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

Forests available for wood supply (excluding stands ineligible for inventory)

Data retrieval year Survey years	2010 2006 to 2009							
	Broadleaved stand		Conifer stand		Mixed stand		Total	
Number of species eligible for inventory in the stand	*1 000 ha*	*%*	*1 000 ha*	*%*	*1 000 ha*	*%*	*1 000 ha*	*%*
1 species	520 ± 37	6	725 ± 44	23	-		1 245 ± 57	9
2 species	871 ± 48	9	669 ± 44	21	100 ± 18	6	1 640 ± 66	12
3 species	1 342 ± 58	14	600 ± 40	19	221 ± 25	14	2 162 ± 73	15
4 species	1 474 ± 61	16	451 ± 34	14	268 ± 27	17	2 193 ± 73	16
5 species	1 431 ± 59	15	302 ± 28	10	240 ± 25	15	1 974 ± 68	14
6 species	1 229 ± 55	13	189 ± 22	6	226 ± 24	15	1 643 ± 63	12
7 species	925 ± 47	10	91 ± 16	3	164 ± 21	11	1 180 ± 53	8
8 species	658 ± 40	7	49 ± 11	2	129 ± 18	8	837 ± 45	6
9 species	416 ± 33	4	n. s.		86 ± 15	6	524 ± 36	4
10 species or more	468 ± 35	5	n. s.		117 ± 18	8	602 ± 40	4
Total	**9 334 ± 110**	**100**	**3 114 ± 81**	**100**	**1 551 ± 62**	**100**	**13 999 ± 107**	**100**
Mean number of species eligible for inventory	5.0		3.1		5.6		4.7	

Source: NFI.
Relevant domain: FAWS, excluding stands ineligible for inventory.

The number of species eligible for inventory per stand is the number of species monitored in a 20 are circular plot* centred on a sampling point, while only counting trees with a stem diameter of at least 7.5 cm at breast height. All species, regardless of their number, are counted when the trees fulfil these inventory conditions.

Stands not eligible for inventory were excluded from this indicator since here the focus is only on species with final crop trees in the stand and which are not simply part of the understorey. Ineligible stands may contain a few trees that would be eligible for inventory, but the number of species calculated would not be representative of the actual diversity of the current or future final crop stand.

The data presented in the ISFM 2005 edition differed considerably from the data presented here because there were fewer classes assessed for the number of trees and also because some species were pooled to ensure consistency between inventories. Sessile, pedunculate and pubescent oaks were thus counted as a single species and equer trees were classified with fruit tree species. These groupings were discarded here so that the data presented would be more in line with the actual situation in forests.

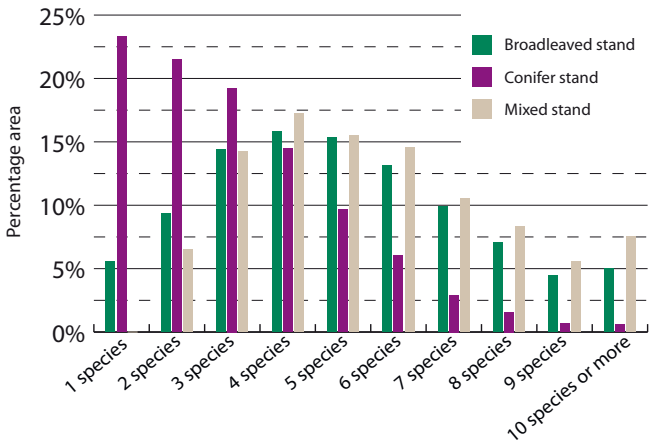
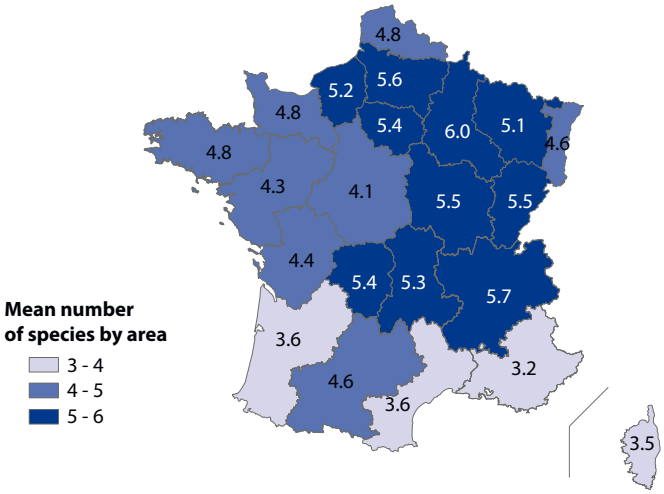


Figure 29: Proportion of FAWS area per number of species eligible for inventory present and per forest type.
Source: NFI, survey years 2006 to 2009.

* The sampling plot corresponds to a 25 m radius around each sampling point.

Over 90% of stands eligible for inventory contain at least two species that have reached the eligible stage and contain 4.7 eligible species on average. Stands with mixtures of three eligible species and more account for 79% of the area and 48% of this area has at least five eligible species. Monospecific stands represent under 10% of the eligible for inventory stand area.
Eligible stands with a broadleaved main species contain 5.0 eligible species on average, whereas stands with a conifer main species contain 3.7. This lower diversity could mainly be explained by the higher proportion of monospecific conifer stands as compared to broadleaved stands.



Map 18: Mean number of species eligible for inventory per administrative region.

Source: NFI, survey years 2006 to 2009.

Champagne-Ardenne, Bourgogne, Picardie, Rhône-Alpes and Franche-Comté regions have the highest mean number of species eligible for inventory per plot, with an average ranging from 5.5 to 6 species per plot. In contrast, Mediterranean regions (PACA, Corsica, Languedoc-Roussillon) have the lowest mean number of eligible species per plot, with fewer than four eligible species per plot on average. This lower diversity in Aquitaine could be explained by the prevalence of maritime pine monocultures in this region. However, in Mediterranean regions, this low intra-stand diversity should be analysed with caution because it is more a reflection of the lower number of eligible species in these stands than a lack of diversity. Indeed, NFI flora analyses, which are not only restricted to trees eligible for inventory, have shown that the Mediterranean is one of the regions with the highest number of tree species. Finally, it should be kept in mind that the regional differences likely mainly reflect the impact of the high soil fertility at the site on the stand diversity.

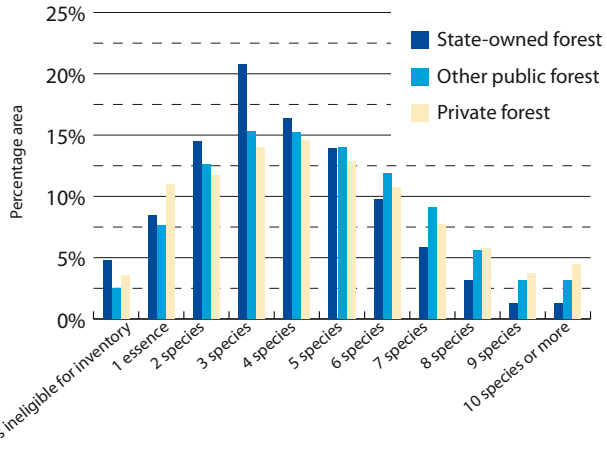
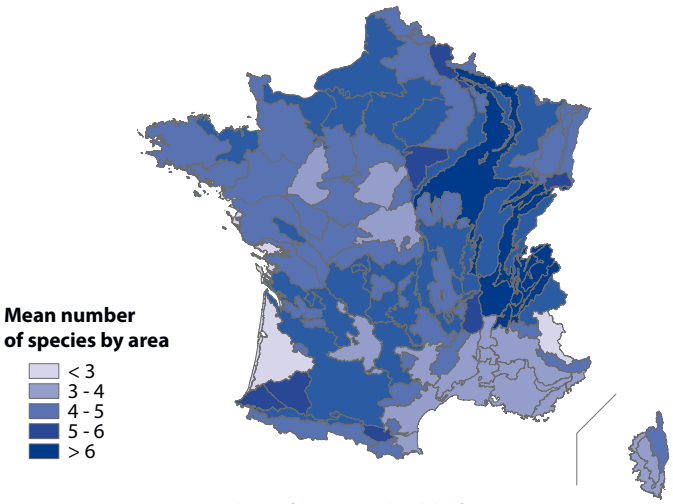


Figure 30: Proportion of FAWS area per number of species eligible for inventory present and forest ownership category.

Source: NFI, survey years 2006 to 2009.

State-owned forests have the lowest mean number of species eligible for inventory, with 4.1 eligible species per plot on average. Twenty-three percent of the state-owned forest area is located in PACA and Languedoc-Roussillon regions, where there are fewer eligible species, which could explain this average, in addition to the fact that many state-owned forests, especially protection forests, are located on relatively infertile land. However, private forests and other public forests have 4.7 eligible species on average. This relative diversity of private forests could be explained by the willingness to manage these forests, and also likely by the presence of various species in unmanaged private forests, since silviculturists do not orient species selection. These factors suggest that the forest ownership category could actually reflect the impact of other sources of variability, such as the type of site on which the stands are located.



Map 19: Mean number of species eligible for inventory per silvoecoregion.

Source: NFI, survey years 2006 to 2009.

