394**	**14,753**	**15,098**

IFN - cartographic data	**available on**	**01/01/1999**	**01/01/2004**
(mean year of photographs)		(1990)	(1995)
area mapped (before application of afforestation rate)		15,659	16,023

* IFN production forests excl. inaccessible

APPENDIX 5

List of trees found in French forests

➪ *Note : this list was drawn up with the help of Mr Jean-Claude Rameau (ENGREF), based on two sources, i.e. lists of the Inventaire forestier national and the guide "Flore forestière française, guide écologique illustré", by Rameau et al., 1989 and 1993. It was further supplemented by INRA and AFOCEL. This selection overlooks a certain number of exotic species that generally occur in small more or less experimental areas.*

List of trees indigenous to France and found in forests

	CONIFERS				
1	*Abies alba*	silver fir	9	*Pinus mugo*	dwarf mountain pine
2	*Juniperus communis*	common juniper	10	*Pinus nigra laricio corsicana*	Corsican pine
3	*Juniperus oxycedrus*	prickly juniper, cade	11	*Pinus laricio salzmannii*	Pyrenean pine
4	*Juniperus thurifera*	Spanish juniper, savin	12	*Pinus pinaster*	maritime pine
5	*Larix decidua*	European larch	13	*Pinus pinea*	stone or umbrella pine
6	*Picea abies*	common spruce	14	*Pinus sylvestris*	Scots pine
7	*Pinus cembra*	arolla pine	15	*Pinus uncinata*	mountain pine
8	*Pinus halepensis*	Aleppo pine	16	*Taxus baccata*	yew
	BROADLEAVED				
1	*Acer campestre*	field maple	30	*Pyrus amygdaliformis*	almond-leaved pear
2	*Acer monspessulanum*	Montpellier maple	31	*Pyrus pyraster*	wild pear
3	*Acer opalus*	Italian maple	32	*Quercus cerris*	Turkey oak
4	*Acer platanoides*	Norway maple	33	*Quercus ilex*	holm oak
5	*Acer pseudoplatanus*	sycamore	34	*Quercus petraea*	sessile oak
6	*Alnus cordata*	Corsican alder	35	*Quercus pubescens*	pubescent oak
7	*Alnus glutinosa*	common alder	36	*Quercus pyrenaica*	Pyrenean oak
8	*Alnus incana*	grey alder	37	*Quercus robur*	pedunculate oak
9	*Betula pendula*	silver birch	38	*Quercus suber*	cork oak
10	*Betula pubescens*	hairy birch	39	*Salix alba*	white willow
11	*Carpinus betulus*	hornbeam	40	*Salix caprea*	sallow, goat willow
12	*Castanea sativa*	sweet chestnut	41	*Salix daphnoides*	violet willow
13	*Cornus mas*	cornelian cherry	42	*Salix fragilis*	crack willow
14	*Crataegus monogyna*	common hawthorn	43	*Salix pentandra*	bay-leaved willow
15	*Fagus sylvatica*	beech	44	*Salix viminalis*	common osier
16	*Fraxinus angustifolia*	narrow-leaved ash	45	*Sambucus nigra*	elder
17	*Fraxinus excelsior*	common ash	46	*Sorbus aria*	common whitebeam
18	*Fraxinus ornus*	manna or flowering ash	47	*Sorbus aucuparia*	rowan, mountain ash
19	*Ilex aquifolium*	holly	48	*Sorbus domestica*	service tree
20	*Malus sylvestris*	crab apple	49	*Sorbus latifolia*	service tree of Fontainebleau
21	*Olea europaea*	olive	50	*Sorbus mougeoti*	Mougeot service tree
22	*Ostrya carpinifolia*	hop-hornbeam	51	*Sorbus torminalis*	wild service tree
23	*Populus alba*	white poplar	52	*Tamarix gallica*	tamarisk
24	*Populus canescens*	grey poplar	53	*Tilia argentea*	silver-leaved lime
25	*Populus nigra*	black poplar	54	*Tilia cordata*	small-leaved lime
26	*Populus tremula*	aspen	55	*Tilia platyphyllos*	broad-leaved lime
27	*Prunus avium*	wild cherry	56	*Ulmus glabra*	wych elm
28	*Prunus brigantina*	Briançon apricot	57	*Ulmus laevis*	European white elm
29	*Prunus padus*	bird cherry	58	*Ulmus minor*	lock elm

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

An acclimatized tree is one which: 1) was introduced long enough ago to have clearly shown, over more than one generation, that it is well adapted to the environmental and climatic conditions prevailing in France; and which 2) can reproduce naturally in forests, without human intervention.

	CONIFERS			**BROADLEAVED**	
1	*Abies nordmanniana*	Caucasina fir	1	*Juglans regia*	common walnut
2	*Cedrus atlantica*	Atlas cedar	2	*Quercus rubra*	red oak
3	*Cupressus sempervirens*	Italian or funeral cyprus	3	*Robinia pseudacacia*	false acacia
4	*Pinus nigra nigra*	Austrian pine			
5	*Pinus nigra laricio calabrica*	Calabrian pine			
6	*Pseudotsuga menziesii*	Douglas fir			

List of exotic trees sometimes found in forests

	CONIFERS			**BROADLEAVED**	
1	*Abies bornmulleriana*	Turkish fir	1	*Acacia dealbata*	mimosa
2	*Abies cephalonica*	Greek fir	2	*Acer negundo*	box elder
3	*Abies cilicica*	Cilician fir	3	*Aesculus hippocastanum*	horse chestnut
4	*Abies concolor*	Colorado fir	4	*Ailanthus altissima*	tree of heaven
5	*Abies grandis*	Vancouver fir	5	*Celtis australis*	nettle tree
6	*Abies numidica*	Numidian fir	6	*Eucalyptus sp*	eucalyptus
7	*Abies pinsapo*	Spanish or hedgehog fir	7	*Juglans nigra*	black walnut
8	*Abies procera*	noble fir	8	*Gleditschia triacanthos*	honey locust
9	*Calocedrus decurrens*	California incense tree	9	*Laburnum anagyroïdes*	laburnum
10	*Cedrus brevifolia*	Cyprus cedar	10	*Liquidambar styraciflua*	liquidambar
11	*Cedrus deodara*	deodar	11	*Liriodendron tulipifera*	tulip tree
12	*Cedrus libani*	cedar of Lebanon	12	*Platanus hybrida*	London plane
13	*Chamaecyparis lawsoniana*	Lawson cypress	13	*Platanus orientalis*	Oriental plane
14	*Cryptomeria japonica*	Japanese red cedar	14	*Populus deltoides*	eastern cottonwood
15	*Cupressocyparis leylandii*	Leyland cypress	15	*Populus trichocarpa*	black cottonwood
16	*Cupressus arizonica*	Arizona cypress	16	*Prunus laurocerasus*	cherry laurel
17	*Cupressus atlantica*	Atlas cypress	17	*Prunus lusitanica*	Portuguese laurel
18	*Cupressus dupreziana*	Tassili cypress	18	*Prunus serotina*	black cherry
19	*Cupressus macrocarpa*	Monterey cypress	19	*Quercus palustris*	pin oak
20	*Larix eurolepis*	Dunkeld larch			
21	*Larix kaempferi*	Japanese larch			
22	*Metasequoia glyptostroboides*	dawn redwood			
23	*Picea sitchensis*	Sitka spruce			
24	*Pinus brutia*	Turkish pine			
25	*Pinus contorta*	lodgepole pine			
26	*Pinus eldarica*	eldarica pine			
27	*Pinus radiata*	Monterey pine			
28	*Pinus rigida*	northern pitch pine			
29	*Pinus strobus*	Weymouth pine			
30	*Pinus taeda*	incense pine			
31	*Sequoia sempervirens*	redwood			
32	*Sequoiadendron giganteum*	wellingtonia, giant sequoia			
33	*Taxodium distichum*	swamp or bald cypress			
34	*Thuja plicata*	western red cedar			
35	*Tsuga heterophylla*	western hemlock			

APPENDIX 6

List of forest species observed by the French National Forest Inventory (IFN) in its dendrometric surveys

A tree is a woody plant with a single stem that is bare at the base, including a trunk and a crown, and which can grow to more than 7 m high in the adult stage.

	BROADLEAVED				
02	*Quercus robur*	pedunculate oak	23	*Pirus communis*	pear
03	*Quercus petraea*	sessile oak		*Pirus malus*	apple
04	*Quercus rubra*	red oak		*Prunus amygdalus*	almond
05	*Quercus pubescens*	pubescent oak		*Prunus domestica*	plum
06	*Quercus ilex*	holm oak		*Sorbus aria*	common whitebeam
07	*Quercus pyrenaica*	Pyrenean oak		*Sorbus aucuparia*	rowan, mountain ash
08	*Quercus suber*	cork oak		*Sorbus domestica*	service tree
09	*Fagus sylvatica*	beech		*Sorbus latifolia*	service tree of Fontainebleau
10	*Castanea sativa*	chestnut		*Sorbus mougeoti*	Mougeot service tree
11	*Carpinus betulus*	hornbeam		*Ficus carica*	fig
12	*Betula pubescens*	hairy birch			
	Betula pendula	silver birch	24	*Populus tremula*	aspen
13	*Alnus glutinosa*	common alder	25	*Salix* sp.	willow (all species except creeping or bushy willows)
	Alnus incana	grey alder			
	Alnus cordata	Italian or Corsican alder			
14	*Robinia pseudacacia*	false acacia	26	*Platanus acerifolia*	London plane
15	*Acer platanoides*	Norway maple		*Platanus occidentalis*	American plane
	Acer pseudoplatanus	sycamore		*Platanus orientalis*	Oriental plane
16	*Celtis australis*	nettle tree	27	*Juglans regia*	common walnut
17	*Fraxinus excelsior*	common ash		*Juglans nigra*	black walnut
	Fraxinus angustifolia	narrow-leaved ash	28	*Olea europaea*	olive
	Fraxinus ornus	manna or flowering ash	29		other exotic hardwoods
18	*Ulmus minor*	lock elm	30	*Morus alba*	white mulberry
	Ulmus glabra	wych elm		*Morus nigra*	black mulberry
	Ulmus levis	European white elm	31	*Corylus avellana*	hazel
19	*Populus nigra, deltoides*	cultivated poplars	32	*Ostrya carpinifolia*	hop-hornbeam
	trichocarpa et hybrides		33	*Populus* sp.	Italian poplar & various non-cultivated species (e.g. white poplar)
20	*Tilia cordata*	small-leaved lime			
	Tilia platyphyllos	broad-leaved lime			
21	*Acer campestris*	field maple	34	*Quercus cerris*	Turkey oak
	Acer opalus	Italian maple	35	*Tamarix* sp.	tamarisk
	Acer Monspessulanum	Montpellier maple	36	*Eucalyptus* sp.	eucalyptus
22	*Prunus avium*	wild cherry	37	*Alnus viridis*	green alder
	Prunus cerasus	cherry	38	*Laburnum anagyroides*	laburnum
	Prunus padus	bird cherry		*Laburnum alpinum*	Alpine laburnum
			39	*Cornus mas*	cornelian cherry
			40	*Arbutus unedo*	arbutus
			41	*Sorbus torminalis*	wild service tree
			49		other indigenous broadleaved species
	CONIFERS				
51	*Pinus pinaster*	maritime pine	61	*Abies alba*	silver fir
52	*Pinus sylvestris*	Scots pine	62	*Picea abies*	common spruce
53	*Pinus nigra laricio corsicana*	Corsican pine	63	*Larix decidua*	European larch
	Pinus nigra laricio calabrica	Calabrian pine	64	*Pseudotsuga menziesii*	Douglas fir
	Pinus laricio salzmannii	Pyrenean pine	65	*Cedrus atlantica*	Atlas cedar
54	*Pinus nigra nigra*	Austrian pine	66	*Cupressus sempervirens*	Italian or funeral cypress
55	*Pinus pinea*	stone or umbrella pine	67	*Taxus baccata*	yew
56	*Pinus strobus*	Weymouth pine	68		other exotic conifers
57	*Pinus halepensis*	Aleppo pine	69	*Juniperus thurifera*	Spanish juniper, savin
	Pinus brutia (or eldarica)	Turkish pine	71	*Abies nordmanniana*	Caucasian fir
58	*Pinus uncinata*	mountain pine	72	*Abies grandis*	Vancouver fir
59	*Pinus cembra*	arolla pine	73	*Picea sitchensis*	Sitka spruce
60	*Pinus mugo*	dwarf mountain pine	74	*Larix leptolepis*	Dunkeld larch
			75		Other indigenous conifers

n.b. The numbers indicate the species groupings used in the dendrometric surveys
(all species are included in the floristic surveys)

Appendix 7 - IFN logging classification

LOGGING CLASS	LOGGING TRAIL	HAULING DISTANCE	SLOPE	TYPE OF TERRAIN
EASY	None "	< 1000 m < 200 m	< 15% 15 - 30%	level and manageable level and manageable
MEDIUM	None " " "	200 - 1000 m " < 200 m 1000 - 2000 m	15 - 30% < 15% < 30% < 15%	level and manageable rugged or wet rugged or wet level and manageable
DIFFICULT	None " " " " " Trail to build	< 200 m 200 - 1000 m " 1000 - 2000 m " > 2000 m any	> 30% 15 - 30% > 30% < 15% > 15% any any	any rugged or wet any rugged or wet any any any
VERY DIFFICULT	Trail impossible (cable hauling, helitransport,...)	any	any	any

