Criterion 1

MAINTENANCE AND APPROPRIATE ENHANCEMENT OF FOREST RESOURCES AND THEIR CONTRIBUTION TO GLOBAL CARBON CYCLES

Indicator 1.1

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

The French Service de la statistique et de la prospective (SSP, formerly SCEES) of the French ministry responsible for forests (MAAPRAT) has been conducting annual surveys since 1982 on landuse patterns. The landmark sampling changes that took place in 1991 and 2005 gave rise to three series of survey results, i.e. Teruti 1 between 1982 and 1990, Teruti 2 between 1992 and 2003 and Teruti-Lucas since 2006. The forest area presented here was estimated on the basis of the Teruti 2 surveys for the ISFM 2005 edition and the Teruti-Lucas surveys for more recent data.

All data on forests available for wood supply are NFI statistics. Definitions for each category are given in Appendix III.

Sustainable Forest Management Indicator (ISFM) 2005 Edition

Landuse		1993		1998		2003*	
		1 000 ha	*%*	*1 000 ha*	*%*	*1 000 ha*	*%*
Forest (incl. poplar plantations)		14 811	27	15 220	28	15 408	28
	Broadleaved	9 466	64	9 715	64	9 852	64
	Conifers	4 052	27	4 122	27	4 090	27
	Mixed	1 292	9	1 384	9	1 466	10
Other wooded land***		1 935	4	1 825	3	1 743	3
Thickets, hedges and scattered trees		1 664	3	1 563	3	1 517	3
Total wooded lands and other lands with tree cover		**18 410**	**34**	**18 608**	**34**	**18 668**	**34**
Others		36 509	66	36 311	66	36 251	66
Total France		**54 919**	**100**	**54 919**	**100**	**54 919**	**100**

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

ISFM 2010 Edition

Landuse		2006*		2007		2008		2009		2010	
		1000 ha	*%*	*1000 ha*	*%*	*1000 ha*	*%*	*1000 ha*	*%*	*1000 ha*	*%*
Forest (incl. poplar plantations)		15 095	27	15 128	28	15 115	28	15 125	28	15 137	28
	Broadleaved	9 206	17	9 303	17	9 243	17	9 281	17	9 300	17
	Conifers	3 293	6	3 272	6	3 283	6	3 244	6	3 227	6
	Mixed	2 530	5	2 492	5	2 530	5	2 548	5	2 556	5
	Temporarily unstocked	65	0	61	0	59	0	52	0	54	0
Other wooded land***		2 442	4	2 456	4	2 499	5	2 510	5	2 499	5
Thickets, hedges and scattered trees		1 947	4	1 909	3	1 898	3	1 872	3	1 863	3
Total wooded lands and other lands with tree cover		**19 484**	**35**	**19 493**	**35**	**19 512**	**36**	**19 508**	**36**	**19 499**	**36**
Others		35 436	65	35 426	65	35 407	64	35 411	64	35 420	64
Total France		**54 919**	**100**	**54 919**	**100**	**54 919**	**100**	**54 919**	**100**	**54 919**	**100**

Source: SSP-Teruti-Lucas. Forests excluding poplar plantations correspond to physical nomenclature codes 31100, 31200 and 31300, poplar plantations to code 31400, clearcuts to code 34000. Thickets and hedges or rows respectively correspond to codes 32000 and 33000. Other wooded lands correspond to heathlands, fallows, maquis and garrigues in the Teruti-Lucas survey (code 40000).

* The decline in the forest area estimates between 2003 and 2006 is associated with the sampling and nomenclature changes between the Teruti and Teruti-Lucas surveys. Note that the confidence interval for the forest area data is ± 0.2 Mha.

