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.

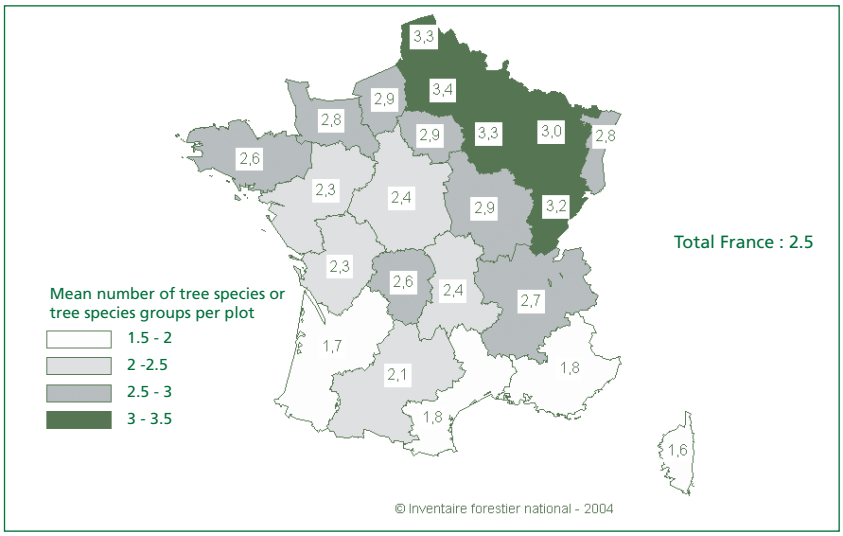
This indicator can be summarised on the basis of the mean number of tree species per stand, which increased from 2.46 to 2.54 within 10 years throughout France. The distribution by forest type confirms the previous analysis, i.e. mixed stands currently contain 3.30 species on average, as compared to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

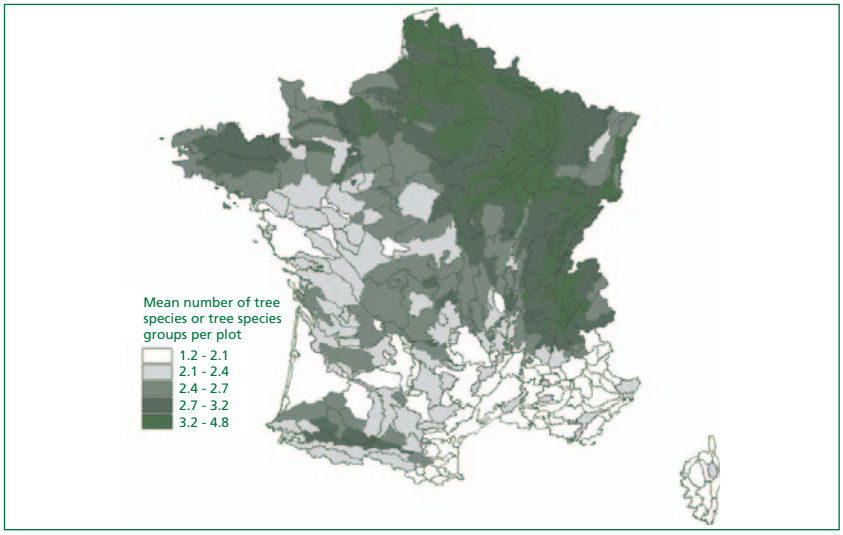
Map 17 highlights some differences within administrative regions. The situation is homogeneous in the Mediterranean region but varied in Aquitaine, i.e. the low diversity of monospecific maritime pine stands on the Landes plateau contrasts with the richness of pedunculate oak stands on the Gascogne hillsides 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.



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

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.