Appendix 8 - Certified sustainably managed forest area

Forest ownership category	Certified forest area in 2004			
	PEFC		FSC	
	ha	% forest area	ha	% forest area
state-owned forest	1,561,800	99.3%	0	0.0%
other public forest governed by forest regulations	847,900	33.9%	0	0.0%
private forest	1,181,500	10.4%	15, 300	0.1%
Total	**3,591,200**	**23.3%**	**15, 300**	**0.1%**

(Source: Program for the Endorsement of Forest Certification schemes (PEFC), situation on 30/11/04 and the Forest Stewardship Council (FSC), situation on 10/11/04; forest area according to SCEES/Teruti 2003 classified per property according to IFN data from the last inventory; PEFC and FSC certified forest areas sometimes apply to the same forests)

APPENDIX 9

List of threatened species

Vascular plants outside the Mediterranean region

1) species exclusively or very often found in forests

Bell flower	*Campanula cervicaria*	Rare
Atlantic polystichum	*Dryopteris aemula*	Vulnerable
Shield fern	*Dryopteris cristata*	Endangered
Dame's violet	*Hesperis inodora*	Vulnerable
Holly fern	*Polystichum braunii*	Vulnerable

2) species with mixed behaviour, found to an equal extent in forests and open areas

Centaury ssp. aemilii	*Centaurea balbisiana aemilii*	Vulnerable
Centaury ssp. jordaniana	*Centaurea balbisiana jordaniana*	Rare
Centaury ssp. verguini	*Centaurea balbisiana verguini*	Vulnerable
Centaury ssp. albida	*Centaurea maculosa albida*	Endangered
Cotoneaster delphinensis	*Cotoneaster delphinensis*	Vulnerable
Dauphinium requienii	*Delphinium requienii*	Vulnerable
Knautia lebrunii	*Knautia lebrunii*	Endangered
Leucojum fabrei	*Leucojum fabrei*	Endangered
Senecio ruthienensis	*Senecio ruthienensis*	Vulnerable

Mammals

1) species exclusively or very often found in forests

Western barbastelle	*Barbastella barbastellus*	Vulnerable
Northern bat	*Eptesicus nilssoni*	Rare
Lynx	*Lynx lynx*	Endangered
Bechstein's bat	*Myotis bechsteini*	Vulnerable
Lesser mouse-eared bat	*Myotis blythii*	Vulnerable
Brandt's bat	*Myotis brandti*	Rare
Geoffrey's bat	*Myotis emarginatus*	Vulnerable
Large mouse-eared bat	*Myotis myotis*	Vulnerable
Lesser noctule	*Nyctalus leisleri*	Vulnerable
Noctule	*Nyctalus noctula*	Vulnerable
Mediterranean horseshoe bat	*Rhinolophus euryale*	Vulnerable
Great horseshoe bat	*Rhinolophus ferrumequinum*	Vulnerable
Lesser horseshoe bat	*Rhinolophus hipposideros*	Vulnerable
Brown bear	*Ursus arctos*	Endangered

2) species with mixed behaviour, found to an equal extent in forests and open areas

European mink	*Mustela lutreola*	Endangered
Long-fingered bat	*Myotis capaccinii*	Vulnerable
Alpine shrew mouse	*Sorex alpinus*	Rare
Parti-coloured bat	*Vespertilio murinus*	Rare

Birds

1) species exclusively or very often found in forests

Siskin	*Carduelis spinus*	Rare
Black stork	*Ciconia nigra*	Vulnerable
White-backed woodpecker	*Dendrocopos leucotos*	Rare
Pygmy owl	*Glaucidium passerinum*	Rare
Booted eagle	*Hieraaetus pennatus*	Rare
Three-towed woodpecker	*Picoides tridactylus*	Vulnerable

2) species with mixed behaviour, found to an equal extent in forests and open areas

Eagle owl	*Bubo bubo*	Rare
Scarlet grosbeak	*Carpodacus erythrinus*	Vulnerable
Short-toed eagle	*Circaetus gallicus*	Rare
Great spotted cuckoo	*Clamator glandarius*	Rare
Roller	*Coracias garrulus*	Rare
Black-shouldered kite	*Elanus caeruleus*	Vulnerable
Lanius (excubitor) meridionalis	*Lanius (excubitor) meridionalis*	Vulnerable
Lesser grey shrike	*Lanius minor*	Endangered
Osprey, bald buzzard	*Pandion haliaetus*	Vulnerable
Spectacled warbler	*Sylvia conspicillata*	Vulnerable

Reptiles

1) species exclusively or very often found in forests: none

2) species with mixed behaviour, found to an equal extent in forests and open areas

Pygmy lizard	*Algyroides fitzingeri*	Rare
Testudo hermanni	*Testudo hermanni*	Vulnerable

Amphibians

1) species with mixed behaviour, found to an equal extent in forests and open areas: none

2) species with mixed behaviour, found to an equal extent in forests and open areas

Fire-belly toad	*Bombina variegata*	Vulnerable
European tree frog	*Hyla arborea*	Vulnerable
Triturus alpestris	*Triturus alpestris*	Vulnerable
Great water newt	*Triturus cristatus*	Vulnerable
Marbled newt	*Triturus marmoratus*	Vulnerable

(Source: Muséum national d'histoire naturelle, working document 2000)

APPENDIX 10

List of arboretums with public access

(Source: ENGREF/Arboretum national des Barres, 2005)

Name	Address	Postal code	Town	public arboretum network affiliation
Jardin botanique de la Mhotte		03210	SAINT-MENOUX	
Arboretum de Balaine		03460	VILLENEUVE-sur-ALLIER	
Jardin botanique des Cordeliers	Collège Maria Borelly	04000	DIGNE-les-BAINS	
Jardin ethnobotanique de Salagon	Prieure de Salagon	04300	MANE	
Jardin alpin du Lautaret	Col du Lautaret	05220	LE MONETIER-les-BAINS	
Jardin botanique de la ville de Nice	78, corniche fleurie	06000	NICE	
Parc floral Phoenix	405, promenade des Anglais	06000	NICE	
Jardin botanique exotique, Villa Val Rameh	Avenue Saint Jacques	06500	MENTON	
Jardin botanique de la villa Thuret	61, boulevard du Cap - BP 2078	06606	ANTIBES Cedex	x
Parc botanique de la Tour Veille	Avenue d'Anduze	30100	ALES EN CEVENNES	
Les Jardins du Nouveau Monde		02300	BLERANCOURT	
L'Ami des Plantes		06220	VALLAURIS	
Arboretum Saint-Antoine		10130	EVRY-le-CHATEL	
Arboretum de Villardebelle		11580	VILLARDEBELLE	
Jardin botanique de la ville de Marseille	48, avenue clot Bey	13008	MARSEILLE	
Jardin botanique de la ville et de l'Université de Caen	5, place Blot	14000	CAEN	
Arboretum de Grimbosq		14220	GRIMBOSQ	
Arboretum d'Arpajon/Cère		15130	ARPAJON/CERE	
Arboretum du Chêne Vert		16150	CHABANAIS	
Parc floral d'Apremont	Apremont-sur-Allier	18150	LA GUERCHE-sur-l'AUBOIS	
Jardin botanique de l'Arquebuse	1, avenue Albert 1er	21033	DIJON	
Les jardins de Kerdalo		22220	TREDARZEC	
La Roche Branlante Jean Laborey	Chemin des douaniers	22270	PLOUMANAC'H	
Arboretum de Neuvic		24190	NEUVIC	
Jardin botanique de la ville et de l'Université de Besançon	Place du Maréchal Leclerc	25000	BESANÇON	
Arboretum d'Harcourt		27800	HARCOURT	
Jardin botanique de Cornouaille	Pont l'Abbé	29120	COMBRIT	
Parc du château de Trevarez		29250	SAINT GOAZEC	
Keroniel (M. Jean Lennon)	10, rue Pasteur	29307	ELLIANT	
Jardin exotique de Roscoff	Roc'h Hievec, route de Car Ferry	29680	ROSCOFF	
Arboretum du Poerop	Le Poerop	29690	HUELGOAT	
Bambouseraie de Prafrance		30140	ANDUZE	
Arboretum de la Foux	Forêt domaniale de l'Aigoual	30570	SAINT SAUVEUR DES POURCILS	
Arboretum de l'Hort de Dieu	Forêt domaniale de l'Aigoual	30570	VALERAUGUE	
Jardin des plantes de Toulouse	Allée frédéric Mistral - 35, allée Jules Guesde	31000	TOULOUSE	
Arboretum de Jouéou		31110	BAGNERES DE LUCHON	
Arboretum Coursiana		32480	LA ROMIEU	
Arboretum de la Bordette		32480	LA ROMIEU	
Jardin botanique de Bordeaux	Terrasses du jardin public, Place Bardineau	33000	BORDEAUX	
Jardin des plantes	163, rue Auguste Broussonnet	34000	MONTPELLIER	
Jardin botanique de la ville de Rennes	5, boulevard de la Duchesse Anne	35000	RENNES	
Jardin botanique de Tours	33, boulevard Tonnelé	37000	TOURS	
Jardin des plantes	Rue Dolomieu	38000	GRENOBLE	
Arboretum de Chevreuil, forêt domaniale de la Joux		39300	SUPT-CHAMPAGNOLE	
Parc botanique de la Fosse		41800	FONTAINE LES COTEAUX	
Arboretum des Grands Murcins		42370	ARCON	
Jardin des plantes	Rue Stanislas Baudry	44000	NANTES	
Parc du Grand Blottereau	Boulevard Auguste-Péneau	44000	NANTES	

Name	Address	Postal code	Town	public arboretum network affiliation
Jardin des plantes	Route de Saint-Mesmin	45000	ORLEANS	
Arboretum des prés des Culands		45130	MEUNG SUR LOIRE	
Arboretum national des Barres	Domaine des Barres	45290	NOGENT SUR VERNISSON	x
Le Jardin de l'Arbre		45290	VARENNES CHANGY	
Arboretum des Grandes Bruyères		45450	INGRANNES	
Arboretum Gaston Allard	Rue du château d'Orgemont	49000	ANGERS	
La Roche Fauconnière		50100	CHERBOURG	
Jardin botanique de Vauville	Vauville	50440	BEAUMONT SUR HAGUE	
Arboretum d'Amance	INRA, Centre de recherche de Nancy	54280	CHAMPENOUX	x
Conservatoire botanique national de Nancy	Jardin du Montet	54600	VILLIERS LES NANCY	
Jardin botanique	27 ter, rue de Pont-à-Mousson	57950	MONTIGNY LES METZ	
Arboretum de Boulogne	BP 729	62321	BOULOGNE SUR MER	
Arboretum de Royat	33, rue Eugène Gilbert	63000	CLERMONT FERRAND	
Arboretum de Tournay		65190	TOURNAY	
Jardin botanique de l'Université de Strasbourg	28, rue Goethe	67000	STRASBOURG	
Jardin botanique du col de Saverne	RN 4	67700	SAVERNE	
Jardin botanique de Lyon	Parc de la Tête d'Or	69000	LYON	
Arboretum de Pézanin		71970	DOMPIERRE LES ORMES	x
Jardin des plantes du Mans	4, rue de Sinault	72000	LE MANS	
Jardin des Plantes, Museum National d'Histoire Naturelle	57, rue Cuvier	75007	PARIS	
Arboretum de l'Ecole du Breuil	Route de la ferme - Bois de Vincennes	75012	PARIS	
Parc de Bagatelle	Route de Sèvres, Bois de Boulogne	75016	PARIS	
Jardin des plantes de Rouen	114, ter avenue des Martyrs de la résistance	76100	ROUEN	
Jardin Vastérival (uniquement sur RV)		76119	SAINT MARGUERITE SUR MER	
Arboretum du parc de Rouelles	Rouelles	76610	LE HAVRE	
Domaine national de Versailles et du Trianon	Château de Versailles	78000	VERSAILLES	
Arboretum de Chèvreloup	30, route de Versailles	78150	ROCQUENCOURT	x
Arboretum et jardin botanique	Institut national agronomique Paris Grignon	78850	THIVERVAL GRIGNON	
Arboretum du Parc du Château de Rambures		80140	RAMBURES	
Jardin botanique de Samara		80310	LA CHAUSSEE TRIANCOURT	
Jardins méditerranéens du Domaine du Rayol	Avenue du commandant Rigaud	83820	LE RAYOL CANADEL	
Jardin des plantes de Poitiers	Rue du Jardin des Plantes, boulevard Chasseigne	86000	POITIERS	
Jardin botanique de Limoges et jardin de l'évêché	Place de la cathédrale	87000	LIMOGES	
Arboretum de la Jonchère Saint-Maurice		87340	LA JONCHERE SAINT MAURICE	x
Maison des arbres et des oiseaux - Arboretum municipal	Mairie	91370	VERRIERES LE BUISSON	
Réserve naturelle Roger de Vilmorin - Arboretum	1, Voie de l'Aulne	91370	VERRIERES LE BUISSON	
Parc de la Faculté des sciences d'Orsay	3, rue Georges Clémenceau	91405	ORSAY	x
Arboretum de la vallée aux Loups	46, rue de Chateaubriand	92290	CHATENAY MALABRY	
Jardin exotique de Monaco	62, boulevard du jardin exotique	98000	MONACO	