** cf. Appendix III

*** Other wooded lands correspond to heathlands, fallows, maquis and garrigues.

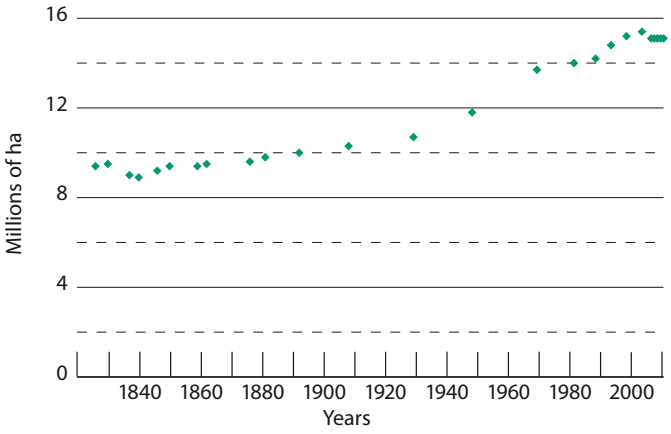


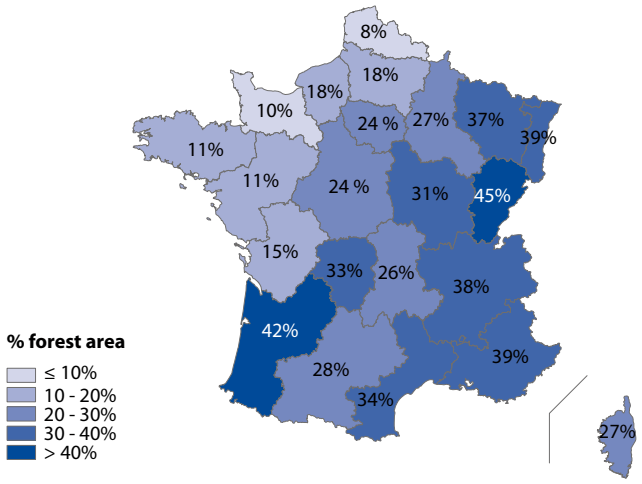
Figure 1: Variation in forest area over the last 2 centuries.

Source: Cinotti, based on a multi-source compilation for the pre-1980 period, SCEES.
Teruti until 2003 and SSP-Teruti-Lucas from 2006.

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

The area of land under forest has increased markedly since the early 19th century—it seems to have virtually expanded by two-thirds in nearly 2 centuries.

This situation, which is common to most European countries, is especially the upshot of higher agricultural yields and the reduced need for land for food production in the 19th and 20th centuries. It has also led to planned and natural reforestation of marginal land that had been cleared and cultivated as a result of population pressure. This has simplified erosion and flood control initiatives within the framework of national policies. This sharp rise in forest area over 2 centuries is, however, uneven and disguises the fact that land is still being cleared as a result of urban growth and infrastructural development, particularly around large built-up areas and also that some unique forest environments, such as alluvial forests, are dwindling because of major projects undertaken to modify the course of large rivers.



Map 1: Percentage of forest area by administrative region in 2010.
Source: SSP – Teruti-Lucas.

Due to the switch from the Teruti survey to the Teruti-Lucas survey, it is not possible to make direct comparisons between annual forest areas. **The decline in forest area between the 2003 and 2006 surveys was due to the sampling and nomenclature changes***. The increase in other wooded land area is due to the fact that fallows were not distinguished from heathlands in the Teruti-Lucas survey, while the increase in hedge area could be explained by the change in the hedge definition.
Even though the direction of the trend is beyond doubt, the different values plotted on the graph should be considered with caution since, until 1960, they were based on estimates from varied sources, often drawn from the land register. This register is above all a fiscal instrument that often underestimates forest areas. From certain surveys, it can be estimated that in slack periods of afforestation the land register's underestimate is usually around 20%, but that in periods of intense afforestation the underestimate may be as much as 50% for some localities. The land register figures have nevertheless become much more reliable in recent years.
From the 1980s, new statistical methods using aerial photography and field studies (Teruti survey of the SSP) and the permanent inventory of forest resources conducted by the French National Forest Inventory (NFI) have improved the assessment of forest areas.