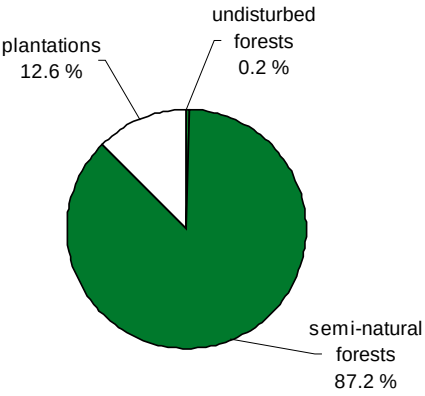


Figure 17: Forest area according to the extent of naturalness (source: MAP and IFN, 2004)

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.

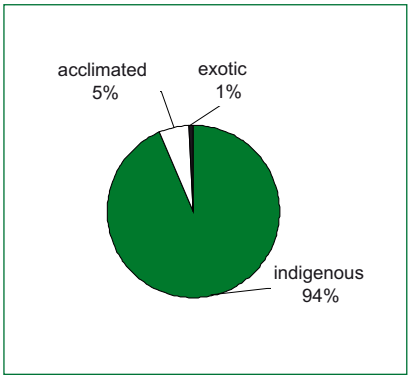


Figure 18: Forest area according to the extent of naturalness of the main species (source: IFN, 2004)

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).

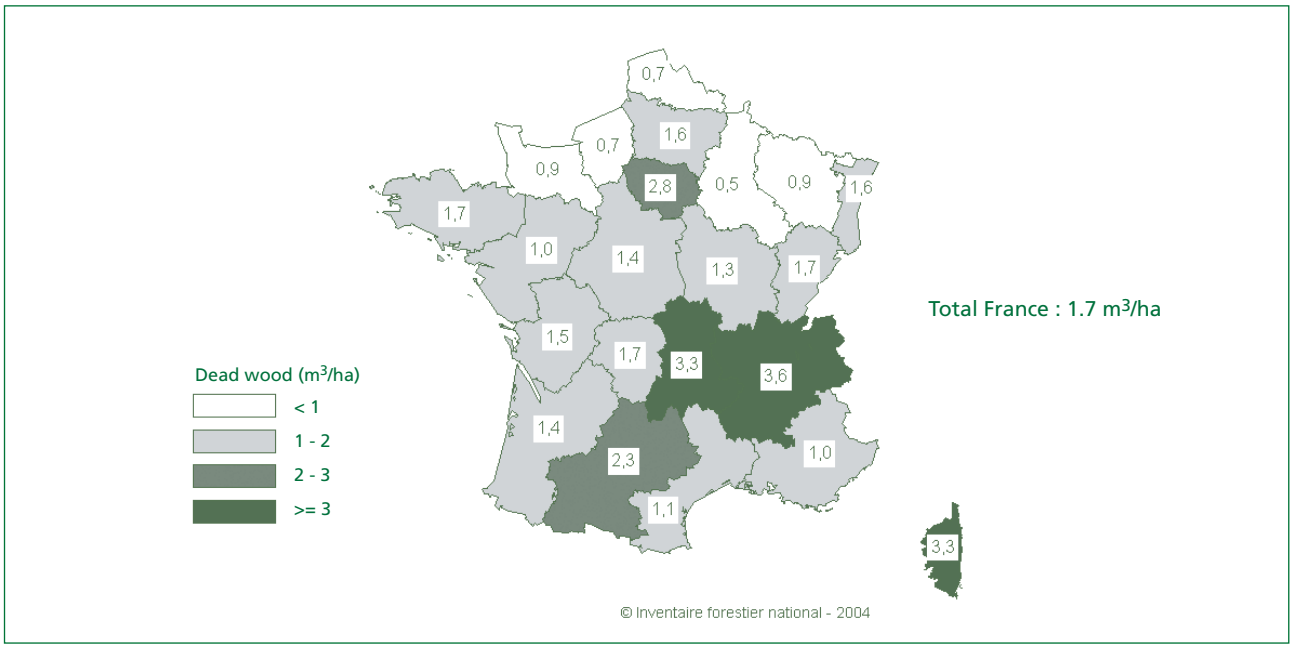
Mixed stands have the highest per-ha deadwood volume (2.5 m³/ha), ahead of conifer stands (2 m³/ha) and broadleaved stands (1.5 m³/ha). Mixed stands also showed the most marked increase in deadwood volume over the last 15 years.
Of the main tree species involved, chestnut has the highest total deadwood 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.