APPENDIX 11

Detailed tables by paragraph (IFN and Teruti data)

Appendix to § 1.1.1 Forest area gains and losses

SCEES/Teruti transition matrix for 1997/2003 per pooled category (units: ha)

Codes	11 - 15	16, 17	18 - 21	22, 23, 26	24, 25	27 - 67	69 - 70	72	68, 73, 84	74 - 83, 85 - 91, 99	Total 2003
11 - 15	934,837	1,694	4,624	3,300	1,703	21,530	3,698	911	3,046	6,891	**982,234**
16, 17	2,798	790,880	7,485	491	0	16,172	11,369	0	302	697	**830,194**
18 - 21	6,243	17,352	14,673,903	79,646	9,954	122,051	229,212	7,312	6,747	15,787	**15,168,207**
22, 23, 26	2,047	497	41,527	796,356	2,101	18,529	19,678	11,199	11,214	5,761	**908,909**
24, 25	305	0	6,982	1,801	209,287	17,817	3,288	302	300	53	**240,135**
27 - 67	10,775	35,170	68,024	31,784	5,109	28,710,005	261,343	22,873	50,943	44,985	**29,241,011**
69, 70	3,645	25,767	78,463	12,335	2,252	326,851	1,760,226	2,292	12,602	16,090	**2,240,523**
72	2,012	0	8,238	19,398	803	17,637	6,346	545,537	3,758	4,047	**607,776**
68, 73, 84	2,002	802	11,257	13,767	599	152,816	36,117	6,306	1,209,121	61,120	**1,493,907**
74 - 83, 85 - 91, 99	3,548	1,297	33,922	12,349	897	190,354	44,880	6,450	68,003	2,844,689	**3,206,389**
Total 1997	**968,212**	**873,459**	**14,934,425**	**971,227**	**232,705**	**29,593,762**	**2,376,157**	**603,182**	**1,366,036**	**3,000,120**	**54,919,285**

Legend:
11 - 15: water and wetlands
16, 17: soil with outcropping parent rock (rocks, talus, dunes, etc.)
18 - 21: woodland and forests
22, 23, 26: thickets and scattered trees
24, 25: poplar plantations and associated
27 - 67: farmland in use
69, 70: heathland (including garrigues and maquis) and fallow land
72: hedges
68, 73, 84: grassland, trails and ornamental gardens
74 - 83, 85 - 91, 99: man-made areas +/- structures, prohibited areas

(Source: Agreste/Teruti n° 157; March 2004)

Appendix to § 1.1.3 Forest area by IFN forest structure

1) Forest stands available for wood production (excluding poplar plantations)

Administrative region	Forest structure	1989		1994		1999		2004		1994-2004
		ha	%	ha	%	ha	%	ha	%	annual variation rate
ALSACE	regular high forest	230,890	77.1%	248,110	80.7%	248,110	80.7%	253,420	82.4%	0.2%
	irregular high forest	110	0.0%	1,660	0.5%	1,660	0.5%	3,600	1.2%	8.1%
	coppice	23,060	7.7%	18,570	6.0%	18,570	6.0%	12,050	3.9%	-4.2%
	mixed coppice/broadleaved high forest	38,580	12.9%	33,700	11.0%	33,700	11.0%	27,760	9.0%	-1.9%
	mixed coppice/conifer high forest	4,530	1.5%	3,250	1.1%	3,250	1.1%	5,430	1.8%	5.3%
	temporarily unstocked*	2,230	0.7%	2,080	0.7%	2,080	0.7%	5,150	1.7%	9.5%
Total ALSACE		**299,400**	**100.0%**	**307,370**	**100.0%**	**307,370**	**100.0%**	**307,410**	**100.0%**	**0.0%**
AQUITAINE	regular high forest	1,121,550	66.1%	1,099,470	64.8%	1,098,930	64.2%	1,119,680	64.4%	0.2%
	irregular high forest	58,120	3.4%	43,550	2.6%	61,480	3.6%	61,990	3.6%	3.6%
	coppice	170,820	10.1%	147,530	8.7%	143,830	8.4%	139,920	8.1%	-0.5%
	mixed coppice/broadleaved high forest	212,220	12.5%	230,210	13.6%	230,620	13.5%	261,800	15.1%	1.3%
	mixed coppice/conifer high forest	96,010	5.7%	101,300	6.0%	101,420	5.9%	104,580	6.0%	0.3%
	temporarily unstocked*	37,450	2.2%	75,000	4.4%	75,390	4.4%	49,720	2.9%	-4.0%
Total AQUITAINE		**1,696,170**	**100.0%**	**1,697,060**	**100.0%**	**1,711,680**	**100.0%**	**1,737,680**	**100.0%**	**0.2%**
AUVERGNE	regular high forest	302,990	46.6%	342,770	50.4%	342,770	50.4%	376,070	55.2%	0.9%
	irregular high forest	144,460	22.2%	125,490	18.5%	125,490	18.5%	99,830	14.7%	-2.3%
	coppice	74,800	11.5%	56,770	8.4%	56,770	8.4%	53,490	7.9%	-0.6%
	mixed coppice/broadleaved high forest	98,050	15.1%	113,000	16.6%	113,000	16.6%	106,910	15.7%	-0.6%
	mixed coppice/conifer high forest	23,830	3.7%	37,290	5.5%	37,290	5.5%	39,070	5.7%	0.5%
	temporarily unstocked*	5,870	0.9%	4,360	0.6%	4,360	0.6%	5,450	0.8%	2.3%
Total AUVERGNE		**650,020**	**100.0%**	**679,670**	**100.0%**	**679,670**	**100.0%**	**680,830**	**100.0%**	**0.0%**
BASSE-NORMANDIE	regular high forest	63,170	43.5%	77,860	52.9%	77,860	52.9%	101,190	62.7%	2.7%
	irregular high forest	0	0.0%	0	0.0%	0	0.0%	430	0.3%	
	coppice	17,500	12.1%	15,580	10.6%	15,580	10.6%	19,290	11.9%	2.2%
	mixed coppice/broadleaved high forest	62,450	43.0%	45,140	30.6%	45,140	30.6%	32,280	20.0%	-3.3%
	mixed coppice/conifer high forest	1,500	1.0%	6,820	4.6%	6,820	4.6%	4,390	2.7%	-4.3%
	temporarily unstocked*	480	0.3%	1,910	1.3%	1,910	1.3%	3,900	2.4%	7.4%
Total BASSE-NORMANDIE		**145,090**	**100.0%**	**147,310**	**100.0%**	**147,310**	**100.0%**	**161,470**	**100.0%**	**0.9%**
BOURGOGNE	regular high forest	175,540	18.8%	220,850	23.0%	234,230	24.4%	241,400	25.1%	0.9%
	irregular high forest	37,200	4.0%	22,110	2.3%	19,340	2.0%	23,070	2.4%	0.4%
	coppice	86,790	9.3%	86,380	9.0%	85,910	9.0%	78,300	8.1%	-1.0%
	mixed coppice/broadleaved high forest	606,650	64.8%	594,810	62.0%	584,920	61.0%	583,210	60.6%	-0.2%
	mixed coppice/conifer high forest	25,610	2.7%	31,350	3.3%	30,660	3.2%	32,690	3.4%	0.4%
	temporarily unstocked*	4,280	0.5%	3,940	0.4%	4,050	0.4%	3,860	0.4%	-0.2%
Total BOURGOGNE		**936,070**	**100.0%**	**959,430**	**100.0%**	**959,110**	**100.0%**	**962,540**	**100.0%**	**0.0%**
BRETAGNE	regular high forest	112,840	44.9%	112,840	44.9%	145,610	45.9%	145,610	45.9%	2.6%
	irregular high forest	8,630	3.4%	8,630	3.4%	1,020	0.3%	1,020	0.3%	-19.2%
	coppice	54,850	21.8%	54,850	21.8%	52,440	16.5%	52,440	16.5%	-0.4%
	mixed coppice/broadleaved high forest	48,320	19.2%	48,320	19.2%	84,580	26.6%	84,580	26.6%	5.8%
	mixed coppice/conifer high forest	23,660	9.4%	23,660	9.4%	31,290	9.9%	31,290	9.9%	2.8%
	temporarily unstocked*	3,160	1.3%	3,160	1.3%	2,500	0.8%	2,500	0.8%	-2.3%
Total BRETAGNE		**251,470**	**100.0%**	**251,470**	**100.0%**	**317,450**	**100.0%**	**317,450**	**100.0%**	**2.4%**
CENTRE	regular high forest	202,680	25.4%	225,550	28.0%	264,840	32.4%	325,580	37.7%	3.7%
	irregular high forest	12,090	1.5%	13,360	1.7%	10,410	1.3%	5,990	0.7%	-7.7%
	coppice	142,930	17.9%	133,390	16.6%	124,840	15.3%	121,900	14.1%	-0.9%
	mixed coppice/broadleaved high forest	377,650	47.4%	367,930	45.7%	360,290	44.0%	358,870	41.5%	-0.2%
	mixed coppice/conifer high forest	57,590	7.2%	60,160	7.5%	53,410	6.5%	48,390	5.6%	-2.2%
	temporarily unstocked*	3,480	0.4%	4,040	0.5%	4,590	0.6%	3,580	0.4%	-1.2%
Total CENTRE		**796,420**	**100.0%**	**804,430**	**100.0%**	**818,380**	**100.0%**	**864,300**	**100.0%**	**0.7%**
CHAMPAGNE-ARDENNE	regular high forest	188,550	29.5%	188,550	29.5%	203,140	31.9%	230,680	36.0%	2.0%
	irregular high forest	130	0.0%	130	0.0%	450	0.1%	860	0.1%	21.1%
	coppice	48,410	7.6%	48,410	7.6%	39,220	6.2%	38,070	5.9%	-2.4%
	mixed coppice/broadleaved high forest	383,180	60.0%	383,180	60.0%	375,690	59.0%	353,770	55.3%	-0.8%
	mixed coppice/conifer high forest	15,130	2.4%	15,130	2.4%	15,250	2.4%	14,450	2.3%	-0.5%
	temporarily unstocked*	3,380	0.5%	3,380	0.5%	3,250	0.5%	2,080	0.3%	-4.7%
Total CHAMPAGNE-ARDENNE		**638,780**	**100.0%**	**638,780**	**100.0%**	**637,000**	**100.0%**	**639,900**	**100.0%**	**0.0%**