Indicator 4.1.1

Proportion of the main species in stands

Forests available for wood supply – excluding temporarily unstocked stands

Proportion of the main species in basal area

ISFM 2005 Edition

Data retrieval year	1989	1994	1999	2004
Average year	1981	1986	1991	1996
Main tree species	*Proportion of the main species relative to the basal area for all tree species (% purity)*			
Pedunculate oak / Sessile oak	63	62	62	59
Beech	69	68	67	67
Chestnut	80	80	79	79
Pubescent oak	86	86	85	83
Hornbeam	57	57	56	55
Common ash	48	49	49	48
Birch	59	58	58	58
False acacia	71	73	71	71
Holm oak	85	86	85	84
Aspen	50	49	49	46
Large alder	75	73	74	74
Large maple	43	43	45	45
Small maple	50	49	46	47
Cherry or wild cherry	42	41	40	41
Linden	49	49	46	48
Other broadleaved	65	64	64	63
Total broadleaved	**66**	**66**	**65**	**64**
Common spruce	75	77	77	78
Silver fir	76	76	75	75
Scots pine	77	76	75	74
Maritime pine	86	87	86	87
Douglas fir	79	82	82	81
Corsican pine	82	81	82	83
Austrian pine	83	82	82	82
Larch	79	80	79	79
Aleppo pine	75	75	75	72
Other Conifers	80	80	80	80
Total conifers	**79**	**79**	**79**	**79**
Total	**71**	**71**	**71**	**70**

Source: NFI.
Relevant domain: FAWS, excluding poplar plantations and including thickets, for trees eligible for inventory.

ISFM 2010 Edition

Data retrieval year	2010
Survey years	2006 to 2009
Main tree species	*Proportion of the main tree species relative to the basal area for all tree species (% purity)*
Pedunculate oak	60
Sessile oak	65
Beech	66
Chestnut	72
Pubescent oak	75
Common ash	48
Hornbeam	50
Cultivated poplar	78
Holm oak	78
Birch	49
False acacia	62
Large alder	64
Large maple	46
Aspen	48
Linden	45
Small maple	52
Cherry or wild cherry	53
Other broadleaved	71
Total broadleaved	64
Common spruce	79
Silver fir	75
Scots pine	79
Maritime pine	89
Douglas fir	82
Corsican pine	85
Austrian pine	82
Larch	80
Aleppo pine	88
Other conifers	82
Total conifers	81
Total	70

Source: NFI.
Relevant domain: FAWS.

The main species here is the one with the greatest cover eligible for inventory within the stand (assessed within a 20 are* circular plot around a sampling point) or, when there is no eligible cover, the species with the greatest cover ineligible for inventory (assessed within a 7 are** circular plot around a sampling point). This definition is in line with that used until 2004, except in mixed coppice/high forest stands where the main species is the one with the greatest cover in the high forest layer. This change concerning the determination of the main species in mixed stands means that there is more area in which the main species is a coppice species. Classification of these areas with a main species frequently found in coppices, and no longer with a high forest species, means that there is a lower percentage of basal area for coppice species than previously (at mixed species sampling points, the presence of high forest trees decreases the percentage of basal area for coppice species trees).

Despite the fact that forest management is focused to an increasing extent on enhancing species diversity, French silviculturists still give priority to one or two main gregarious species, associated with secondary species or an understorey. This is why the percentage of basal area of the main species remains high (70 %).

In conifer stands, the main species clearly predominates in terms of basal area (81%) as compared to broadleaved stands (64% of the basal area).

Stands of valuable broadleaved species and various preponderant broadleaved species have a low percentage of the main tree species relative to the basal area, i.e. not above 53% for valuable broadleaved species (wild cherry, ash, large maple) and 50% for various broadleaved species (birch, hornbeam, aspen).

* corresponding to a circular 25 m radius plot around the sampling point.
** corresponding to a circular 15 m radius plot around the sampling point.

Percentage area of stands eligible for survey in which the main species is pure or preponderant (at least 50% of the cover for this species and less than 15% for the second most common species) in all eligible stands in which it is the main species

A stand is considered pure for a given species if the relative free cover for this species is over 75%. A species is considered preponderant if its relative free cover is over 50% and the rate of the second most common species in the stand is not higher than 15% (see Appendix V).

On average, stands in which the main species is pure or preponderant represent 51% of the area of stands eligible for survey.

Except for pubescent and holm oak stands, broadleaved stands in which the main species is preponderant represent under 50% of the total area of the main species concerned.

The lowest rate is noted for birch—stands in which this species is preponderant represent only 29% of the stands in which birch is the main species.
The trend is reversed for conifers, with the lowest rate obtained by fir and spruce. These stands, which are commonly found in mountain areas, are often mixed with beech.

Data retrieval year	**2010**		
Survey years	**2006 to 2009**		
Main tree species	*Area of stands*	*Area of eligible stands in which the tree species predominates*	*Proportion of the area in which the main tree species predominates*
	1000 ha	*1000 ha*	*%*
Pedunculate oak	1 840 ± 64	696 ± 42	38
Sessile oak	1 586 ± 55	750 ± 40	47
Beech	1 351 ± 54	618 ± 38	46
Pubescent oak	1 275 ± 54	836 ± 45	66
Chestnut	692 ± 41	326 ± 29	47
Holm oak	589 ± 40	366 ± 32	62
Common ash	539 ± 37	149 ± 20	28
Hornbeam	528 ± 34	76 ± 14	14
Birch	248 ± 25	72 ± 13	29
Cultivated poplar	198 ± 21	174 ± 19	88
False acacia	173 ± 22	65 ± 14	38
Large alder	132 ± 19	39 ± 11	30
Other broadleaved	812 ± 47	232 ± 26	29
Maritime pine	924 ± 45	782 ± 42	85
Scots pine	851 ± 45	517 ± 36	61
Common spruce	571 ± 37	333 ± 29	58
Silver fir	550 ± 34	284 ± 25	52
Douglas fir	358 ± 30	258 ± 25	72
Austrian pine	176 ± 22	117 ± 18	66
Corsican pine	173 ± 21	129 ± 18	75
Aleppo pine	168 ± 23	130 ± 20	78
Larch	98 ± 15	69 ± 13	71
Other conifers	165 ± 21	112 ± 17	68
Total	**13 999 ± 107**	**7 132 ± 110**	**51**

Source: NFI.
Relevant domain: FAWS, excluding stands ineligible for inventory.

Indicator 4.2

Area of regeneration within forest stands, classified by regeneration type and main tree species in the stand

Forests available for wood supply

The method used until 2005 to generate data for this indicator, i.e. based on aerial photo observation, is no longer applied. This technique involved overlaying field plots of the previous inventory over aerial photographs of the latest inventory. This method was not reliable as it was hard to determine the type of cutting on aerial photographs.

With the new inventory method, it is now possible to use field data for this indicator, i.e. on the presence and even type of cutting, the type of plantation and the main species in the stand. The felling details describe the type of cutting conducted at the sampling point during the 5 years prior to the inventory, with the following conditions: clearcutting with rehabilitation, clearcutting without rehabilitation, total cutting of the overstorey, intensive cutting of the overstorey, partial or no cutting.

The type of regeneration is classified as natural in the following situations:

– clearcutting noted without rehabilitation and unplanted stand;
– total cutting of the stand overstorey;
– intensive cutting of the overstorey.

Conversely, the type of regeneration is classified as artificial in the following situations:

– clearcutting noted without rehabilitation and planted stand;
– clearcutting noted with rehabilitation;
– stands temporarily unstocked and absence of recent cutting (if the cutting is not recent and the area is completely unstocked, it is presumed that planting is necessary to maintain the wooded state).

This method is quite reliable, but the data should still be carefully interpreted, i.e. some inventory data can be circumstantial. For instance, if the sampling point is inventoried right after clearcutting and there are no signs of rehabilitation, it does not necessarily mean that no rehabilitation work will take place, so this classification could turn out to be inaccurate.

Data retrieval year	**2010**			
Survey years	**2006 to 2009**			
	Main tree species		**Total**	
	Broadleaved	**Conifers**		
Regeneration type	*1000 ha/ year*	*1000 ha/ year*	*1000 ha/ year*	*%*
Artificial	12.8	14.6	27.4	29
Natural	53.0	14.5	67.6	71
Total	**65.8**	**29.2**	**95.0**	**100**

Source: NFI.
Relevant domain: FAWS.

Note: the results do not take variations of forest area into account (see 1.1.1.).

The area regenerated annually is estimated at 95,000 ha, nearly 30% of which is artificially regenerated. This area is slightly greater than that obtained based on the previous aerial photo observation method (82,800 ha in the ISFM 2005 edition).
Almost 70% of the regenerated stands are broadleaved. Most artificially regenerated stands are conifers (53%), whereas a major proportion of naturally regenerated stands are broadleaved (78%).

The main naturally regenerated species are pedunculate, pubescent and sessile oak, chestnut, beech and maritime pine. The fact that this latter species is seldom found in natural regeneration stands suggests that its presence highlights the shortcomings of the method discussed above. The main species regenerated artificially are especially maritime pine and Douglas fir, as well as pedunculate oak, beech and cultivated poplar.

Indicator 4.3

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

Forests available for wood supply

The areas are classified as follows:

– Undisturbed forests were estimated at 30,000 ha due to the lack of data on this topic. By definition, these are forests that have existed since time immemorial, are composed exclusively of native species and there has been no human intervention for at least 50 years. This estimation was based on 1994 data from the Office national des forêts and the French National Forest Inventory. The value for private forests was estimated by applying the same ratio as that applied for public forests between undisturbed forest and forest not available for wood supply (estimated by NFI), this data could thus be slightly overestimated—private forests are less represented in mountain areas where most undisturbed forests are found;

– All plantations, regardless of their age, are now classified under the plantations category while differentiating planted species (broadleaved, conifer and mixed planted species). In the ISFM 2005 edition, an age limit of 40 years old was set for plantations, beyond which stands were classified under semi-natural forests by default;

– Semi-natural forests are those which, by default, do not qualify as plantations or undisturbed forests.