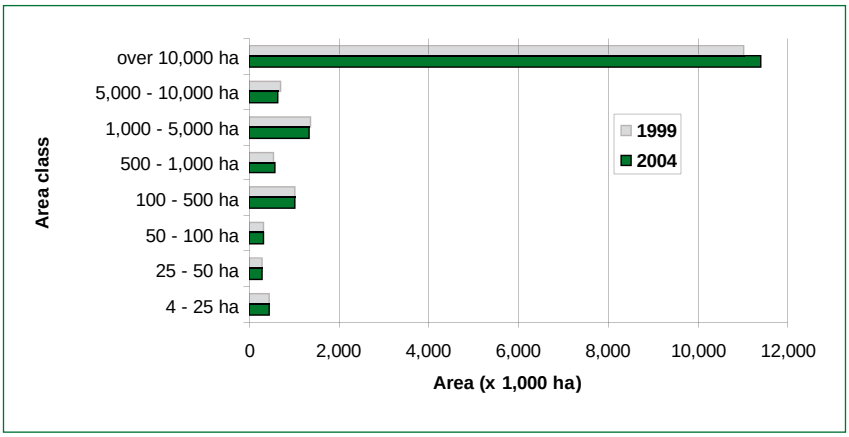


Figure 19: Forest area (including poplar stands) per forest range area in 1999 and 2004 (source: IFN)

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

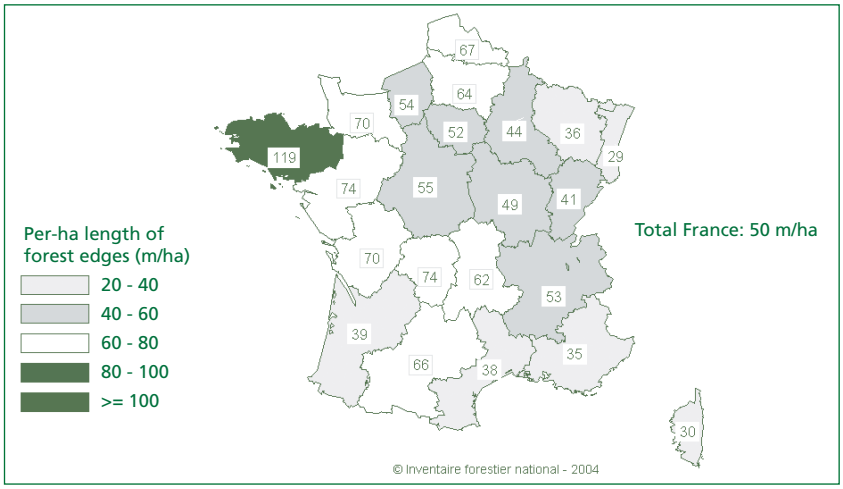
Forest stands (including poplar plantations) and other wooded lands

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

			2001 area (ha)	2004 area (ha)			2004
MCPFE protection class		Type of protected area	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.