APPENDIX 11

Administrative region	Forest structure	1989		1994		1999		2004		1994-2004
		ha	%	ha	%	ha	%	ha	%	annual variation rate
CORSE	regular high forest	106,460	50.0%	79,830	51.5%	79,830	51.5%	79,830	51.5%	0.0%
	irregular high forest	7,900	3.7%	9,210	5.9%	9,210	5.9%	9,210	5.9%	0.0%
	coppice	55,330	26.0%	39,920	25.7%	39,920	25.7%	39,920	25.7%	0.0%
	mixed coppice/broadleaved high forest	36,790	17.3%	20,680	13.3%	20,680	13.3%	20,680	13.3%	0.0%
	mixed coppice/conifer high forest	6,110	2.9%	5,350	3.5%	5,350	3.5%	5,350	3.5%	0.0%
	temporarily unstocked*	420	0.2%	80	0.1%	80	0.1%	80	0.1%	0.0%
Subtotal CORSE		**213,010**	**100.0%**	**155,070**	**100.0%**	**155,070**	**100.0%**	**155,070**	**100.0%**	**0.0%**
Unspecified CORSE		0		71,470		71,470		71,470		
Total CORSE		**213,010**		**226,540**		**226,540**		**226,540**		**0.0%**
FRANCHE-COMTE	regular high forest	243,980	36.2%	243,980	36.2%	319,740	47.2%	322,610	47.6%	2.8%
	irregular high forest	84,690	12.6%	84,690	12.6%	71,490	10.6%	72,120	10.6%	-1.6%
	coppice	52,710	7.8%	52,710	7.8%	45,060	6.7%	44,340	6.5%	-1.7%
	mixed coppice/broadleaved high forest	272,530	40.5%	272,530	40.5%	221,400	32.7%	220,380	32.5%	-2.1%
	mixed coppice/conifer high forest	17,340	2.6%	17,340	2.6%	17,560	2.6%	16,780	2.5%	-0.3%
	temporarily unstocked*	1,980	0.3%	1,980	0.3%	2,030	0.3%	1,700	0.3%	-1.5%
Total FRANCHE-COMTE		**673,220**	**100.0%**	**673,220**	**100.0%**	**677,270**	**100.0%**	**677,930**	**100.0%**	**0.1%**
HAUTE-NORMANDIE	regular high forest	68,550	33.1%	98,820	44.9%	98,820	44.9%	148,620	68.1%	4.2%
	irregular high forest	0	0.0%	0	0.0%	0	0.0%	90	0.0%	
	coppice	15,230	7.3%	14,010	6.4%	14,010	6.4%	13,950	6.4%	0.0%
	mixed coppice/broadleaved high forest	116,260	56.1%	96,580	43.9%	96,580	43.9%	51,300	23.5%	-6.1%
	mixed coppice/conifer high forest	7,070	3.4%	8,560	3.9%	8,560	3.9%	2,790	1.3%	-10.6%
	temporarily unstocked*	120	0.1%	1,900	0.9%	1,900	0.9%	1,410	0.6%	-3.0%
Total HAUTE-NORMANDIE		**207,220**	**100.0%**	**219,880**	**100.0%**	**219,880**	**100.0%**	**218,160**	**100.0%**	**-0.1%**
ILE-DE-FRANCE	regular high forest	46,450	19.6%	46,450	19.6%	112,200	44.7%	112,200	44.7%	9.2%
	irregular high forest	3,260	1.4%	3,260	1.4%	420	0.2%	420	0.2%	-18.6%
	coppice	54,010	22.8%	54,010	22.8%	21,700	8.6%	21,700	8.6%	-8.7%
	mixed coppice/broadleaved high forest	122,010	51.5%	122,010	51.5%	110,620	44.1%	110,620	44.1%	-1.0%
	mixed coppice/conifer high forest	10,660	4.5%	10,660	4.5%	5,150	2.1%	5,150	2.1%	-7.0%
	temporarily unstocked*	320	0.1%	320	0.1%	850	0.3%	850	0.3%	10.3%
Total ILE-DE-FRANCE		**236,700**	**100.0%**	**236,700**	**100.0%**	**250,940**	**100.0%**	**250,940**	**100.0%**	**0.6%**
LANGUEDOC-ROUSSILLON	regular high forest	342,530	44.0%	360,770	45.7%	388,830	48.4%	388,830	48.4%	0.8%
	irregular high forest	27,550	3.5%	29,720	3.8%	19,320	2.4%	19,320	2.4%	-4.2%
	coppice	325,640	41.8%	316,270	40.0%	307,110	38.3%	307,110	38.3%	-0.3%
	mixed coppice/broadleaved high forest	36,260	4.7%	34,210	4.3%	31,220	3.9%	31,220	3.9%	-0.9%
	mixed coppice/conifer high forest	43,380	5.6%	44,800	5.7%	53,540	6.7%	53,540	6.7%	1.8%
	temporarily unstocked*	3,930	0.5%	4,010	0.5%	2,830	0.4%	2,830	0.4%	-3.4%
Subtotal LANGUEDOC-ROUSSILLON		**779,290**	**100.0%**	**789,780**	**100.0%**	**802,850**	**100.0%**	**802,850**	**100.0%**	**0.2%**
Unspecified LANGUEDOC-ROUSSILLON		0		30,390		108,380		108,380		
Total LANGUEDOC-ROUSSILLON		**779,290**		**820,170**		**911,230**		**911,230**		**1.1%**
LIMOUSIN	regular high forest	262,990	50.5%	287,290	51.8%	287,290	51.8%	290,660	52.4%	0.1%
	irregular high forest	14,380	2.8%	23,800	4.3%	23,800	4.3%	10,980	2.0%	-7.4%
	coppice	88,330	17.0%	68,600	12.4%	68,600	12.4%	92,960	16.8%	3.1%
	mixed coppice/broadleaved high forest	131,940	25.3%	140,750	25.4%	140,750	25.4%	121,350	21.9%	-1.5%
	mixed coppice/conifer high forest	16,510	3.2%	27,730	5.0%	27,730	5.0%	28,120	5.1%	0.1%
	temporarily unstocked*	6,420	1.2%	6,510	1.2%	6,510	1.2%	10,380	1.9%	4.8%
Total LIMOUSIN		**520,560**	**100.0%**	**554,680**	**100.0%**	**554,680**	**100.0%**	**554,450**	**100.0%**	**0.0%**
LORRAINE	regular high forest	475,140	56.5%	474,050	56.6%	495,240	59.7%	495,240	59.7%	0.4%
	irregular high forest	9,860	1.2%	10,090	1.2%	12,380	1.5%	12,380	1.5%	2.1%
	coppice	33,730	4.0%	29,980	3.6%	19,060	2.3%	19,060	2.3%	-4.4%
	mixed coppice/broadleaved high forest	310,460	36.9%	312,170	37.3%	288,550	34.8%	288,550	34.8%	-0.8%
	mixed coppice/conifer high forest	9,040	1.1%	7,330	0.9%	9,470	1.1%	9,470	1.1%	2.6%
	temporarily unstocked*	3,430	0.4%	3,210	0.4%	4,610	0.6%	4,610	0.6%	3.7%
Total LORRAINE		**841,650**	**100.0%**	**836,830**	**100.0%**	**829,310**	**100.0%**	**829,310**	**100.0%**	**-0.1%**

Administrative region	Forest structure	1989		1994		1999		2004		1994-2004
		ha	%	ha	%	ha	%	ha	%	annual variation rate
MIDI-PYRENEES	regular high forest	432,710	40.2%	468,910	43.0%	488,300	43.6%	485,320	42.4%	0.3%
	irregular high forest	46,530	4.3%	59,480	5.5%	70,510	6.3%	59,070	5.2%	-0.1%
	coppice	321,950	29.9%	300,270	27.5%	299,210	26.7%	311,050	27.2%	0.4%
	mixed coppice/broadleaved high forest	245,910	22.8%	225,000	20.6%	226,590	20.2%	252,030	22.0%	1.1%
	mixed coppice/conifer high forest	26,380	2.4%	32,860	3.0%	31,040	2.8%	34,700	3.0%	0.5%
	temporarily unstocked*	3,400	0.3%	4,360	0.4%	3,520	0.3%	3,150	0.3%	-3.2%
Subtotal MIDI-PYRENEES		**1,076,880**	**100.0%**	**1,090,880**	**100.0%**	**1,119,160**	**100.0%**	**1,145,330**	**100.0%**	**0.5%**
Unspecified MIDI-PYRENEES		0		25,530		25,530		25,530		
Total MIDI-PYRENEES		**1,076,880**		**1,116,410**		**1,144,690**		**1,170,860**		**0.5%**
NORD - PAS-DE-CALAIS	regular high forest	41,660	54.4%	41,660	54.4%	41,660	54.4%	50,160	60.9%	1.9%
	irregular high forest	270	0.4%	270	0.4%	270	0.4%	350	0.4%	2.7%
	coppice	5,560	7.3%	5,560	7.3%	5,560	7.3%	6,140	7.5%	1.0%
	mixed coppice/broadleaved high forest	27,910	36.5%	27,910	36.5%	27,910	36.5%	24,820	30.1%	-1.2%
	mixed coppice/conifer high forest	660	0.9%	660	0.9%	660	0.9%	530	0.6%	-2.2%
	temporarily unstocked*	510	0.7%	510	0.7%	510	0.7%	350	0.4%	-3.7%
Total NORD - PAS-DE-CALAIS		**76,570**	**100.0%**	**76,570**	**100.0%**	**76,570**	**100.0%**	**82,360**	**100.0%**	**0.7%**
PAYS DE LA LOIRE	regular high forest	109,970	40.3%	109,970	40.3%	121,740	43.0%	150,320	50.6%	3.2%
	irregular high forest	1,530	0.6%	1,530	0.6%	1,540	0.5%	2,610	0.9%	5.5%
	coppice	64,660	23.7%	64,660	23.7%	59,210	20.9%	55,340	18.6%	-1.5%
	mixed coppice/broadleaved high forest	74,570	27.3%	74,570	27.3%	78,390	27.7%	68,670	23.1%	-0.8%
	mixed coppice/conifer high forest	19,810	7.3%	19,810	7.3%	18,970	6.7%	17,550	5.9%	-1.2%
	temporarily unstocked*	2,390	0.9%	2,390	0.9%	2,960	1.0%	2,490	0.8%	0.4%
Total PAYS DE LA LOIRE		**272,930**	**100.0%**	**272,930**	**100.0%**	**282,810**	**100.0%**	**296,970**	**100.0%**	**0.8%**
PICARDIE	regular high forest	73,730	26.3%	146,670	50.8%	146,670	50.8%	152,580	52.6%	0.4%
	irregular high forest	5,600	2.0%	0	0.0%	0	0.0%	310	0.1%	
	coppice	31,900	11.4%	22,140	7.7%	22,140	7.7%	21,380	7.4%	-0.3%
	mixed coppice/broadleaved high forest	163,370	58.4%	115,480	40.0%	115,480	40.0%	112,770	38.9%	-0.2%
	mixed coppice/conifer high forest	5,190	1.9%	2,270	0.8%	2,270	0.8%	2,310	0.8%	0.2%
	temporarily unstocked*	40	0.0%	2,380	0.8%	2,380	0.8%	840	0.3%	-9.9%
Total PICARDIE		**279,830**	**100.0%**	**288,940**	**100.0%**	**288,940**	**100.0%**	**290,190**	**100.0%**	**0.0%**
POITOU-CHARENTES	regular high forest	92,880	26.6%	92,880	26.6%	102,010	27.5%	102,010	27.5%	0.9%
	irregular high forest	6,460	1.8%	6,460	1.8%	6,660	1.8%	6,660	1.8%	0.3%
	coppice	104,960	30.0%	104,960	30.0%	110,640	29.9%	110,640	29.9%	0.5%
	mixed coppice/broadleaved high forest	115,510	33.0%	115,510	33.0%	123,460	33.3%	123,460	33.3%	0.7%
	mixed coppice/conifer high forest	27,350	7.8%	27,350	7.8%	24,410	6.6%	24,410	6.6%	-1.1%
	temporarily unstocked*	2,460	0.7%	2,460	0.7%	3,250	0.9%	3,250	0.9%	2.8%
Total POITOU-CHARENTES		**349,630**	**100.0%**	**349,630**	**100.0%**	**370,430**	**100.0%**	**370,430**	**100.0%**	**0.6%**
PROVENCE-ALPES-COTE D'AZUR	regular high forest	569,920	52.0%	566,880	51.2%	566,880	51.2%	601,660	50.6%	0.6%
	irregular high forest	42,770	3.9%	45,440	4.1%	45,440	4.1%	80,280	6.8%	5.9%
	coppice	317,190	28.9%	322,150	29.1%	322,150	29.1%	294,490	24.8%	-0.9%
	mixed coppice/broadleaved high forest	20,430	1.9%	20,820	1.9%	20,820	1.9%	36,570	3.1%	5.8%
	mixed coppice/conifer high forest	140,300	12.8%	145,600	13.2%	145,600	13.2%	174,110	14.6%	1.8%
	temporarily unstocked*	5,060	0.5%	5,270	0.5%	5,270	0.5%	1,840	0.2%	-10.0%
Total PROVENCE-ALPES-COTE D'AZUR		**1,095,660**	**100.0%**	**1,106,160**	**100.0%**	**1,106,160**	**100.0%**	**1,188,950**	**100.0%**	**0.7%**
RHONE-ALPES	regular high forest	487,640	37.5%	487,230	37.3%	557,820	43.4%	594,460	46.2%	2.0%
	irregular high forest	217,700	16.7%	218,040	16.7%	189,670	14.8%	167,960	13.1%	-2.6%
	coppice	302,940	23.3%	300,980	23.0%	252,430	19.6%	244,800	19.0%	-2.0%
	mixed coppice/broadleaved high forest	183,520	14.1%	186,500	14.3%	163,680	12.7%	165,900	12.9%	-1.2%
	mixed coppice/conifer high forest	105,580	8.1%	111,250	8.5%	117,240	9.1%	108,570	8.4%	-0.2%
	temporarily unstocked*	2,560	0.2%	3,330	0.3%	4,370	0.3%	5,120	0.4%	4.4%
Subtotal RHONE-ALPES		**1,299,950**	**100.0%**	**1,307,330**	**100.0%**	**1,285,210**	**100.0%**	**1,286,800**	**100.0%**	**-0.2%**
Unspecified RHONE-ALPES		0		0		64,000		64,000		
Total RHONE-ALPES		**1,299,950**		**1,307,330**		**1,349,220**		**1,350,810**		**0.3%**
Subtotal France		**13,336,510**		**13,444,110**		**13,597,250**		**13,821,330**		**0.3%**
Total Unspecified France		0		127,390		269,390		269,390		
Total France		**13,336,510**		**13,571,500**		**13,866,630**		**14,090,720**		**0.4%**

* clearcut or accident within the previous 5 years

(Source: IFN, criterion determined only for inventoried forest stands available for wood supply)