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 account for 12% of the forest area, or over 1.9 million ha, and mainly involve conifers. Douglas fir is the top-ranking species planted, with around 350,000 ha. Indigenous species follow, with maritime pine and common spruce, followed by Corsican pine and Austrian pine. The plantation area will likely decrease in the coming years—sales of forest plants dropped sharply following the storms of 1999 and 2009 (DGPAAT/SDFB, 2011).

Pedunculate oak, sessile oak and beech plantations represent 7% of the plantation area. Less human intervention is required in these plantations as compared to others since they are logged at an advanced age.

Semi-natural forests represent 88% of the total area, with broadleaved species accounting for two-thirds of the stands, and these forests contain most of the mixed forest stands.

The naturalness concept is hard to assess. Studies carried out by the French National Institute for Agricultural Research (INRA) highlighted the advantages of the 'old forest' concept, which could be used to develop a supplementary indicator.

This indicator, which would be based on how long the area has been in a wooded state, rather than on the age of the trees or the stand structure, would be aimed at revealing the functioning and diversity of forest ecosystems. This research resulted in the identification of typical plant associations in long-standing forests.

Data retrieval year	**2010**		
Survey years	**2006 to 2009**		
Naturality degree	*Forest type*	*1000 ha*	*%*
Undisturbed forests		30	0
Semi-natural forests	Broadleaved stands	9 722	63
	Conifer stands	2 273	15
	Mixed stands	1 392	9
	Total semi-natural forests	13 387	87
Plantations	Broadleaved planted species	376	2
	Conifer planted species	1 496	10
	Mixed planted species	n. s.	
	Total plantations	1 901	12
Total		**15 319**	**100**

Source: NFI.
Relevant domain: FAWS.

Indicator 4.3.1

Area of very old regular high forests forming specific habitats

Forests available for wood supply

ISFM 2005 Edition

Data retrieval year		1989		1994		1999		2004	
Average year		1981		1986		1991		1996	
Main tree species	*age limit**	*ha*	*% total area of the species*	*ha*	*% total area of the species*	*ha*	*% total area of the species*	*ha*	*% total area of the species*
Pedunculate oak	180 years	13 800	3	14 900	3	12 800	2	10 300	1
Sessile oak	240 years	700	0	900	0	700	0	400	0
Pubescent oak	150 years	3 800	3	5 200	4	6 800	4	7 800	5
Holm oak**	200 years	1 800	13	700	6	700	6	700	6
Cork oak	120 years	4 600	8	4 200	7	4 200	7	5 100	10
Beech	180 years	30 700	5	35 800	5	29 000	4	30 800	4
Chestnut	150 years	23 900	20	17 200	15	17 800	15	16 500	14
Common ash	120 years	4 600	7	5 500	6	6 900	5	7 000	4
Large alder	70 years	3 500	25	2 500	24	2 200	23	2 600	20
Aspen	70 years	1 600	17	1 100	12	1 400	16	1 100	11
Birch	50 years	9 400	39	10 500	54	11 200	53	15 000	56
Lowland fir	160 years	0	0	0	0	100	0	0	0
Lowland spruce	160 years	0	0	200	0	200	0	100	0
Mountain fir	200 years	11 200	3	12 400	4	11 800	3	11 300	3
Mountain spruce	200 years	10 200	3	9 400	2	8 900	2	9 900	2
Maritime pine	140 years	900	0	800	0	900	0	1 400	0
Scots pine	200 years	2 000	0	1 500	0	1 300	0	1 200	0
Corsican pine	200 years	1 900	2	2 100	2	2 000	2	2 000	2
Mountain pine	150 years	7 400	15	7 400	15	7 400	15	5 800	12
Larch	200 years	9 000	11	8 700	10	8 700	10	10 700	11
Total		**141 000**	**3**	**141 000**	**3**	**135 100**	**2**	**139 800**	**2**

** area underestimated in 1994, 1999 and 2004 owing to the absence of a field inventory for certain formations in the Mediterranean region.
Source: NFI.
Relevant domain: regular high forests in FAWS, excluding poplar plantations and including thickets.

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

ISFM 2010 Edition

Data retrieval year		2010	
Survey years		2006 to 2009	
Main tree species	*age limit**	*ha*	*% total area of the species*
Pedunculate oak	180 years	27 000 ± 8 000	1
Sessile oak	240 years	2 000 to 9 000 ha	0
Pubescent oak	150 years	15 000 to 20 000 ha	1
Holm oak	200 years	-	0
Cork oak	120 years	< 8 000 ha	4
Beech	180 years	52 000 ± 11 000	4
Chestnut	150 years	< 10 000 ha	1
Common ash	120 years	10 000 to 25 000 ha	3
Large alder	70 years	5 000 to 15 000 ha	7
Aspen	70 years	5 000 to 15 000 ha	10
Birch	50 years	28 000 ± 8 000	9
Lowland fir	160 years	-	0
Lowland spruce	160 years	< 3 000 ha	0
Mountain fir	200 years	2 000 to 10 000 ha	1
Mountain spruce	200 years	2 000 to 12 000 ha	1
Maritime pine	140 years	< 6 000 ha	0
Scots pine	200 years	< 3 500 ha	0
Corsican pine	200 years	< 3 500 ha	0
Mountain pine	150 years	< 5 000 ha	3
Larch	200 years	1 000 to 9 000 ha	5
Total		**207 000 ± n.d.**	**3**

Source: NFI.
Relevant domain: regular high forests in FAWS, excluding poplar plantations.
The dash (-) symbol indicates that this type of stand was not identified at any NFI sampling points, but it does not necessarily mean that no stands of this type exist.

For most species, the data accuracy is too low to present (the data are claimed to be non-significant). In this case, a possible data interval is indicated. Variations between the data published in 2005 and the 2010 data cannot be precisely interpreted. A considerable part of the differences could be due to the changes in definition and uniformization of the inventory procedures in France.
As previously, we limited the evaluation of these old stand areas to regular high forests so as to ensure a certain continuum for this indicator.

Stands in a phase of advanced maturity or even senescence contain specific habitats that are host to certain animal or plant species. However, it should be noted that this 'stand' approach does not account for individual trees that are sometimes kept by foresters for their positive impact on biodiversity. Moreover, the data should be carefully interpreted since only one age limit per species, as defined on the basis of expert opinion, is considered here, without accounting for between site differences.

For 2010, the very old regular high forest area represents 3% of the total regular high forest area. The situation is still highly variable depending on the species considered. Pedunculate oak, beech and birch are the only species for which the data are significant. The abundance of birch stands of over 50 years old could be explained by the ageing of former coppices of this species that were converted into regular high forest. The old birch stand area was already increasing in the 2005 edition of this report, which was also the case for pubescent oak (non-significant for the 2010 edition).

It would be beneficial to supplement this indicator, which is currently limited to regular high forests, with an assessment of old stands in other forest structures, or at least an evaluation of the presence of very old trees in stands. More generally, the concept of specific habitats formed by old stands could be specified and enhanced. Finally, the presented data could be refined through a revision of the age limits per species according to the site conditions.

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

Indicator 4.4

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

ISFM 2005 Edition

Data retrieval year	1989		1994		1999		2004	
Average year	1981		1986		1991		1996	
Tree species	*1000 ha*	*%*	*1000 ha*	*%*	*1000 ha*	*%*	*1000 ha*	*%*
Indigenous	12 648	95	12 724	94	12 942	94	13 117	94
Acclimatized	582	4	663	5	696	5	754	5
Exotic	99	1	118	1	129	1	126	1
Subtotal	13 329	100	13 505	100	13 768	100	13 998	100
Unspecified	7		66		99		93	
Total	**13 337**		**13 572**		**13 867**		**14 091**	

Source: NFI.
Relevant domain: FAWS, excluding poplar plantations, including thickets.

The exotic, acclimatized or indigenous aspect of species is considered here on a national level. Species classified in each category are listed in Appendix VII.

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.

Although data of the 2005 and 2010 editions are not fully comparable, there seems to have been some degree of stability: supplementary forest areas mainly boosted the indigenous species (cf. species list in Appendix VII) and acclimatized species compartments, but to a lesser extent. Proportionally, the percentage of exotic species seems to have increased most, but this variation is hard to confirm due to the changes in definition.

There is a clear high proportion (92%) of stands with an **indigenous** main tree species. The area they cover increases, partly due to natural afforestation.

Acclimatized species currently occupy 6% of the forest area. These species are especially characterized by their better natural regeneration capacity, and are mainly represented by Douglas fir, Austrian pine and false acacia. This latter species alone accounts for around 191,000 ha. These species also represent 6% of the growing stock (154 Mm^3), divided as follows: 37 Mm^3 in broadleaved stands, 98 Mm^3 in conifer stands, and 19 Mm^3 in mixed stands.

Exotic species only cover 2% of the inventoried forest area. The main species concerned are cultivated poplar, Sitka spruce and Vancouver fir. The volume of exotic species represents 2% of the total growing stock, i.e. 56 Mm^3, including 33 Mm^3 in broadleaved stands, 18 Mm^3 in conifer stands, and 4 Mm^3 in mixed stands.

ISFM 2010 Edition

Data retrieval year	2010		
Survey years	2006 to 2009		
Tree species	*1000 ha*		*%*
Indigenous	14 040	± 109	92
Acclimatized	908	± 50	6
Exotic	326	± 27	2
Temporarily unstocked stand	45	± 13	0
Total	**15 319**	**± 104**	**100**

Source: NFI.
Relevant domain: FAWS.