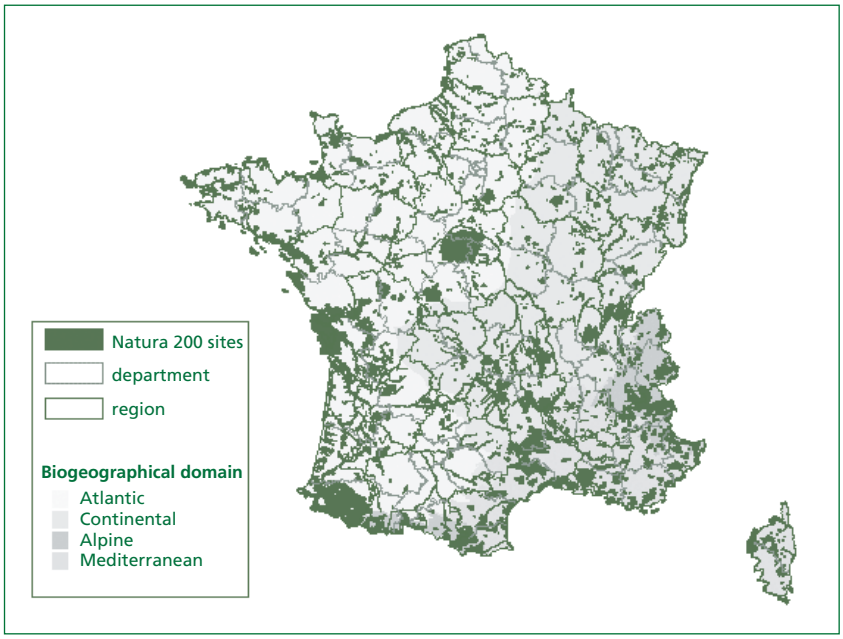
Finally, there are also other protection statuses in France, including the landuse planning classification "woodlands to be preserved". This status prohibits any change in classification or landuse strategy that could jeopardise woodland conservation, protection or creation.

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.)

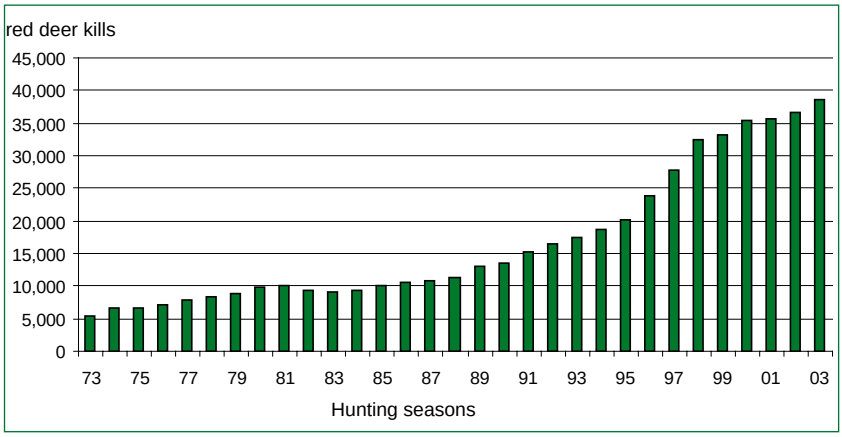


Figure 20: Variations in annual red deer kills from 1973 to 2003
(source: réseau cervidés-sanglier ONCFS-FNC)

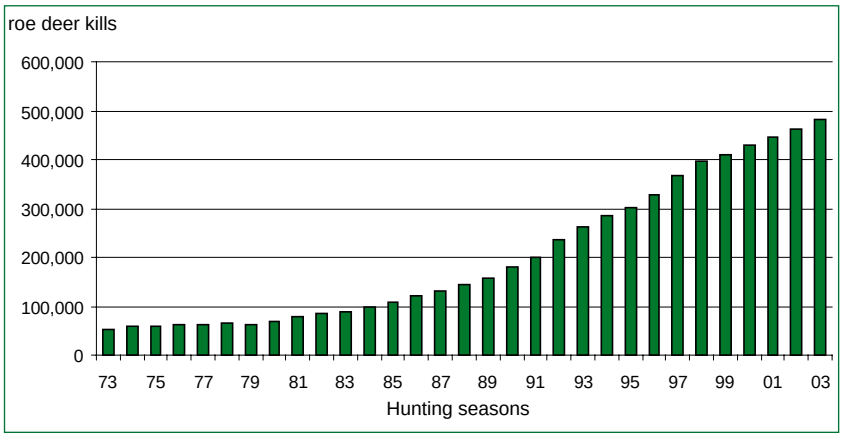


Figure 21: Variations in annual roe deer kills from 1973 to 2003
(source : réseau cervidés-sanglier ONCFS-FNC)

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.