2) Poplar planations

Administrative region	1989		1994		1999		2004		1994-2004
	ha	%	ha	%	ha	%	ha	%	annual variation rate
ALSACE	2,650	1.3%	3,560	1.8%	3,560	1.7%	3,100	1.4%	-1.4%
AQUITAINE	16,550	8.2%	15,520	7.7%	15,570	7.5%	19,640	8.9%	2.4%
AUVERGNE	1,720	0.8%	2,000	1.0%	2,000	1.0%	2,310	1.0%	1.4%
BASSE-NORMANDIE	2,480	1.2%	3,090	1.5%	3,090	1.5%	4,260	1.9%	3.3%
BOURGOGNE	11,120	5.5%	11,590	5.7%	11,670	5.6%	11,330	5.2%	-0.2%
BRETAGNE	3,640	1.8%	3,640	1.8%	7,460	3.6%	7,460	3.4%	7.5%
CENTRE	20,260	10.0%	21,260	10.5%	20,510	9.9%	20,680	9.4%	-0.3%
CHAMPAGNE-ARDENNE	26,140	12.9%	26,140	13.0%	26,120	12.6%	26,630	12.1%	0.2%
CORSE	50	0.0%	70	0.0%	70	0.0%	70	0.0%	0.0%
FRANCHE-COMTE	4,110	2.0%	4,110	2.0%	3,350	1.6%	3,340	1.5%	-2.1%
HAUTE-NORMANDIE	2,300	1.1%	2,240	1.1%	2,240	1.1%	1,880	0.9%	-1.7%
ILE-DE-FRANCE	10,650	5.3%	10,650	5.3%	12,200	5.9%	12,200	5.6%	1.4%
LANGUEDOC-ROUSSILLON	470	0.2%	560	0.3%	390	0.2%	390	0.2%	-3.6%
LIMOUSIN	1,030	0.5%	980	0.5%	980	0.5%	680	0.3%	-3.6%
LORRAINE	3,500	1.7%	4,140	2.0%	3,960	1.9%	3,960	1.8%	-0.4%
MIDI-PYRENEES	12,200	6.0%	10,630	5.3%	11,400	5.5%	12,530	5.7%	1.7%
NORD - PAS-DE-CALAIS	11,950	5.9%	11,950	5.9%	11,950	5.8%	16,050	7.3%	3.0%
PAYS DE LA LOIRE	11,690	5.8%	11,690	5.8%	15,190	7.3%	18,110	8.2%	4.5%
PICARDIE	34,370	17.0%	32,310	16.0%	32,310	15.6%	32,860	14.9%	0.2%
POITOU-CHARENTES	11,250	5.6%	11,250	5.6%	13,180	6.4%	13,180	6.0%	1.6%
PROVENCE-ALPES-COTE D'AZUR	80	0.0%	80	0.0%	80	0.0%	430	0.2%	18.2%
RHONE-ALPES	14,200	7.0%	14,310	7.1%	9,500	4.6%	8,790	4.0%	-4.8%
Total France	**202,400**	**100.0%**	**201,750**	**100.0%**	**206,790**	**100.0%**	**219,870**	**100.0%**	**0.9%**

(Source: IFN, poplar plantations (landuse 5))

Appendix to § 1.3 Growing stock by diameter distribution

Forest stands available for wood supply

IFN stem volume (7 cm top diameter)

group	species	diameter class	1989		1994		1999		2004		1994-2004
			growing stock (K m³)	% growing stock	growing stock (K m³)	% growing stock	growing stock (K m³)	% growing stock	growing stock (K m³)	% growing stock	annual variation rate
Broadleaved	oaks	10-25 cm	141,450	32.6%	149,393	32.0%	155,360	31.1%	153,789	29.3%	0.3%
		30-55 cm	239,753	55.2%	259,255	55.5%	274,354	54.9%	290,790	55.4%	1.2%
		60-85 cm	49,604	11.4%	54,818	11.7%	65,769	13.2%	75,511	14.4%	3.3%
		90-115 cm	3,040	0.7%	3,293	0.7%	3,884	0.8%	4,354	0.8%	2.8%
		120 cm and over	422	0.1%	383	0.1%	428	0.1%	394	0.1%	0.3%
	Total oaks		**434,269**	**100.0%**	**467,141**	**100.0%**	**499,795**	**100.0%**	**524,837**	**100.0%**	**1.2%**
	beech	10-25 cm	67,683	31.6%	69,118	31.0%	72,710	30.9%	75,012	31.0%	0.8%
		30-55 cm	110,388	51.6%	115,583	51.9%	122,458	52.1%	125,048	51.7%	0.8%
		60-85 cm	33,085	15.5%	35,149	15.8%	36,709	15.6%	38,491	15.9%	0.9%
		90-115 cm	2,722	1.3%	2,697	1.2%	2,900	1.2%	3,002	1.2%	1.1%
		120 cm and over	112	0.1%	136	0.1%	195	0.1%	174	0.1%	2.5%
	Total beech		**213,990**	**100.0%**	**222,683**	**100.0%**	**234,972**	**100.0%**	**241,727**	**100.0%**	**0.8%**
	other broadleaved	10-25 cm	301,738	72.9%	316,547	71.8%	338,552	70.4%	361,357	68.8%	1.3%
		30-55 cm	96,037	23.2%	107,236	24.3%	123,782	25.7%	143,413	27.3%	2.9%
		60-85 cm	11,250	2.7%	12,955	2.9%	14,481	3.0%	16,006	3.0%	2.1%
		90-115 cm	3,323	0.8%	3,130	0.7%	3,003	0.6%	3,129	0.6%	0.0%
		120 cm and over	1,574	0.4%	1,225	0.3%	1,287	0.3%	1,173	0.2%	-0.4%
	Total other broadleaved		**413,922**	**100.0%**	**441,093**	**100.0%**	**481,105**	**100.0%**	**525,078**	**100.0%**	**1.8%**
Total broadleaved			**1,062,181**		**1,130,917**		**1,215,873**		**1,291,641**		**1.3%**
Conifers	white conifers	10-25 cm	72,770	26.7%	87,159	29.7%	102,263	31.8%	105,006	30.5%	1.9%
		30-55 cm	162,341	59.6%	166,794	56.9%	177,003	55.0%	191,165	55.6%	1.4%
		60-85 cm	35,597	13.1%	37,147	12.7%	39,763	12.4%	44,846	13.0%	1.9%
		90-115 cm	1,810	0.7%	2,118	0.7%	2,702	0.8%	2,737	0.8%	2.6%
		120 cm and over	79	0.0%	97	0.0%	62	0.0%	60	0.0%	-4.6%
	Total white conifers		**272,597**	**100.0%**	**293,315**	**100.0%**	**321,792**	**100.0%**	**343,814**	**100.0%**	**1.6%**
	maritime pine	10-25 cm	53,967	32.8%	52,966	28.6%	52,444	28.0%	49,302	24.7%	-0.7%
		30-55 cm	104,401	63.5%	123,948	66.9%	126,474	67.4%	138,945	69.6%	1.1%
		60-85 cm	5,961	3.6%	8,057	4.3%	8,437	4.5%	11,242	5.6%	3.4%
		90-115 cm	161	0.1%	264	0.1%	264	0.1%	219	0.1%	-1.9%
		120 cm and over	0	0.0%	0	0.0%	0	0.0%	15	0.0%	
	Total maritime pine		**164,490**	**100.0%**	**185,234**	**100.0%**	**187,619**	**100.0%**	**199,724**	**100.0%**	**0.8%**
	Douglas fir	10-25 cm	9,532	10.2%	16,899	17.5%	22,998	23.2%	26,766	26.3%	4.7%
		30-55 cm	5,292	5.6%	9,760	10.1%	16,497	16.7%	24,428	24.0%	9.6%
		60-85 cm	617	0.7%	1,304	1.4%	1,745	1.8%	2,366	2.3%	6.1%
		90-115 cm	8	0.0%	11	0.0%	17	0.0%	59	0.1%	18.2%
	Total Douglas fir		**15,449**	**16.5%**	**27,974**	**29.0%**	**41,256**	**41.7%**	**53,619**	**52.6%**	**6.7%**
	other red conifers	10-25 cm	93,842	45.3%	96,537	44.8%	99,037	44.3%	101,858	42.7%	0.5%
		30-55 cm	104,641	50.5%	109,765	50.9%	115,292	51.6%	126,145	52.9%	1.4%
		60-85 cm	8,040	3.9%	8,413	3.9%	8,441	3.8%	9,454	4.0%	1.2%
		90-115 cm	743	0.4%	723	0.3%	729	0.3%	778	0.3%	0.7%
		120 cm and over	91	0.0%	124	0.1%	132	0.1%	166	0.1%	2.9%
	Total other red conifers		**207,356**	**100.0%**	**215,562**	**100.0%**	**223,631**	**100.0%**	**238,400**	**100.0%**	**1.0%**
Total conifers			**659,893**		**722,086**		**774,298**		**835,557**		**1.5%**
Subtotal			**1,722,074**		**1,853,003**		**1,990,171**		**2,127,198**		**1.4%**
unspecified			476		727		693		3		
Total			**1,722,550**		**1,853,730**		**1,990,864**		**2,127,201**		**1.4%**

(Source: IFN, excluding poplar plantations, only for inventoried forest stands available for wood supply, based on overbark stem volume for trees with 7 cm top diameter and more than 7.5 cm trunk diameter at breast height (1.30 m); the A diameter class refers to stems with a diameter ranging from A-2.5 cm to A+2.5 cm)

Appendix to § 2.1 Variations in atmospheric deposition under the forest canopy (throughfall) in the RENECOFOR network