A few exotic or acclimatized tree species are now known to be invasive in France. The box elder (*Acer negundo*) can modify the floristic species composition in relict alluvial forests. Dense black cherry (*Prunus serotina*) stands hamper regeneration of shade-intolerant tree species (oak, Scots pine), leading to a decline in vegetation diversity. Copal trees (*Ailanthus altissima*) tend to uniformize landscapes and habitats.

Indicator 4.5

Volume of standing and lying deadwood on forest and other wooded land, classified by forest type, size or decomposition stage

The previous inventory method applied at NFI until 2004 only took trees that had been dead for less than 5 years into account when the field team surveyed the plot. This only gave partial information on the total deadwood volume in forests (according to an NFI study in Haut-Rhin department, one fifth of the volume was accounted for). The new inventory method records the existing deadwood, however old (see Appendix II).

Standing deadwood per forest type and age

Data retrieval year	2010		
Forest type	*Volume of wood from standing trees dead for less than 5 years*	*Volume of wood from standing trees dead for more than 5 years*	*Total volume of standing deadwood*
	m³/ha	*m³/ha*	*m³/ha*
Broadleaved	2.2 ± 0.2	3.9 ± 0.3	6.1 ± 0.4
Conifers	3.4 ± 0.7	3.6 ± 0.7	7.0 ± 1.0
Mixed	4.3 ± 1.2	5.1 ± 1.5	9.3 ± 1.9
Total	**2.7 ± 0.2**	**3.9 ± 0.2**	**6.5 ± 0.3**

Source: NFI, survey years 2008 and 2009.
Relevant domain: FAWS excluding temporarily unstocked stands.

The death date of a standing tree is determined using different indices:

– the state of conservation of a stump log;

– the age of stem or branch shoots of broadleaved species damaged when a tree is felled;

– the period since the recovery or acceleration of diameter and/or height growth of adjacent previously competing trees (by assessing the thickness of growth rings of trees using a Pressler increment borer).

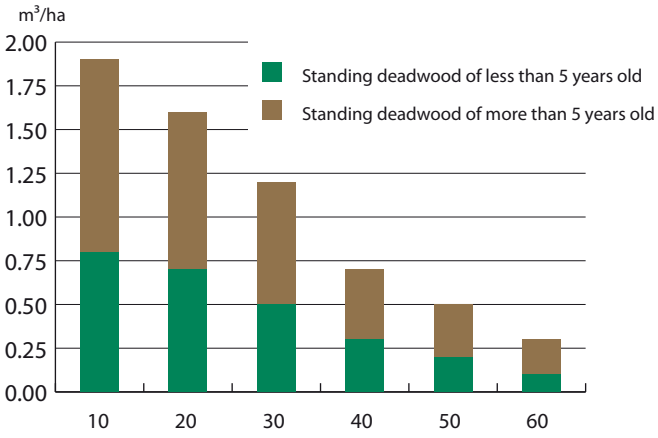
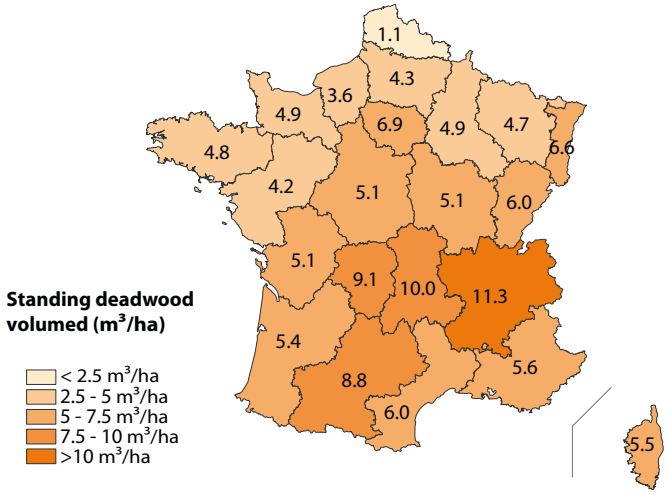


Figure 31: Standing deadwood volume per ha, diameter class and age.



Map 20: Standing deadwood volume per ha and per administrative region.

Source: NFI, survey years 2008 and 2009.

The volume of standing deadwood of all ages is around 101 Mm^3, 40% of which is less than 5 years old.

61% of this total volume is found in broadleaved stands. However, these stands have the lowest volume per hectare: 6.4 m^3/ha versus 7 m^3/ha in conifer stands and 9.3 m^3/ha in mixed stands, whereas these latter stands only account for 15% of the total standing deadwood volume.

The distribution of the standing deadwood volume per age (± 5 years old) is quite balanced in mixed and conifer stands. However, standing deadwood of over 5 years old is by far the overriding compartment in broadleaved stands (64% of the standing deadwood stock).

The situation varies markedly from region to region, ranging from 1.1 m^3/ha in Nord-Pas-de-Calais to 11.3 m^3/ha in Rhône-Alpes. The highest per-ha standing deadwood volumes occur in the Rhône-Alpes, Auvergne, Limousin or Midi-Pyrénées regions. On the other hand, the lowest per-ha stocks are found in the northern half of France (Nord-Pas-de-Calais, Haute-Normandie, Picardie, Pays-de-la-Loire, Lorraine, Bretagne or Champagne-Ardenne).

This could be mainly explained by the logging difficulties encountered in these regions. Indeed, the per-ha standing deadwood volume increases as the logging conditions get harsher: stands in easy logging conditions have on average a standing deadwood volume of 5.1 m^3/ha, as compared to 6.8 m^3/ha for stands in average difficulty conditions and 9 m^3/ha for stands considered as very difficult for logging.

The highest volume of standing deadwood is found in chestnut stands (15 m^3/ha), followed by common spruce stands (14.2 m^3/ha) and silver fir stands (13.2 m^3/ha). In contrast, holm oak, Aleppo pine, Austrian pine and pubescent oak stands have the lowest standing deadwood volumes (under 4 m^3/ha). Overall, standing deadwood volumes are 6.2 m^3/ha (± 0.4 m^3/ha) in stands mainly containing broadleaved species and 7.3 m^3/ha (± 0.9 m^3/ha) in stands mainly consisting of conifer species.

Finally, private forests have the greatest standing deadwood volumes (6.8 m^3/ha), followed by non-state-managed public forests (5.8 m^3/ha) and then state-owned forests (5.2 m^3/ha).

Standard windfalls of less than 5 years old (excluding poplar plantations)

Data retrieval year Survey years	2010 2006 to 2008	
Forest type	*1 000 m^3*	*Referenced to the inventoried area (m^3/ha)*
Broadleaved	4 331 ± 882	0.5
Conifers	2 364 ± 923	0.7
Mixed	1 132 ± 614	0.7
Total	**7 826 ± 1 150**	**0.5**

Source: NFI, survey years 2006 to 2008.
Relevant domain: FAWS, excluding temporarily unstocked stands and poplar plantations. Windfalls resulting from the January 2009 Klaus storm are not included in these data.

This section focuses on windfalls of less than 5 years old at the time they were assessed by field agents, while overlooking windfalls caused by cyclone Klaus (cf. Indicator 2.4 where storm damage is discussed). Older windfalls are considered as lying deadwood, a category that is covered hereafter.
The windfall date of a considered tree is determined using the same indices as those used for determining the standing deadwood date, along with the age of the vegetation growing on the clump of soil upon which an uprooted windfall tree was previously growing.

Windfalls considered here were less than 5 years old.
The per-ha windfall volume is lower in broadleaved stands (0.5 m^3/ha) than in conifer or mixed stands (0.7 m^3/ha). Per-ha volumes are identical regardless of whether the composition (broadleaved, conifer or mixed stand types) or main species (broadleaved, conifers) is taken into account.

The per-ha windfall volume is higher in Rhône-Alpes (1.1 m^3/ha), Auvergne (1.0 m^3/ha), Aquitaine, Picardie and Bretagne (0.8 m^3/ha) regions. These are mountain regions (where windfalls can be caused by locally strong winds or snow storms), or coastal regions affected by high winds and storms. In regions where windfalls are less common, it is often impossible to obtain sufficiently reliable data because of the low number of windfalls observed.

Lying deadwood

Lying deadwood is inventoried separately from standing deadwood.

Data retrieval year	2010											
Survey years	2008 - 2009											
Diameter class	*Broadleaved stand*			*Conifer stand*			*Mixed stand*			*Total*		
	m³/ha			m³/ha			m³/ha			m³/ha		
5 and 10 cm	7.5	±	0.3	8.0	±	0.6	9.2	±	1.0	7.8	±	0.2
15 and 20 cm	3.6	±	0.3	4.5	±	0.7	5.3	±	1.0	4.0	±	0.3
25 and 30 cm	2.2	±	0.4	2.7	±	0.7	4.0	±	1.5	2.5	±	0.3
More than 35 cm	2.4	±	0.6	1.5	±	1.0	3.9	±	1.7	2.4	±	0.5
Total	**15.7**	**±**	**0.7**	**16.6**	**±**	**1.6**	**22.5**	**±**	**3.3**	**16.6**	**±**	**0.6**

Source: NFI, survey years 2008 and 2009.
Relevant domain: FAWS, excluding temporarily unstocked stands.