Plot	Period	Mean annual deposition												Mean precipitation under the forest canopy (mm/year)
		H+	Cl	S-SO4	N-NO3	Na	N-NH4	K	Mg	Ca	Fe	Al	Mn	
		kg/ha/yr	kg/ha/yr	kg/ha/yr	kg/ha/yr	kg/ha/yr	kg/ha/yr	kg/ha/yr	kg/ha/yr	kg/ha/yr	g/ha/yr	g/ha/yr	g/ha/yr	
CHP 40	1993-1998	22.20	59.41	10.89	2.44	30.53	3.03	39.33	5.98	12.93	64.11	102.64	376.54	844.58
CHP 40	1999-2003	12.07	55.57	9.02	2.43	28.62	4.17	39.34	5.74	12.08	105.11	92.74	442.93	810.82
	Variation	*-10.13*	*-3.84*	*-1.87*	*-0.01*	*-1.91*	*1.15*	*0.00*	*-0.25*	*-0.86*	*40.99*	*-9.90*	*66.39*	*33.76*
	Variation in %	***-45.64***	***-6.47***	***-17.17***	***-0.40***	***-6.26***	***37.81***	***0.01***	***-4.10***	***-6.61***	***63.93***	***-9.64***	***17.63***	***4.00***
CHP 59	1993-1998	60.21	24.72	13.18	2.75	11.99	8.84	34.24	4.29	11.41	79.96	102.00	1284.90	738.15
CHP 59	1999-2003	30.14	22.85	9.50	2.88	10.62	11.94	43.30	4.17	9.90	119.54	95.70	1228.59	850.45
	Variation	*-30.08*	*-1.87*	*-3.68*	*0.13*	*-1.36*	*3.09*	*9.06*	*-0.12*	*-1.51*	*39.58*	*-6.30*	*-56.32*	*-112.30*
	Variation in %	***-49.95***	***-7.56***	***-27.93***	***4.79***	***-11.38***	***34.97***	***26.45***	***-2.78***	***-13.23***	***49.50***	***-6.18***	***-4.38***	***-15.21***
CHS 35	1993-1998	13.06	35.69	7.45	2.79	16.94	8.12	25.82	3.42	6.07	67.66	73.23	1611.09	590.29
CHS 35	1999-2003	8.79	32.62	5.10	2.35	15.73	7.01	24.75	3.18	6.23	94.54	57.72	1472.97	637.10
	Variation	*-4.26*	*-3.07*	*-2.35*	*-0.44*	*-1.21*	*-1.11*	*-1.07*	*-0.25*	*0.15*	*26.88*	*-15.51*	*-138.12*	*-46.82*
	Variation in %	***-32.66***	***-8.61***	***-31.58***	***-15.65***	***-7.16***	***-13.70***	***-4.15***	***-7.27***	***2.54***	***39.73***	***-21.18***	***-8.57***	***-7.93***
CHS 41	1993-1998	19.95	19.23	5.48	2.48	7.50	2.96	19.78	2.13	8.57	65.80	79.73	1564.37	524.22
CHS 41	1999-2003	13.46	16.02	3.74	2.79	7.21	3.54	18.80	2.18	7.91	73.51	59.14	1225.59	634.22
	Variation	*-6.49*	*-3.21*	*-1.74*	*0.31*	*-0.28*	*0.59*	*-0.98*	*0.05*	*-0.66*	*7.72*	*-20.59*	*-338.78*	*-110.00*
	Variation in %	***-32.52***	***-16.69***	***-31.77***	***12.60***	***-3.78***	***19.81***	***-4.94***	***2.28***	***-7.75***	***11.73***	***-25.83***	***-21.66***	***-20.98***
CPS 77	1993-1998	19.28	18.83	7.13	2.94	7.05	4.63	21.15	2.56	12.43	74.24	108.66	2008.28	508.97
CPS 77	1999-2003	10.34	15.87	4.75	3.07	6.32	5.06	19.64	2.86	11.27	126.14	106.67	1937.41	552.45
	Variation	*-8.94*	*-2.95*	*-2.38*	*0.12*	*-0.73*	*0.43*	*-1.51*	*0.30*	*-1.16*	*51.90*	*-2.00*	*-70.86*	*-43.48*
	Variation in %	***-46.37***	***-15.69***	***-33.42***	***4.15***	***-10.37***	***9.34***	***-7.12***	***11.92***	***-9.34***	***69.91***	***-1.84***	***-3.53***	***-8.54***
DOU 71	1993-1998	152.66	23.32	9.49	9.26	13.90	5.20	13.00	3.14	8.75	43.42	167.97	697.29	1178.61
DOU 71	1999-2003	76.65	22.32	6.88	9.05	12.86	5.45	12.38	3.19	8.04	77.22	160.39	827.36	1121.97
	Variation	*-76.02*	*-0.99*	*-2.61*	*-0.21*	*-1.04*	*0.24*	*-0.63*	*0.06*	*-0.72*	*33.81*	*-7.58*	*130.07*	*56.64*
	Variation in %	***-49.79***	***-4.25***	***-27.53***	***-2.31***	***-7.50***	***4.64***	***-4.84***	***1.77***	***-8.20***	***77.86***	***-4.51***	***18.65***	***4.81***
EPC 08	1993-1998	389.38	34.13	24.73	12.21	17.62	11.64	32.22	2.90	14.97	144.74	329.18	2157.96	947.44
EPC 08	1999-2003	158.45	29.18	14.29	10.30	15.70	9.16	23.78	2.88	9.44	163.58	484.18	1845.94	1107.62
	Variation	*-230.92*	*-4.95*	*-10.44*	*-1.91*	*-1.92*	*-2.48*	*-8.44*	*-0.02*	*-5.53*	*18.84*	*154.99*	*-312.02*	*-160.17*
	Variation in %	***-59.31***	***-14.52***	***-42.22***	***-15.61***	***-10.89***	***-21.28***	***-26.19***	***-0.61***	***-36.96***	***13.02***	***47.08***	***-14.46***	***-16.91***
EPC 63	1993-1998	46.75	16.17	6.38	4.81	7.54	2.94	13.70	2.70	9.14	74.39	304.44	654.97	537.22
EPC 63	1999-2003	29.25	15.98	4.24	4.40	8.07	2.61	12.92	2.58	6.93	102.95	236.48	569.61	508.08
	Variation	*-17.50*	*-0.19*	*-2.14*	*-0.41*	*0.53*	*-0.33*	*-0.78*	*-0.12*	*-2.21*	*28.57*	*-67.95*	*-85.37*	*29.14*
	Variation in %	***-37.44***	***-1.16***	***-33.53***	***-8.60***	***7.02***	***-11.21***	***-5.70***	***-4.38***	***-24.17***	***38.41***	***-22.32***	***-13.03***	***5.42***
EPC 74	1993-1998	133.34	7.68	7.22	6.04	2.88	4.37	14.63	1.42	10.91	100.99	200.80	199.85	860.99
EPC 74	1999-2003	72.63	7.50	4.96	7.27	3.04	5.26	13.24	1.53	10.81	126.68	200.62	208.28	1004.37
	Variation	*-60.71*	*-0.18*	*-2.26*	*1.23*	*0.15*	*0.89*	*-1.39*	*0.11*	*-0.10*	*25.69*	*-0.18*	*8.43*	*-143.38*
	Variation in %	***-45.53***	***-2.33***	***-31.30***	***20.38***	***5.34***	***20.34***	***-9.48***	***7.44***	***-0.93***	***25.44***	***-0.09***	***4.22***	***-16.65***
EPC 87	1993-1998	44.52	27.78	7.01	4.63	14.09	3.18	23.03	3.01	6.45	34.32	194.95	314.07	808.80
EPC 87	1999-2003	24.57	27.75	6.25	5.34	13.96	4.39	26.46	3.13	6.96	89.99	211.85	350.87	783.79
	Variation	*-19.94*	*-0.03*	*-0.76*	*0.72*	*-0.12*	*1.21*	*3.43*	*0.12*	*0.51*	*55.67*	*16.91*	*36.80*	*25.00*
	Variation in %	***-44.80***	***-0.12***	***-10.86***	***15.46***	***-0.88***	***38.22***	***14.89***	***4.05***	***7.88***	***162.19***	***8.67***	***11.72***	***3.09***
HET 30	1993-1998	288.77	38.08	18.44	8.57	21.86	6.99	26.54	3.94	20.60	57.91	399.23	618.87	2449.89
HET 30	1999-2003	130.71	32.39	12.80	8.47	19.01	7.39	17.28	3.59	19.74	149.16	175.72	607.15	2036.22
	Variation	*-158.06*	*-5.69*	*-5.64*	*-0.09*	*-2.85*	*0.40*	*-9.26*	*-0.35*	*-0.86*	*91.25*	*-223.51*	*-11.72*	*413.67*
	Variation in %	***-54.74***	***-14.95***	***-30.58***	***-1.11***	***-13.05***	***5.72***	***-34.89***	***-8.91***	***-4.18***	***157.56***	***-55.98***	***-1.89***	***16.89***
HET 64	1993-1998	43.52	33.26	11.38	5.16	17.09	4.58	20.47	3.36	13.11	20.45	111.27	398.36	905.88
HET 64	1999-2003	19.07	27.70	9.11	4.96	13.92	4.26	19.02	2.83	10.66	53.59	74.47	384.38	913.72
	Variation	*-24.45*	*-5.56*	*-2.27*	*-0.20*	*-3.17*	*-0.32*	*-1.45*	*-0.52*	*-2.45*	*33.14*	*-36.81*	*-13.98*	*-7.84*
	Variation in %	***-56.18***	***-16.73***	***-19.94***	***-3.89***	***-18.54***	***-7.01***	***-7.10***	***-15.61***	***-18.65***	***162.10***	***-33.08***	***-3.51***	***-0.87***
PL 20	1993-1998	93.86	112.33	12.36	3.95	64.00	0.86	12.75	9.44	20.17	66.79	661.87	454.95	1095.09
PL 20	1999-2003	51.77	99.11	10.46	3.92	56.03	0.76	12.67	8.65	21.24	124.08	598.46	340.26	1058.99
	Variation	*-42.09*	*-13.22*	*-1.89*	*-0.03*	*-7.96*	*-0.10*	*-0.08*	*-0.79*	*1.07*	*57.30*	*-63.41*	*-114.69*	*36.09*
	Variation in %	***-44.85***	***-11.77***	***-15.31***	***-0.79***	***-12.45***	***-11.26***	***-0.61***	***-8.34***	***5.32***	***85.80***	***-9.58***	***-25.21***	***3.30***
PM 17	1993-1998	73.00	114.07	9.19	3.72	64.69	2.06	9.79	9.14	10.30	25.38	85.41	128.66	573.87
PM 17	1999-2003	97.08	142.64	10.03	3.62	78.60	2.35	7.46	10.70	11.36	55.14	95.03	133.30	716.52
	Variation	*24.08*	*28.57*	*0.84*	*-0.10*	*13.91*	*0.29*	*-2.34*	*1.56*	*1.06*	*29.76*	*9.62*	*4.64*	*-142.65*
	Variation in %	***32.99***	***25.05***	***9.16***	***-2.76***	***21.50***	***14.07***	***-23.85***	***17.06***	***10.25***	***117.24***	***11.26***	***3.61***	***-24.86***
PM 40c	1993-1998	43.44	39.51	7.23	2.06	21.24	1.70	17.21	5.61	10.02	29.63	214.54	77.84	683.27
PM 40c	1999-2003	60.57	39.23	5.28	2.79	19.45	2.37	13.25	5.03	10.45	71.08	237.57	91.22	629.14
	Variation	*17.13*	*-0.29*	*-1.96*	*0.73*	*-1.79*	*0.68*	*-3.97*	*-0.57*	*0.43*	*41.44*	*23.03*	*13.38*	*54.12*
	Variation in %	***39.44***	***-0.73***	***-27.03***	***35.68***	***-8.43***	***39.87***	***-23.05***	***-10.21***	***4.28***	***139.85***	***10.73***	***17.19***	***7.92***
PM 72	1993-1998	38.26	30.56	6.99	5.29	15.80	8.42	12.14	2.85	6.86	27.23	97.45	304.35	610.86
PM 72	1999-2003	22.56	35.09	6.07	6.10	18.27	9.19	12.39	3.35	6.87	68.03	114.04	433.47	730.07
	Variation	*-15.70*	*4.53*	*-0.92*	*0.81*	*2.47*	*0.77*	*0.25*	*0.50*	*0.01*	*40.80*	*16.60*	*129.13*	*-119.21*
	Variation in %	***-41.04***	***14.84***	***-13.14***	***15.32***	***15.60***	***9.09***	***2.08***	***17.40***	***0.11***	***149.83***	***17.03***	***42.43***	***-19.52***
PM 85	1993-1998	42.31	235.09	15.94	6.43	128.78	7.04	14.03	17.71	15.44	45.11	62.81	82.38	507.87
PM 85	1999-2003	66.23	238.99	15.27	4.39	133.42	3.66	15.67	17.80	12.85	76.91	71.07	111.66	591.12
	Variation	*23.92*	*3.90*	*-0.67*	*-2.04*	*4.64*	*-3.39*	*1.64*	*0.09*	*-2.59*	*31.80*	*8.26*	*29.28*	*-83.25*
	Variation in %	***56.53***	***1.66***	***-4.19***	***-31.70***	***3.60***	***-48.08***	***11.68***	***0.53***	***-16.75***	***70.49***	***13.15***	***35.54***	***-16.39***