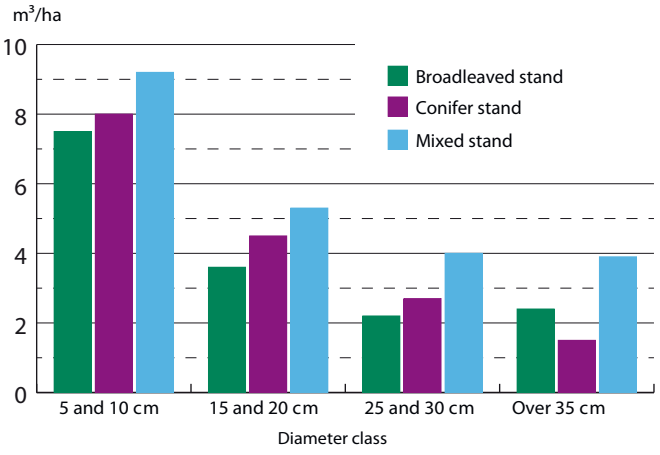
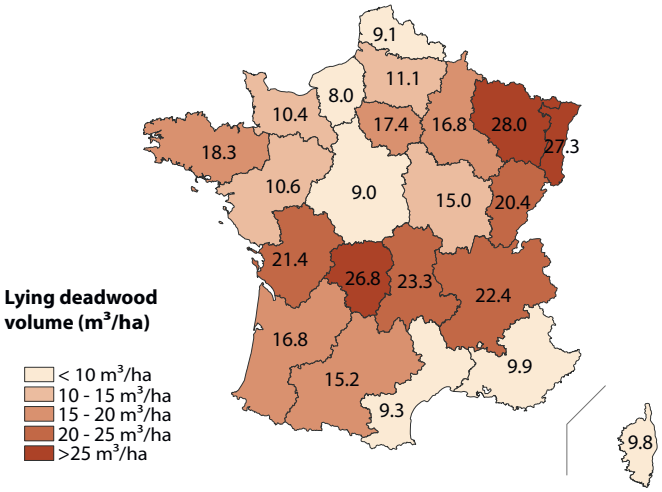


Figure 32: Per-ha lying deadwood volume per diameter class and forest type.



Map 21: Per-ha lying deadwood volume per administrative region.

Source: NFI, survey years 2008 and 2009.

Lying deadwood represents a total volume of 257 Mm³ (±10). The per-ha lying deadwood volume is highest in mixed stands (22 m³/ha), followed by conifer stands (17 m³/ha) and broadleaved stands (16 m³/ ha). As broadleaved stands account for the largest forest area, 64% of the total lying deadwood volume is found in these stands, with 21% found in conifer stands and 15% in mixed stands.

The situation varies from region to region, with per-ha lying deadwood volumes ranging from 28 m³/ha in Lorraine to 8 m³/ha in Haute-Normandie. The Alsace region comes immediately after Lorraine with 27 m³/ha, followed by mountain regions: Limousin (27 m³/ha), Auvergne (23 m³/ha), Rhône-Alpes (22 m³/ha) and Franche-Comté (20 m³/ha), and one exceptional non-mountainous region, Poitou-Charentes (21 m³/ha).

The presence of high quantities of lying deadwood in certain mountain regions may be explained by snow storms in these regions, which can induce windfalls and tree crown breakage. In regions such as Lorraine and Alsace, this abundance of lying deadwood should be interpreted with caution since there are also very high per-ha volumes of live trees in these regions. It is therefore logical that substantial quantities of lying deadwood may be found in stands with high growing stock after they have been logged. It is also likely that trees knocked down or damaged during the 1999 storms were not totally removed, which means that this wood contributes to the lying deadwood volume.

The extent of deadwood decomposition is classified in five categories on the basis of two criteria, i.e. the presence of bark and its texture:

– if bark is present and the wood is solid, not decomposed, sometimes with the presence of branches, the extent of decomposition is considered zero;

– if bark is present and its texture is partially soft, with the absence of young branches, the extent of decomposition is low;

– if the bark is fragmented and its texture is partially soft, with the absence of young branches, the extent of decomposition is average;

– if bark is absent and average to heavy rotting is noted, the extent of decomposition is high;

– if bark is absent, there is complete rotting and the shape of the log is altered, the extent of decomposition is very high.

Over three-quarters of the lying deadwood stock has an average to very high level of decomposition. This corresponds to longer time spent in these compartments than the time spent in zero to low decomposition compartments.

30% of lying deadwood is under 7.5 cm diameter, and almost 50% consists of logs with a diameter ranging from 12.5 to 22.5 cm. The two last diameter classes (22.5 to 32.5 cm and 32.5 cm and more) account for the last quarter of the lying deadwood stock to an equal extent.

The extents of lying deadwood decomposition are relatively identical irrespective of the log diameter.

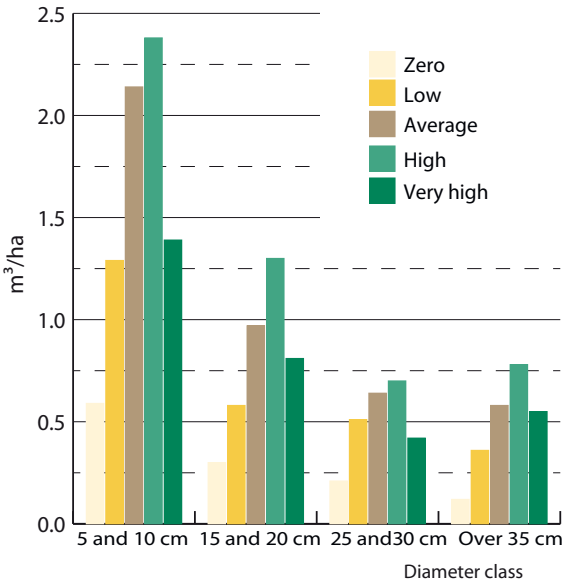
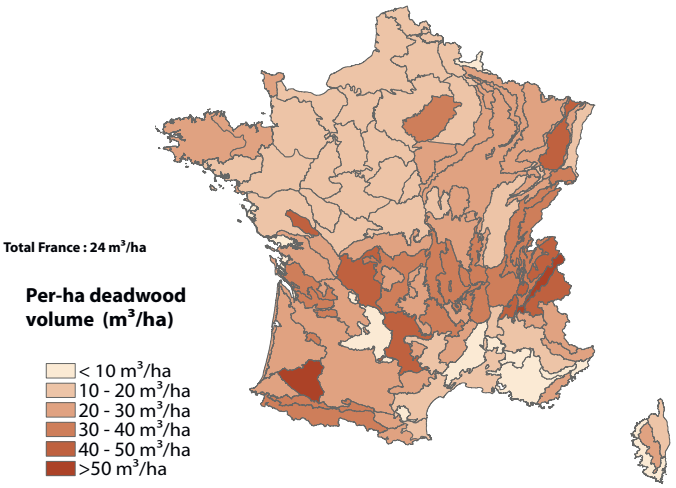


Figure 33: Per-ha lying deadwood volume, per diameter class and decomposition stage.

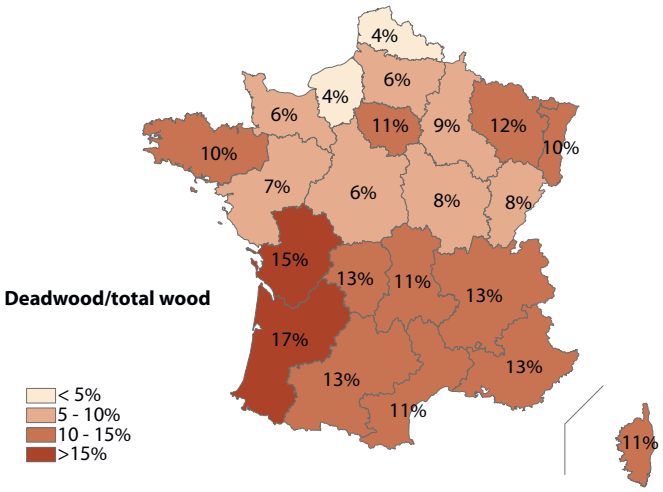
Source: NFI, survey years 2008 to 2009.

Total deadwood volume per-ha for all deadwood types

Proportion of deadwood in the wood volume per-ha



Map 22: Per-ha deadwood volume, for all types of deadwood combined, per SER.



Map 23: Deadwood/total wood ratio by administrative region.

Source: NFI, survey years 2008 to 2009.

There are marked differences between regions: Aquitaine has the highest per-ha deadwood rate, with deadwood accounting for 17% of the per-ha wood volume. This abundance of deadwood—windfalls, standing and lying deadwood—highlights the effect of cyclone Klaus in 2009 (windfalls represent 24% of the per-ha deadwood volume in this region), while also indicating that the damaged trees have not all been removed. Conversely, Nord-Pas-de-Calais and Haute-Normandie have the lowest per-ha deadwood rate (4%).

Indicator 4.6

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

Production of forest tree seeds and plants for artificial regeneration

Selected or tested stands	Broadleaved		Conifers		Total		2004-10 variation
	2004	2010	2004	2010	2004	2010	
Number of species	8	8	12	13	20	21	5.0 %
Number of species with indigenous resources	7	7	8	8	15	15	-
Number of regions of provenance (RP)	53	59	57	59	110	118	7.3 %
Number of RP with indigenous stands	51	56	43	41	94	97	3.2 %
Number of stands	773	807	936	850	1 709	1 657	- 3.0 %
Number of indigenous stands	625	661	555	480	1180	1141	- 3.3 %
Total area (ha) of indigenous stands	21 819	23 142	28 713	32 035	50 532	55 177	9.2 %
Total area (ha)	22 455	23 788	37 058	39 929	59 513	63 863	7.3 %
Qualified or tested seed orchards	**Broadleaved**		**Conifers**		**Total**		
	2004	**2010**	**2004**	**2010**	**2004**	**2010**	
Number	1	5	13	22	14	27	93.0 %
Area (ha)	1	4	321	433	322	437	35.7 %
Qualified 'clone mixture' varieties (black poplar)	**Broadleaved**		**Conifers**		**Total**		
	2004	**2010**	**2004**	**2010**	**2004**	**2010**	
Number	0	3	0	0	0	3	-
Tested clones	**Broadleaved**		**Conifers**		**Total**		
	2004	**2010**	**2004**	**2010**	**2004**	**2010**	
Number	44	44	10	10	54	54	-

Source: CEMAGREF, 2010.