Plot	Period	Mean annual deposition												Mean precipitation under the forest canopy (mm/year)
		H+	Cl	S-SO4	N-NO3	Na	N-NH4	K	Mg	Ca	Fe	Al	Mn	
		g/ha/yr	kg/ha/yr	kg/ha/yr	kg/ha/yr	kg/ha/yr	kg/ha/yr	kg/ha/yr	kg/ha/yr	kg/ha/yr	g/ha/yr	g/ha/yr	g/ha/yr	
PS 44	1993-1998	79.64	83.44	10.53	3.94	45.21	8.03	19.17	6.39	7.16	45.11	245.69	179.51	594.20
PS 44	1999-2003	73.50	80.89	8.38	3.50	43.53	6.49	19.19	6.06	6.38	73.61	219.06	219.33	700.89
	Variation	*-6.14*	*-2.55*	*-2.15*	*-0.43*	*-1.68*	*-1.54*	*0.02*	*-0.33*	*-0.78*	*28.51*	*-26.63*	*39.82*	*-106.70*
	Variation in %	***-7.72***	***-3.06***	***-20.40***	***-11.02***	***-3.71***	***-19.20***	***0.11***	***-5.18***	***-10.84***	***63.21***	***-10.84***	***22.18***	***-17.96***
PS 67a	1993-1998	165.07	12.61	10.84	7.27	5.17	8.17	17.51	1.90	9.37	60.08	336.43	1672.12	507.80
PS 67a	1999-2003 (sauf 2000)	95.23	12.18	6.21	6.83	5.75	10.42	11.87	1.37	6.34	67.77	176.40	867.72	589.14
	Variation	*-69.84*	*-0.43*	*-4.63*	*-0.44*	*0.58*	*2.25*	*-5.64*	*-0.53*	*-3.03*	*7.70*	*-160.03*	*-804.40*	*-81.34*
	Variation in %	***-42.31***	***-3.40***	***-42.75***	***-6.02***	***11.24***	***27.54***	***-32.21***	***-28.06***	***-32.35***	***12.81***	***-47.57***	***-48.11***	***-16.02***
PS 76	1993-1998	685.04	90.80	34.87	5.74	49.77	6.33	27.26	7.56	17.41	107.84	907.07	2516.18	586.54
PS 76	1999-2003	282.07	63.08	17.92	6.19	35.43	7.40	14.62	5.34	10.08	84.35	343.77	1261.86	691.65
	Variation	*-402.97*	*-27.72*	*-16.96*	*0.44*	*-14.34*	*1.07*	*-12.64*	*-2.22*	*-7.34*	*-23.50*	*-563.30*	*-1254.32*	*-105.11*
	Variation in %	***-58.82***	***-30.53***	***-48.62***	***7.74***	***-28.82***	***16.96***	***-46.36***	***-29.40***	***-42.14***	***-21.79***	***-62.10***	***-49.85***	***-17.92***
SP 05	1993-1998	4.33	5.97	4.54	0.29	1.62	0.44	29.83	1.98	12.88	53.75	249.14	89.19	622.07
SP 05	1999-2003	2.90	5.43	3.94	0.69	1.56	0.79	31.38	2.26	13.95	71.94	236.37	106.39	611.00
	Variation	*-1.43*	*-0.54*	*-0.60*	*0.39*	*-0.06*	*0.35*	*1.55*	*0.28*	*1.07*	*18.19*	*-12.77*	*17.20*	*11.06*
	Variation in %	***-32.98***	***-9.11***	***-13.16***	***134.28***	***-3.98***	***80.77***	***5.20***	***13.87***	***8.32***	***33.83***	***-5.12***	***19.29***	***1.78***
SP 11	1993-1998	55.11	24.95	11.15	4.37	12.70	2.51	30.28	2.80	15.27	106.78	229.76	234.64	826.18
SP 11	1999-2002	27.13	26.42	9.12	3.64	13.19	2.24	36.90	2.94	13.60	137.22	258.87	254.94	826.69
	Variation	*-27.97*	*1.47*	*-2.03*	*-0.73*	*0.49*	*-0.28*	*6.63*	*0.14*	*-1.67*	*30.45*	*29.11*	*20.30*	*-0.52*
	Variation in %	***-50.76***	***5.88***	***-18.24***	***-16.70***	***3.86***	***-10.94***	***21.88***	***5.01***	***-10.93***	***28.51***	***12.67***	***8.65***	***-0.06***
SP 25	1993-1998	100.03	14.95	9.03	6.51	6.86	5.23	24.27	2.00	12.39	74.13	254.71	406.79	1228.86
SP 25	1999-2003	110.58	14.86	6.97	6.93	7.20	4.60	19.14	2.13	12.62	143.47	146.57	377.90	1522.95
	Variation	*10.55*	*-0.09*	*-2.06*	*0.41*	*0.34*	*-0.63*	*-5.13*	*0.14*	*0.23*	*69.34*	*-108.14*	*-28.88*	*-294.09*
	Variation in %	***10.55***	***-0.61***	***-22.85***	***6.35***	***5.01***	***-12.03***	***-21.14***	***6.85***	***1.85***	***93.54***	***-42.46***	***-7.10***	***-23.93***
SP 38	1993-1998	71.06	6.11	6.41	1.73	1.72	1.91	19.22	0.94	7.40	56.60	158.59	828.03	1003.48
SP 38	1999-2003	32.33	5.83	5.31	1.72	1.76	1.94	19.47	1.50	8.31	86.93	161.92	1147.00	1106.89
	Variation	*-38.72*	*-0.27*	*-1.11*	*-0.01*	*0.04*	*0.03*	*0.25*	*0.56*	*0.92*	*30.33*	*3.33*	*318.97*	*-103.42*
	Variation in %	***-54.50***	***-4.45***	***-17.26***	***-0.47***	***2.40***	***1.43***	***1.31***	***59.58***	***12.37***	***53.59***	***2.10***	***38.52***	***-10.31***
SP 57	1993-1998	158.79	13.80	11.24	5.38	5.52	3.67	23.07	1.14	7.81	58.13	206.80	3146.66	734.12
SP 57	1999-2003	91.36	12.61	6.94	5.35	5.55	3.73	19.01	1.38	7.19	95.18	150.75	2368.91	811.38
	Variation	*-67.43*	*-1.19*	*-4.30*	*-0.03*	*0.03*	*0.06*	*-4.06*	*0.24*	*-0.62*	*37.05*	*-56.05*	*-777.75*	*-77.26*
	Variation in %	***-42.46***	***-8.61***	***-38.25***	***-0.61***	***0.56***	***1.63***	***-17.61***	***20.78***	***-7.94***	***63.74***	***-27.10***	***-24.72***	***-10.52***
SP 68	1993-1998	93.42	10.07	6.03	4.23	4.74	2.98	18.34	1.56	5.83	46.93	221.99	190.37	656.52
SP 68	1999-2003	53.15	8.58	4.44	5.98	4.00	3.65	17.41	1.36	5.81	68.69	190.47	246.82	755.31
	Variation	*-40.27*	*-1.48*	*-1.59*	*1.75*	*-0.74*	*0.67*	*-0.92*	*-0.20*	*-0.01*	*21.77*	*-31.52*	*56.45*	*-98.78*
	Variation in %	***-43.10***	***-14.74***	***-26.40***	***41.36***	***-15.53***	***22.59***	***-5.03***	***-12.79***	***-0.25***	***46.38***	***-14.20***	***29.66***	***-15.05***
	Mean 1993-1998	112.96	43.56	10.97	4.81	22.95	4.84	21.49	4.23	11.29	62.75	234.86	853.78	812.53
	Mean 1999-2003	63.56	41.95	7.96	4.81	22.26	4.99	20.05	4.14	10.27	96.40	190.62	733.15	857.79
	Variation	*-49.40*	*-1.61*	*-3.01*	*0.00*	*-0.69*	*0.15*	*-1.44*	*-0.08*	*-1.02*	*33.65*	*-44.24*	*-120.63*	*-45.26*
	Variation in %	***-43.73***	***-3.70***	***-27.42***	***-0.03***	***-3.02***	***3.18***	***-6.70***	***-1.94***	***-9.07***	***53.63***	***-18.84***	***-14.13***	***-5.57***

Appendix to § 4.7: Landscape-level spatial pattern of forest cover

administrative region	area class	1999				2004			
		number of forest units	mean area mapped per forest unit (ha)	total mapped area ha	total mapped area %	number of forest units	mean area mapped per forest unit (ha)	total mapped area ha	total mapped area %
ALSACE	4-25 ha	343	10	3,550	1.1%	384	10	3,755	1.1%
	25-50 ha	81	37	2,993	0.9%	87	35	3,069	0.9%
	50-100 ha	53	71	3,768	1.2%	48	71	3,394	1.0%
	100-500 ha	72	226	16,239	5.0%	71	195	13,863	4.2%
	500-1,000 ha	24	639	15,344	4.7%	22	672	14,788	4.5%
	1,000-5,000 ha	17	1,705	28,981	9.0%	20	1,839	36,776	11.2%
	5,000-10,000 ha	2	7,125	14,251	4.4%	1	6,562	6,562	2.0%
	over 10,000 ha	4	59,621	238,483	73.7%	4	61,660	246,639	75.0%
Total ALSACE		**596**	**543**	**323,608**	**100.0%**	**637**	**516**	**328,847**	**100.0%**
AQUITAINE	4-25 ha	2,914	11	31,644	1.7%	3,151	10	32,972	1.8%
	25-50 ha	572	35	20,102	1.1%	623	35	21,931	1.2%
	50-100 ha	388	68	26,295	1.4%	392	68	26,674	1.4%
	100-500 ha	363	198	71,869	3.9%	380	196	74,516	4.0%
	500-1,000 ha	45	630	28,333	1.5%	47	641	30,114	1.6%
	1,000-5,000 ha	37	1,836	67,948	3.7%	37	1,845	68,273	3.7%
	5,000-10,000 ha	6	3,651	21,903	1.2%	5	3,993	19,965	1.1%
	over 10,000 ha	9	173,705	1,563,344	85.4%	9	174,540	1,570,861	85.1%
Total AQUITAINE		**4,334**	**423**	**1,831,437**	**100.0%**	**4,644**	**397**	**1,845,305**	**100.0%**
AUVERGNE	4-25 ha	2,000	11	21,597	2.9%	2,117	10	20,856	2.7%
	25-50 ha	420	35	14,648	2.0%	414	34	14,160	1.8%
	50-100 ha	231	68	15,778	2.1%	210	67	14,076	1.8%
	100-500 ha	234	218	50,942	6.9%	223	207	46,263	6.0%
	500-1,000 ha	35	680	23,817	3.2%	41	656	26,905	3.5%
	1,000-5,000 ha	32	1,961	62,766	8.5%	24	1,896	45,504	5.9%
	5,000-10,000 ha	6	5,948	35,690	4.8%	5	4,740	23,699	3.1%
	over 10,000 ha	3	170,521	511,563	69.4%	6	95,947	575,680	75.0%
Total AUVERGNE		**2,961**	**249**	**736,802**	**100.0%**	**3,040**	**252**	**767,143**	**100.0%**
BASSE-NORMANDIE	4-25 ha	1,386	9	12,870	8.9%	1,667	9	15,711	9.9%
	25-50 ha	232	34	7,969	5.5%	265	35	9,300	5.9%
	50-100 ha	129	69	8,876	6.1%	160	70	11,139	7.0%
	100-500 ha	164	203	33,316	23.1%	173	210	36,404	22.9%
	500-1,000 ha	20	614	12,279	8.5%	26	609	15,829	10.0%
	1,000-5,000 ha	15	1,915	28,725	19.9%	17	2,008	34,133	21.5%
	5,000-10,000 ha	2	6,524	13,048	9.0%	1	7,805	7,805	4.9%
	over 10,000 ha	2	13,635	27,270	18.9%	2	14,227	28,455	17.9%
Total BASSE-NORMANDIE		**1,950**	**74**	**144,351**	**100.0%**	**2,311**	**69**	**158,777**	**100.0%**
BOURGOGNE	4-25 ha	2,481	10	25,984	2.6%	2,762	10	27,286	2.8%
	25-50 ha	516	34	17,728	1.8%	514	35	17,804	1.8%
	50-100 ha	298	69	20,617	2.1%	286	70	20,011	2.0%
	100-500 ha	419	205	85,981	8.7%	408	200	81,733	8.3%
	500-1,000 ha	83	635	52,728	5.3%	90	635	57,147	5.8%
	1,000-5,000 ha	75	1,959	146,943	14.8%	72	1,951	140,502	14.3%
	5,000-10,000 ha	15	5,446	81,697	8.2%	14	5,908	82,716	8.4%
	over 10,000 ha	20	27,981	559,613	56.5%	20	27,792	555,832	56.5%
Total BOURGOGNE		**3,907**	**254**	**991,290**	**100.0%**	**4,166**	**236**	**983,032**	**100.0%**
BRETAGNE	4-25 ha	3,788	10	37,034	11.6%	3,790	10	37,046	11.6%
	25-50 ha	595	35	21,038	6.6%	593	35	20,980	6.6%
	50-100 ha	350	70	24,341	7.7%	350	69	24,293	7.6%
	100-500 ha	359	197	70,900	22.3%	359	197	70,640	22.2%
	500-1,000 ha	43	728	31,284	9.8%	44	719	31,638	9.9%
	1,000-5,000 ha	48	1,806	86,678	27.2%	48	1,806	86,678	27.2%
	5,000-10,000 ha	2	7,975	15,950	5.0%	2	7,975	15,950	5.0%
	over 10,000 ha	2	15,444	30,887	9.7%	2	15,444	30,887	9.7%
Total BRETAGNE		**5,187**	**61**	**318,112**	**100.0%**	**5,188**	**61**	**318,112**	**100.0%**

administrative region	area class	1999				2004			
		number of forest units	mean area mapped per forest unit (ha)	total mapped area ha	total mapped area %	number of forest units	mean area mapped per forest unit (ha)	total mapped area ha	total mapped area %
CENTRE	4-25 ha	4,486	10	43,948	4.9%	4,462	10	44,124	4.8%
	25-50 ha	767	35	26,756	3.0%	785	35	27,468	3.0%
	50-100 ha	452	69	31,172	3.5%	449	69	31,160	3.4%
	100-500 ha	462	197	91,013	10.1%	464	199	92,370	10.0%
	500-1,000 ha	70	638	44,642	5.0%	66	639	42,181	4.6%
	1,000-5,000 ha	69	1,856	128,044	14.2%	72	1,773	127,656	13.8%
	5,000-10,000 ha	10	7,100	71,001	7.9%	11	6,930	76,228	8.2%
	over 10,000 ha	11	42,056	462,611	51.4%	12	40,383	484,601	52.3%
Total CENTRE		**6,327**	**142**	**899,188**	**100.0%**	**6,321**	**146**	**925,789**	**100.0%**
CHAMPAGNE-ARDENNE	4-25 ha	2,030	10	20,032	2.9%	2,029	10	20,025	2.9%
	25-50 ha	349	35	12,079	1.8%	349	35	12,050	1.8%
	50-100 ha	219	70	15,262	2.2%	220	69	15,228	2.2%
	100-500 ha	260	198	51,398	7.5%	261	198	51,644	7.6%
	500-1,000 ha	43	613	26,347	3.9%	43	613	26,347	3.9%
	1,000-5,000 ha	54	1,676	90,500	13.3%	54	1,685	90,975	13.4%
	5,000-10,000 ha	12	6,451	77,418	11.4%	11	6,979	76,767	11.3%
	over 10,000 ha	22	17,634	387,954	57.0%	22	17,634	387,954	57.0%
Total CHAMPAGNE-ARDENNE		**2,989**	**228**	**680,990**	**100.0%**	**2,989**	**228**	**680,990**	**100.0%**
CORSE	4-25 ha	200	12	2,446	0.6%	238	12	2,864	0.6%
	25-50 ha	63	36	2,277	0.6%	58	36	2,111	0.4%
	50-100 ha	61	71	4,335	1.1%	44	68	2,995	0.6%
	100-500 ha	58	233	13,497	3.5%	42	229	9,611	2.0%
	500-1,000 ha	10	624	6,242	1.6%	12	683	8,193	1.7%
	1,000-5,000 ha	14	2,283	31,961	8.4%	6	2,124	12,746	2.7%
	5,000-10,000 ha	1	7,967	7,967	2.1%				
	over 10,000 ha	3	104,428	313,285	82.0%	2	220,029	440,057	92.0%
Total CORSE		**410**	**932**	**382,011**	**100.0%**	**402**	**1,190**	**478,577**	**100.0%**
FRANCHE-COMTE	4-25 ha	657	10	6,883	1.0%	657	10	6,883	1.0%
	25-50 ha	122	36	4,353	0.6%	122	36	4,353	0.6%
	50-100 ha	87	69	5,998	0.9%	88	69	6,086	0.9%
	100-500 ha	96	204	19,616	2.8%	95	206	19,529	2.8%
	500-1,000 ha	31	605	18,762	2.7%	31	605	18,762	2.7%
	1,000-5,000 ha	27	1,997	53,906	7.7%	28	1,961	54,908	7.8%
	5,000-10,000 ha	6	5,262	31,575	4.5%	5	6,115	30,573	4.3%
	over 10,000 ha	7	80,448	563,134	80.0%	7	80,448	563,134	80.0%
Total FRANCHE-COMTE		**1,033**	**682**	**704,226**	**100.0%**	**1,033**	**682**	**704,226**	**100.0%**
HAUTE-NORMANDIE	4-25 ha	883	10	8,518	3.8%	902	10	8,701	3.9%
	25-50 ha	156	34	5,346	2.4%	171	35	6,050	2.7%
	50-100 ha	130	69	8,943	4.0%	115	69	7,936	3.5%
	100-500 ha	152	213	32,307	14.3%	145	202	29,230	13.0%
	500-1,000 ha	28	600	16,806	7.4%	30	609	18,261	8.1%
	1,000-5,000 ha	29	1,748	50,706	22.5%	30	1,842	55,253	24.5%
	5,000-10,000 ha	5	6,169	30,844	13.7%	5	6,237	31,185	13.8%
	over 10,000 ha	3	24,068	72,205	32.0%	3	22,961	68,882	30.5%
Total HAUTE-NORMANDIE		**1,386**	**163**	**225,675**	**100.0%**	**1,401**	**161**	**225,497**	**100.0%**
ILE-DE-FRANCE	4-25 ha	897	10	8,972	3.2%	1,038	10	10,357	3.6%
	25-50 ha	165	34	5,572	2.0%	209	34	7,161	2.5%
	50-100 ha	101	69	6,936	2.5%	102	69	6,987	2.4%
	100-500 ha	130	204	26,570	9.4%	159	193	30,668	10.6%
	500-1,000 ha	35	646	22,616	8.0%	28	608	17,025	5.9%
	1,000-5,000 ha	28	2,030	56,841	20.2%	31	1,972	61,124	21.2%
	5,000-10,000 ha	2	3,014	6,029	2.1%	3	4,664	13,993	4.9%
	over 10,000 ha	3	49,356	148,069	52.6%	4	35,202	140,807	48.9%
Total ILE-DE-FRANCE		**1,361**	**207**	**281,604**	**100.0%**	**1,574**	**183**	**288,124**	**100.0%**

APPENDIX 11

administrative region	area class	1999				2004			
		number of forest units	mean area mapped per forest unit (ha)	total mapped area ha	total mapped area %	number of forest units	mean area mapped per forest unit (ha)	total mapped area ha	total mapped area %
LANGUEDOC-ROUSSILLON	4-25 ha	1,054	10	10,660	0.9%	1,110	10	11,271	0.9%
	25-50 ha	201	35	7,130	0.6%	232	35	8,136	0.7%
	50-100 ha	157	69	10,907	0.9%	149	69	10,280	0.8%
	100-500 ha	154	202	31,035	2.7%	137	202	27,646	2.3%
	500-1,000 ha	13	688	8,948	0.8%	11	718	7,900	0.7%
	1,000-5,000 ha	14	2,275	31,855	2.7%	15	2,227	33,407	2.8%
	5,000-10,000 ha	2	3,470	6,941	0.6%	3	4,190	12,569	1.0%
	over 10,000 ha	2	525,784	1,051,568	90.7%	2	550,697	1,101,393	90.8%
Total LANGUEDOC-ROUSSILLON		**1,597**	**726**	**1,159,043**	**100.0%**	**1,659**	**731**	**1,212,602**	**100.0%**
LIMOUSIN	4-25 ha	1,812	11	20,337	3.8%	2,011	10	19,690	3.4%
	25-50 ha	427	34	14,503	2.7%	322	35	11,198	2.0%
	50-100 ha	230	66	15,194	2.9%	253	67	16,956	3.0%
	100-500 ha	199	203	40,363	7.6%	168	197	33,173	5.8%
	500-1,000 ha	23	625	14,386	2.7%	24	693	16,634	2.9%
	1,000-5,000 ha	14	2,450	34,302	6.4%	16	2,139	34,230	6.0%
	5,000-10,000 ha	4	3,334	13,337	2.5%	4	3,809	15,234	2.7%
	over 10,000 ha	3	126,523	379,570	71.3%	3	141,464	424,392	74.3%
Total LIMOUSIN		**2,712**	**196**	**531,992**	**100.0%**	**2,801**	**204**	**571,507**	**100.0%**
LORRAINE	4-25 ha	987	10	10,030	1.2%	1,042	10	10,650	1.2%
	25-50 ha	245	35	8,555	1.0%	251	35	8,847	1.0%
	50-100 ha	168	71	11,875	1.4%	161	71	11,415	1.3%
	100-500 ha	266	212	56,384	6.6%	262	211	55,344	6.5%
	500-1,000 ha	70	690	48,284	5.7%	72	676	48,695	5.7%
	1,000-5,000 ha	65	1,942	126,211	14.8%	62	1,923	119,203	13.9%
	5,000-10,000 ha	9	6,458	58,119	6.8%	10	6,410	64,100	7.5%
	over 10,000 ha	20	26,533	530,653	62.4%	19	28,284	537,400	62.8%
Total LORRAINE		**1,830**	**465**	**850,110**	**100.0%**	**1,879**	**455**	**855,655**	**100.0%**
MIDI-PYRENEES	4-25 ha	4,466	10	46,802	3.7%	4,963	10	48,323	3.7%
	25-50 ha	780	35	27,534	2.2%	715	35	25,346	1.9%
	50-100 ha	481	68	32,573	2.6%	446	68	30,514	2.3%
	100-500 ha	404	192	77,542	6.1%	393	197	77,559	5.9%
	500-1,000 ha	64	663	42,418	3.4%	65	683	44,400	3.4%
	1,000-5,000 ha	35	1,932	67,630	5.4%	37	1,908	70,591	5.4%
	5,000-10,000 ha	7	6,549	45,846	3.6%	6	6,362	38,170	2.9%
	over 10,000 ha	8	115,262	922,093	73.0%	8	121,982	975,858	74.4%
Total MIDI-PYRENEES		**6,245**	**202**	**1,262,438**	**100.0%**	**6,633**	**198**	**1,310,762**	**100.0%**
NORD-PAS-DE-CALAIS	4-25 ha	827	10	8,234	9.3%	1,078	10	10,509	11.0%
	25-50 ha	149	35	5,243	5.9%	179	34	6,080	6.3%
	50-100 ha	109	68	7,389	8.4%	116	68	7,854	8.2%
	100-500 ha	91	213	19,422	22.0%	101	210	21,216	22.1%
	500-1,000 ha	11	709	7,801	8.8%	14	731	10,229	10.7%
	1,000-5,000 ha	10	1,670	16,696	18.9%	9	1,776	15,984	16.7%
	5,000-10,000 ha	3	7,431	22,293	25.3%	3	7,606	22,817	23.8%
	over 10,000 ha	1	1,194	1,194	1.4%	1	1,255	1,255	1.3%
Total NORD-PAS-DE-CALAIS		**1,201**	**73**	**88,273**	**100.0%**	**1,501**	**64**	**95,944**	**100.0%**
PAYS DE LA LOIRE	4-25 ha	3,129	10	30,984	10.9%	3,729	9	35,407	11.8%
	25-50 ha	479	34	16,413	5.8%	543	34	18,679	6.2%
	50-100 ha	256	69	17,729	6.2%	296	69	20,296	6.7%
	100-500 ha	248	197	48,844	17.1%	260	198	51,353	17.1%
	500-1,000 ha	34	658	22,373	7.8%	37	680	25,142	8.4%
	1,000-5,000 ha	33	2,030	67,001	23.5%	33	2,060	67,977	22.6%
	5,000-10,000 ha	6	6,601	39,606	13.9%	6	6,614	39,683	13.2%
	over 10,000 ha	2	21,078	42,156	14.8%	2	21,078	42,156	14.0%
Total PAYS DE LA LOIRE		**4,187**	**68**	**285,106**	**100.0%**	**4,906**	**61**	**300,692**	**100.0%**

administrative region	area class	1999 number of forest units	1999 mean area mapped per forest unit (ha)	1999 total mapped area ha	1999 total mapped area %	2004 number of forest units	2004 mean area mapped per forest unit (ha)	2004 total mapped area ha	2004 total mapped area %
PICARDIE	4-25 ha	1,675	10	16,912	5.3%	1,733	10	17,302	5.4%
	25-50 ha	344	34	11,858	3.7%	373	35	12,892	4.0%
	50-100 ha	249	69	17,294	5.4%	231	71	16,311	5.1%
	100-500 ha	262	199	52,095	16.3%	280	202	56,685	17.7%
	500-1,000 ha	39	638	24,897	7.8%	31	661	20,481	6.4%
	1,000-5,000 ha	28	1,909	53,441	16.7%	33	1,888	62,294	19.4%
	5,000-10,000 ha	3	6,917	20,752	6.5%				
	over 10,000 ha	3	40,782	122,345	38.3%	4	33,671	134,683	42.0%
Total PICARDIE		**2,603**	**123**	**319,594**	**100.0%**	**2,685**	**119**	**320,648**	**100.0%**
POITOU-CHARENTES	4-25 ha	3,253	10	33,359	9.3%	3,252	10	33,330	9.3%
	25-50 ha	637	35	22,237	6.2%	635	35	22,225	6.2%
	50-100 ha	356	67	23,913	6.7%	356	67	23,764	6.6%
	100-500 ha	336	202	67,956	18.9%	338	201	68,106	19.0%
	500-1,000 ha	60	662	39,691	11.1%	60	662	39,691	11.1%
	1,000-5,000 ha	37	1,985	73,451	20.5%	37	1,985	73,451	20.5%
	5,000-10,000 ha	6	5,262	31,572	8.8%	6	5,262	31,572	8.8%
	over 10,000 ha	2	33,324	66,647	18.6%	2	33,344	66,687	18.6%
Total POITOU-CHARENTES		**4,687**	**77**	**358,827**	**100.0%**	**4,686**	**77**	**358,827**	**100.0%**
PROVENCE-ALPES-	4-25 ha	678	11	7,234	0.5%	766	11	8,062	0.5%
COTE D'AZUR	25-50 ha	158	35	5,572	0.4%	152	34	5,185	0.3%
	50-100 ha	84	72	6,012	0.4%	95	70	6,684	0.4%
	100-500 ha	92	209	19,258	1.2%	77	205	15,784	1.0%
	500-1,000 ha	19	709	13,467	0.9%	19	684	12,997	0.8%
	1,000-5,000 ha	11	1,343	14,777	0.9%	10	1,520	15,204	1.0%
	5,000-10,000 ha	2	5,489	10,978	0.7%	2	5,783	11,565	0.7%
	over 10,000 ha	2	744,194	1,488,387	95.1%	2	749,150	1,498,300	95.2%
Total PROVENCE-ALPES-COTE D'AZUR		**1,046**	**1,497**	**1,565,686**	**100.0%**	**1,123**	**1,401**	**1,573,782**	**100.0%**
RHONE-ALPES	4-25 ha	2,407	10	23,422	1.4%	2,411	10	23,473	1.4%
	25-50 ha	451	34	15,411	0.9%	450	34	15,451	0.9%
	50-100 ha	254	67	17,075	1.0%	255	67	17,172	1.0%
	100-500 ha	257	200	51,307	3.0%	255	200	50,975	3.0%
	500-1,000 ha	42	663	27,843	1.6%	43	651	28,011	1.6%
	1,000-5,000 ha	21	1,644	34,516	2.0%	21	1,643	34,499	2.0%
	5,000-10,000 ha	5	5,366	26,829	1.6%	4	5,099	20,397	1.2%
	over 10,000 ha	4	380,506	1,522,025	88.6%	5	305,690	1,528,451	88.9%
Total RHONE-ALPES		**3,441**	**499**	**1,718,428**	**100.0%**	**3,444**	**499**	**1,718,428**	**100.0%**

(Source: IFN 1999 and 2004, for all forests and poplar plantations of over 4 ha, according to IFN cartographic data, considering that a gap of 200 m does not interrupt the continuity of a forest unit. The forest areas monitored were greater than those derived from statistical data because they were from cartographic analyses (cf. Appendix 3). Forest units overlapping two regions were counted twice, so the data could not be totalled)

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE

MINISTÈRE
DE L'AGRICULTURE
ET DE LA PÊCHE

http://www.agriculture.gouv.fr

September 2006

INVENTAIRE FORESTIER
NATIONAL

http://www.ifn.fr