Marketing of forest reproductive material for the main French tree species is governed by regulations set down in an EU Council Directive. The aim of this directive is to allow foresters to trace the characteristics and qualities of forest genetic resources used for plantation. It involves prohibiting the use of seeds and plants derived from stands considered to be of poor genetic quality and obliging suppliers to give reliable and standardised information on the identity of seed and plant batches.
Following signature of this new EU directive in December 1999, the French forest code texts concerning these regulations were fully updated. These regulations became effective in October 2003 after the adoption in July 2002 of a new system of redistribution of regions of origin and continuously evolve to adapt to new needs. All information on these regulations is available online at: http://agriculture.gouv.fr/graines-et-plants-forestiers.

The objectives of the regulations adopted in 2003 are wide ranging:

– to broaden the regulation scope, especially by increasing the number of species controlled (58). In 2010, besides hybrid poplar cultivars and black poplar varieties which are only propagated vegetatively, metropolitan France now has genetic resources for 48 species, that can be generatively propagated using seeds that are harvested in authorised seed stands in France: 19 conifer and 29 broadleaved species, with 35 of them being 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 giving a reference appearing in the document supplied upon delivery to foresters. This reference is the keystone of this traceability system;
– to set up four marketing categories, including 'identified', 'selected', 'qualified', 'tested' (see Box 5) meeting the diversity of forester needs;
– to better account for new varieties from genetic improvement programmes.

For material in the identified and selected categories, seed sources and selected stands are grouped in regions of origin, which serve as a reference for marketing this material to foresters. These regions of origin were defined on the basis of the importance of species, their distribution, their diversity as assessed in tests or by biochemical analysis, or environmental variations. The number of regions of origin ranges from 1 to 19 depending on the species.

Stand area selection is based on a tradeoff between finding a stand of good genetic quality and its potential for fulfilling the need for plants suitable for current and future situations, while also accounting for new constraints arising as a result of climate change.

Seed orchard areas and the number of clones and 'mixed clonal' varieties are increasing in association with the results of genetic improvement and genetic diversity research programmes.

Since 2004, there has been:
– a slight increase in the number of broadleaved stands resulting from the selection of new stands (sycamore maple, chestnut and sessile oak);
– a decrease in the number of conifer stands, offset by the development of seed orchards. This change follows the disappearance of stands undergoing regeneration, affected by windfalls or pest infestations (maritime pine, Scots pine, Douglas fir, common spruce, etc.);
– an increase in the mean stand area (from 35 to 38 ha), mainly concerning conifers, in order to enhance genetic diversity;
– selection of new stands or varieties to address current needs, either for environment-friendly plantations focused on indigenous material (new 'mixed clonal' varieties of black poplar) or for wood-production oriented plantations with species substitution (loblolly pine stands);
– an increase in the number of seed orchards (both broadleaved and conifers) and wild cherry clones resulting from genetic improvement programmes.

Box 5: 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 species. This material is issued from seed orchards or 'mixed clonal' varieties (plantations of family clones or parental stock) set up specifically to produce seeds or plants 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

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 followed since 1986. Priority was given to *in situ* conservation (in field stands) 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 committee 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 (cultivation from harvested seed or cuttings taken from in the field stands). It currently concerns 14 species or species groups and covers:
- *in situ* conservation stands, already registered in the Registre des Matériels de Base set up for the *in situ* conservation of forest genetic resources of national interest, for beech, silver fir, sessile oak and maritime pine, in the process of registration for common spruce, black poplar, European white elm, common ash, wild cherry and European black pine and in the process of selection for wild service tree and Scots pine;
- *ex situ* conservation plantations, already registered in the Registre des Matériels de Base set up for the *ex situ* conservation of forest genetic resources of national interest, for wild cherry and silver fir;
- *ex situ* collections of clones registered in the Registre des Matériels de Base set up for the *ex situ* conservation of forest genetic resources of national interest for elm, black poplar, service tree, walnut and wild cherry; these collections are fully maintained in clone plots and some clones are also cryopreserved.
N.B.: clones registered in the Registre and preserved in the five national collections are a representative subset of the private collections (INRA, CEMAGREF, IDF) from which they originate.

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.
With the support of participating countries, EUFORGEN has set up and updates a georeferenced database (EUFGIS) on all conservation units that fulfil the dynamic conservation criteria defined and accepted by all EUFORGEN members (http://portal.eufgis.org). Ultimately, a selection carried out by EUFORGEN within this group will make it possible to set up, for each species, sustainable conservation networks that are validated on a pan-European scale.
Further information is available online at: http://agriculture.gouv.fr/conservation-des-ressources.

Species	Natural populations conserved *in situ*				*Ex situ* conservation plantations				*Ex situ* conserved collections			
	2004		2010		2004		2010		2004		2010	
	Nb	*Area (ha)*	*Nb*	*Area (ha)*	*Nb*	*Area (ha)*	*Nb*	*Area (ha)*	*Total number of clones*	*Within national collections*	*Total number of clones*	*Within national collections*
Wild service tree	under discussion		on-going EUFORGEN selection									
Sessile oak	20	2 593	20	2 619								
Service tree			no *in situ* network						140	60	140	60
Common ash			(5)	ongoing review								
Beech	27	3 875	27	3 875								
Wild cherry	under discussion		(2)	ongoing review	2	4	2	4	332	251	332	251
Common walnut			no *in situ* network						90	58	90	58
Elm species	in preparation								426	417	> 430	417
European white elm			(2)	ongoing review								
Black poplar	12 (ongoing selection)		(6)	ongoing review					367	260	> 400	260
Common spruce	in preparation		(24)	ongoing review								
Silver fir	22	3 506	21	3 391	4	28	4	28				
Maritime pine	in preparation		4	900								
Scots pine			ongoing selection									
European black pine			(1)	ongoing review								
Total	**81**	**10 343**	**71 (+40)**	**10 628**	**6**	**32**	**6**	**32**	**1 355**	**1 046**	**> 1 392**	**1 046**

Source: Commission des ressources génétiques forestières (CRGF), CEMAGREF, INRA and ONF; 2004, 2010.
Numbers of populations planned in the ongoing reviews are in brackets.

Indicator 4.7

Fragmentation of forest area in basic units

The data used to calculate this indicator are, for the French departments where it is available, from the NFI forest cartographic database version 2 (v2) (cf. Appendix XII), but version 1 (v1) is used for the rest of France.

In its native form, the v2 database represents forests of over 50 ares, whereas v1 has 2.25 ha thresholding. For the needs of this indicator, the two versions were made to be consistent by eliminating all wooded areas (and non-wooded enclaves within forests) of less than 2.25 ha. There are still three main differences between these versions that may have an impact on the results:

– first, the minimum width for the representation of mapped objects is 20 m for v2 and 75 m for v1, which can result in breaks (or, conversely, new continuities) because of the change in specifications and not a real change in forest masses;

– secondly, the geometric accuracy of objects is significantly greater in v2 because of the mapping method, as automatic segmentation of aerial photos produces entities bearing many more peaks than manual plotting of contours;

– finally, the data used for indicators in the 2000 and 2005 editions had a representation threshold of 4 ha, as compared to 2.25 ha for the present 2010 indicator.

Since forest massif area calculations assume that a break of 200 m does not disturb the continuity overall, the differences specified above only have a minor effect on the results. However, they make it impossible to interpret an indicator of a boundary length per hectare or the gross area of forest massifs (without 200 m buffer zone), since changes in the accuracy of limits are significant.

Fragmentation of forest area is an important factor in evaluating the capacity of forest ranges to host animals or plants requiring special habitats. NFI data are not sufficiently accurate to be able to assess very small forest units. The proposed method thus mainly concerns large animals.

It has been estimated that a break of 200 m would not interrupt the continuity of a forest unit. This option is designed to account for the mobile behaviour of some animals and their circulation between forest units linked by forest or subforest corridors. This approach should ultimately be enhanced by taking potential impassable barriers (highways without special animal crossings, rivers, etc.) into account, but it already offers a preliminary estimation of the spatial distribution of forest units.

However, it would be risky to interpret the spatial distribution patterns of forest units because of the methodological modifications. It is still noteworthy that the class distribution remains similar despite these variations, with over 70% of the forest species being part of large units of over 10,000 ha. These large units could correspond to large uninterrupted forests like the Landes forest with few unstocked areas, or to a mosaic of small tightly clustered massifs as in the western Massif Central region.

The current situation reflects the landholding structure and the heritage from the history of the last centuries, which man cannot modify quickly despite his intentions and his convictions on the desirable state of forest spatial configuration. Moreover, 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 clearings in very compact units can benefit other species.

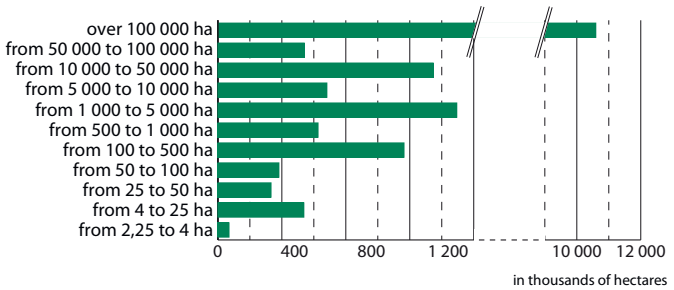


Figure 34: Forest area per range size.

Source: NFI

Area class	Data retrieval year for the cartographic database											
	1999				2004				2010			
	Number of forest units	*Mean area mapped per forest unit*	*Total mapped area*		*Number of forest units*	*Mean area mapped per forest unit*	*Total mapped area*		*Number of forest units*	*Mean area mapped per forest unit*	*Total mapped area*	
		1 000 ha		*%*		*1 000 ha*		*%*		*1 000 ha*		*%*
2.25-4 ha	-	-	-	-	-	-	-	-	18 938	3	58	0
4-25 ha	42 308	10	431	3	45 230	10	449	3	44 777	10	448	3
25-50 ha	7 827	35	275	2	7 962	35	280	2	7 858	35	277	2
50-100 ha	4 766	70	332	2	4 743	70	331	2	4 554	70	318	2
100-500 ha	4 908	209	1 028	7	4 876	208	1 014	6	4 654	208	970	6
500-1,000 ha	787	698	549	4	801	701	561	4	744	701	522	3
1,000-5,000 ha	646	2 096	1 354	9	645	2 080	1 341	8	605	2 058	1 245	8
5,000-10,000 ha	99	6 906	684	4	94	6 825	642	4	81	7 011	568	3
10,000-50,000 ha	71	19 054	1 353	9	92	123 960	11 404	71	57	19 683	1 122	7
50,000-100,000 ha	6	77 648	466	3					6	74 918	450	3
over 100,000 ha	13	705 809	9 175	59					12	882 857	10 594	64
Total	**61 431**	**255**	**15 659**	**100**	**64 443**	**249**	**16 023**	**100**	**82 286**	**201**	**16 571**	**100**

Source: NFI 1999, 2004 and 2010, for all forests and poplar stands of over 4 ha, based on the NFI cartographic database, considering that a 200 m break does not interrupt the continuity of a forest unit.

Indicator 4.8

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

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 edges and premantles, clearings, felled areas, etc. Finally, some species are not considered as forest species, but the forest is essential to them for part of their biological development, e.g. anthophilous insects whose larvae develop in wood, or vertebrates that inhabit trees but can feed in any other type of habitat. The revision of the IUCN Red List of animals after 2005 and the progress in knowledge has led to a discontinuity with respect to previous data and those of 2010, including data on the number of species considered as being forest species. Appendix XIII describes those that were retained so as to facilitate accurate comparisons in 2015.

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.

The need to develop a European biodiversity preservation policy has now been fulfilled. The EU Birds directive (1979) and Habitats, Fauna and Flora directive (1992) gave rise to the European ecological network Natura 2000, which is aimed at preserving biodiversity by maintaining or reestablishing, in a suitable conservation state, natural habitats and habitats of fauna and flora species of community interest. They led to a modification in regulations on the French protection of concerned species, with the publication, in 2007 and 2010, of new lists of protected species, including the protection of roosting areas and breeding sites, to account for the need to integrate habitats partially in taxon conservation.

The publication Cahiers d'habitat, derived from the above mentioned EU directive, with two volumes devoted to the forest that were published in 2001 by the French Ministry of Ecology and Sustainable Development under the auspices of the Muséum national d'histoire naturelle, specify the ecological requirements and recommendations for the management of each type of habitat.

Concerning forest management as such, the 'Gestion forestière et diversité biologique' files now enable forest managers to take biodiversity challenges into better account in their day-to-day practices. These documents, which were written for educational purposes by experts from the École nationale du génie rural des eaux et forêts, the Office national des forêts and the Institut pour le développement forestier, specifically examine forest and associated habitats (mosaic habitats in forest environments or dynamically linked habitats) and, in addition to descriptions of how to recognise species, put forward a series of recommendations on management methods that promote biodiversity preservation.

Our selection of forest species whose status required changing is based on the IUCN Red List of Threatened Species in France, mainly selecting those considered as threatened. The species status terms used in the former editions are out of line with those used by IUCN, for which the rareness concept is not a vulnerability criterion (cf. Box 6).

In an attempt to make a comparison with the 2005 data, CR and EN species were thus placed in the 'endangered' category, VU species in the 'vulnerable' category, and finally NT species in the 'rare' category, which are actually 'near threatened'. For instance, Bechstein's bat is not at all rare, but the trends concerning its situation are negative, which prompted IUCN experts to consider it as near threatened (so there is a risk that its status will worsen if nothing is done to safeguard its habitats).

The results highlight an increase in the number of threatened species, especially birds, amphibians and reptiles. Mammals seem to be less affected, which could be explained by the fact that knowledge has been enhanced on these species—few studies had been focused on these species before 2000 due to difficulties in monitoring them in forest areas. For instance, inventories and studies on Chiroptera species (bats) were very difficult until the advent of sophisticated techniques such as ultrasonic detection, which has improved their accuracy.

	Species living in a strictly forest-type habitat or often present in a forest environment		Species with mixed behaviour distributed fairly evenly between forests and open environments		Total		Variation 2005-2010
	2005	2010	2005	2010	2005	2010	
Vascular plants *							
Number of species	**271**	**329**	**435**	**609**	**706**	**938**	**n.s.**
- endangered	1	n.s.	3	n.s.	4	n.s.	n.s.
- vulnerable	3	n.s.	5	n.s.	8	n.s.	n.s.
- rare	0	n.s.	2	n.s.	2	n.s.	n.s.
Total threatened	**4**	**20**	**10**	**29**	**14**	**49**	**n.s.**
% threatened species	1%	6%	2%	5%	2%	5%	-
Mammals							
Number of species	**39**	**13**	**34**	**38**	**73**	**51**	**n.s.**
- endangered	2	2	1	0	3	2	- 33%
- vulnerable	10	0	1	1	11	1	- 91%
- rare	2	2	2	7	4	9	+ 125%
Total threatened	**14**	**4**	**4**	**8**	**18**	**12**	**- 33%**
% threatened species	36%	31%	12%	21%	25%	24%	-
Birds							
Number of species	**55**	**28**	**65**	**45**	**120**	**73**	**n.s.**
- endangered	0	1	1	3	1	4	+ 300%
- vulnerable	2	8	5	5	7	13	+ 86%
- rare	4	4	4	3	8	7	- 12.5%
Total threatened	**6**	**13**	**10**	**11**	**16**	**24**	**+ 50%**
% threatened species	11%	46%	15%	24%	13%	33%	-
Reptiles							
Number of species	**0**	**0**	**11**	**7**	**11**	**7**	**n.s.**
- endangered	0	0	0	1	0	1	+ 100%
- vulnerable	0	0	1	1	1	1	=
- rare	0	0	1	1	1	1	=
Total threatened	**0**	**0**	**2**	**3**	**2**	**3**	**+ 50%**
% threatened species	0%	0%	18%	43%	18%	43%	-
Amphibians							
Number of species	**4**	**0**	**9**	**9**	**13**	**9**	**n.s.**
- endangered	0	0	0	1	0	1	+ 100%
- vulnerable	0	0	5	1	5	1	- 80%
- rare	0	0	0	1	0	1	+ 100%
Total threatened	**0**	**0**	**5**	**3**	**5**	**3**	**- 40%**
% threatened species	0%	0	56%	33%	38%	33%	-

Sources: Flore forestière française, IDF, 1989, 1993, 2008; IUCN Red List of Threatened Species in France:
Chapter: Orchidées de France métropolitaine, IUCN France, MNHN, FCBN & SFO (2010);
Chapter: Mammifères de France métropolitaine, IUCN France, MNHN, SFEPM & ONCFS (2009);
Chapter: Oiseaux nicheurs de France métropolitaine, IUCN France, MNHN, LPO, SEOF & ONCFS (2008);
Chapter: Reptiles et Amphibiens de France métropolitaine, IUCN France, MNHN & SHF (2009).
*protection status in France in 2010. The list of threatened forest animal and plant species is given in Appendix XIII.

Note: Three categories of threatened species are generally defined:
- category 1: Species living in a strictly forest-type habitat or species commonly present in a forest environment; 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 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 three volumes of the Flore forestière française (Rameau et al., 1989,1993 and 2008) in addition to other works. The 2005 figures did not include Mediterranean species, of which many are threatened, since volume 3 was published after this date. No conclusions can thus be drawn from the figure on variations between 2005 and 2010. 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. As the only redlist currently available concerns orchids, we only focused on species with a protection status, even though this concept only partially coincides with the IUCN criteria (cf. box).

– **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 particularly 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, shifted to category 3, are not included in the 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*).

Box 6: Threatened species and their protection

European directives and ministerial decrees on species protection are complemented by the IUCN Red Lists of Threatened Species. These lists highlight risks that a species is endangered in a given region, based solely on biological criteria and facts (change in distribution range, population dynamics, population changes, risk of alteration or disappearance of certain habitats that are essential for the species' survival, etc.). They reflect the extinction risk of each taxon at time t, and are therefore regularly updated (every 10-20 years depending on the species group). Contrary to certain common beliefs, they do not correspond to rareness indices, nor do they warrant a protection classification, even though they can encourage enhanced protection. The most recent lists for vertebrates were published on 26 March 2008 for reptiles and amphibians, on 3 December 2008 for birds, and on 13 February 2009 for mammals.

Species are classified according to different criteria:
EW: extinct in the wild
Threatened species:
CR: critically endangered
EN: endangered
VU: vulnerable
Other species categories, considered as not threatened:
NT: near threatened (close to the threatened species limit)
LC: least concern (little risk of extinction)
DD: data deficient (insufficient data for evaluation)
NA and NE for species for which the method is not applicable or those that have not been evaluated.

A taxon can therefore evolve, depending on the success of the conservation measures, from a threatened category to a more favourable category.

Indicator 4.9

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

The use of geographical information systems has substantially improved the estimation of protected forest area and other wooded lands since the ISFM 2005 edition. Cartographic data of the French National Forest Inventory (NFI) 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 includes 'other wooded lands' as defined by FAO (NFI heathlands). The Natura 2000 network was dealt with separately (cf. below) for legibility purposes; the proposed sites of community importance and the designated special protection areas overlap different protection classes.

In metropolitan forests, biodiversity is highly protected in an area of 195,000 ha, or 1.3% 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 of 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, consisting of reserves with a unit area of around 50 ha in lowland regions and 100 ha in mountain regions. It has been enhanced at the end of 2005 by the creation of a large-scale strict biological reserve of 2,600 ha in Chizé forest (Deux-Sèvres), supported by the current national hunting and wildlife reserve. This partly explains the marked increase in strict biological reserves.

Moreover, it is estimated that the 'protection of landscapes and specific natural elements' concerns 4.8 million ha of metropolitan forests, or almost a quarter 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 seven metropolitan national parks. The marked increase in these protected areas (almost 1 million ha in 6 years) mainly corresponds to the creation of four new regional natural parks (PNR) in that period, since metropolitan France now has 46 PNR.
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.

MCPFE protection class		Type of protected area	2001	2004			2010			2004 2010
			Area (ha)							Proportion of protected forests (%)
			Forests	Forests	Heathlands*	Total	Forests	Heathlands*	Total	
1	Biodiversity protection									
1.1	No human intervention	Strict biological reserves	1 300	4 300		4 300	14 478	841	15 369	0,03 0,09
		Strict natural reserves	4 000	4 000	4 000	8 000	NA	NA	NA	NA NA
Subtotal 1.1			**5 300**	**8 300**	**4 000**	**12 300**	**NA**	**NA**	**NA**	**NA NA**
1.2	Minimal intervention	National parks: central areas	94 600	94 600	125 600	220 200	122 119	153 985	276 104	0.60 0.70
1.3	Conservation via active management	Natural reserves, excluding strict nature reserves**	57 500	53 200	25 200	78 400	63 746	34 974	98 720	0.30 0.40
		National database Protected areas (ex voluntary nature reserves)		8 700	4 000	12 700	9 661	4 155	13 816	0.10 0.06
		Managed biological reserves	17 400	22 100		22 100	20 495	2 630	23 125	0.10 0.10
Subtotal 1.3			**74 900**	**84 000**	**29 200**	**113 200**	**93 902**	**41 759**	**135 661**	**0.50 0.60**
Subtotal 1 (after deletion of multiple counts)			**174 800**	**186 900**	**158 800**	**345 700**	**225 960**	**194 914**	**420 874**	**1.20 1.30**
2	Protection of landscapes and specific natural elements									
		National parks: peripheral areas	403 800	403 800	287 500	691 300	540 997	299 818	840 815	2.50 3.20
		Regional natural parks	2 547 400	2 724 400	378 500	3 102 900	3 306 957	520 303	3 827 260	17.00 19.50
		Biotope protection prefectoral orders	62 300	55 200	11 500	66 700	81 793	13 660	95 453	0.30 0.50
		Alluvial protection forests	6 200	6 200		6 200	6 201		6 201	0.04 0.04
		Periurban protection forests	10 600	44 600		44 600	80 459		80 459	0.30 0.50
		Conservation of coastal and lacustrine shoreline areas	8 900	10 200	18 800	29 000	19 844	35 467	55 311	0.10 0.10
		National hunting and wildlife reserves	17 000	17 100	4 900	22 000	14 857	4 573	19 430	0.10 0.10
Subtotal 2 (after deletion of multiple counts)			**2 984 300**	**3 170 500**	**689 500**	**3 859 900**	**3 997 507**	**855 003**	**4 852 510**	**19.80 23.60**
Total (after deletion of multiple counts)			**3 159 100**	**3 297 400**	**835 100**	**4 132 500**	**4 081 087**	**1 026 102**	**5 107 189**	**20.60 24.10**
Natura 2000										
Bird Directive		Notified Special protection areas (SPA)	NA	221 300	192 700	414 000	1 878 641	570 958	2 449 598	1.30 12.40
Habitats Directive		Proposed Special areas of conservation (SAC)	NA	NA	NA	NA	2 182 627	777 254	2 959 882	NA 14.40
Total		Total of proposed or designated Natura 2000 sites (after deletion of overlapping areas)	NA	NA	NA	NA	3 178 091	952 850	4 130 942	NA 21.00

*'other wooded lands' as defined by FAO

** The 2010 data were obtained via GIS, which is more accurate, but induces interruptions in data series. In particular, strictly protected parts of natural reserves, whose boundaries are not clearly defined, could not be taken into account and are thus classified with natural reserves, excluding strict nature reserves.

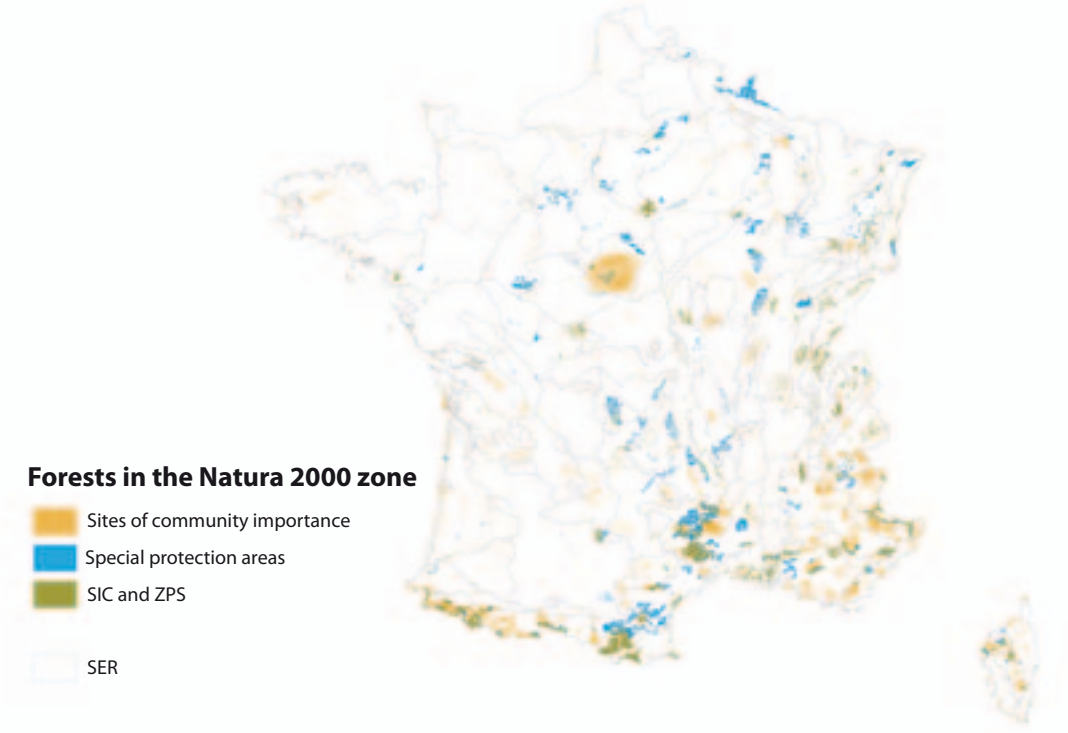
Source: MNHN 2001 and 2004, INPN 2010 and NFI 2010, by intersection of maps and deletion of overlapping areas, Teruti-Lucas for the 2010 %. INPN 2010, http://inpn.mnhn.fr/isb/download/fr/maps.jsp for natural areas; MAAPRAT, 2010, http://agriculture.gouv.fr/les-forets-de-protection,10806 for protection forests.

Woodland type	Special protection area		Special area of conservation		Natura 2000	
	2003	2010	2003	2010	2003	2010
High broadleaved forest	NA	431 465	NA	443 950	NA	674 292
High conifer forest	NA	404 135	NA	474 460	NA	694 971
Mixed high forest	NA	139 875	NA	143 779	NA	208 913
Mixed high broadleaved forest and coppice	NA	282 242	NA	335 834	NA	507 021
Mixed high conifer forest and coppice	NA	111 036	NA	136 779	NA	209 958
Coppice	NA	230 964	NA	292 164	NA	411 810
Open forest	NA	256 686	NA	332 008	NA	436 305
Poplar plantation	NA	22 238	NA	23 654	NA	34 823
Subtotal forest	**221 300**	**1 878 641**	**NA**	**2 182 627**	**1 418 500**	**3 178 091**
Heathland	192 700	570 958	NA	777 254	NA	952 850
Total	**414 000**	**2 449 598**	**NA**	**2 959 881**	**NA**	**4 130 942**

Source: MNHN 2003, INPN 2010 and NFI 2010, by intersection of maps and deletion of overlapping areas.

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 consist of sites that have been specially designated by each Member State in application of the so-called EU Bird (special protection areas) and Habitats (special areas of conservation) directives of 1979 and 1992. To date, France has designated over 4 million ha of heathlands and forests as sites of community importance under these two directives.

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.).



Map 24: Forest locations in the Natura 2000 sites (special areas of conservation and special protection areas).

Source: INPN, 2010.