France ranks 4th amongst EU countries in terms of forest area, surpassed by Sweden with 28 million ha (Mha), Finland with 22 Mha and Spain with 18 Mha (FAO, 2010). The forest area in France has expanded to the current level of 15.1 Mha (SSP, 2010), i.e. 27.6% of the total area. The total forest area has been relatively stable since 2006, with an increase only concerning a few tens of thousands of hectares overall. As compared to the clear increase in forest area that has taken place to date, this downturn is due to a decline in the afforestation of heathland, fallows and farmland. It is also associated with the decrease in agricultural abandonment and in subsidies that were provided to promote farmland afforestation.
The distribution of the different stand types remained stable, around 17% for metropolitan France for broadleaved stands, 6% for conifer stands and slightly less than 5% for mixed stands.
Other wooded lands increased slightly between 2006 and 2010. However, thickets, hedges and scattered trees declined by around 80,000 ha in 5 years.

* The 2003 data are from the Teruti survey, which included around 550,000 sampling points clustered around 36 landmarks. The 2006 data are from the Teruti-Lucas survey, which included around 309,000 sampling points clustered around 10 landmarks. Note also that the 'Low density afforestation' category had been omitted in the Teruti-Lucas survey.

Forests available for wood supply (FAWS)

Data from the new NFI inventory method

(see Cautionary note p. 4)

Data retrieval year Survey years	2010 2006 to 2009	
Forest area	*1000 ha*	*% eligible for inventory*
Poplar plantations	196 ± 20	87
Broadleaved	9 950 ± 113	94
Conifers	3 488 ± 83	93
Mixed	1 641 ± 65	95
Temporarily unstocked stands	44 ± 13	0
Total FAWS	**15 319 ± 104**	**91**

Source: NFI.
Relevant domain: FAWS.

These percentages were calculated solely on the basis of NFI data, but not with the SSP data presented above.

The French National Forest Inventory (NFI) data used for this indicator are from the annual 2006 to 2009 surveys. Despite the fact that their definitions are identical, a comparison with Teruti-Lucas survey data highlights certain differences, especially in regions of the Mediterranean Basin. In these regions, borders between the forest and maquis or garrigues depend on factors that are hard to assess (ground cover rates and potential stand heights). A comparison of the procedures is under way (in 2011).

Percentage of the forest area available for wood supply

Data retrieval year Survey years	2010 2006 to 2009
Forest area	*Percentage forests available for wood supply in the total forest area*
Poplar plantations	100
Broadleaved	96
Conifers	94
Mixed	94
Temporarily unstocked stands	100
Total FAWS	**95**

Source: NFI.
Relevant domain: FAWS.

These percentages were calculated solely on the basis of NFI data, but not with the SSP data presented above.

According to NFI, the forest available for wood supply (FAWS) area (cf. definition in Appendix III) has currently reached 15.3 Mha (± 0.1). The percentage of FAWS area relative to the entire forest area has remained steady (95%, as in the 2005 report). On average, the FAWS area consists of 91% stands eligible for inventory (cf. definition in Appendix III).
Private forests* cover an area of over 11.5 Mha (± 0.1), which means they represent 75% of the FAWS area. The remaining quarter includes state-owned forests (10% of the total) and other public forests (15%).

* NFI assigns a legal property category to each sampling point (state-owned forest, other public forest, private forest). NFI uses ancillary information for this classification: field maps based on forestry regulations provided by the Office National des Forêts (ONF). These maps sometimes compile information that is not recent (1987 to 2002), but they are currently the only available and usable references.

Indicator 1.1.1

Forest area gains and losses

Forest and poplar plantation area gains and losses and during three periods

Origin and allocation of forested area		1992 to 1997			1997 to 2003			2006 to 2010		
		Forested area gains	*Forested area losses*	*Balance*	*Forested area gains*	*Forested area losses*	*Balance*	*Forested area gains*	*Forested area losses*	*Balance*
		Variation in ha/year								
Man-made areas	Areas with structures	300	900	-600	100	1 100	-1 000	300	1 400	-1 100
	Coated or stabilised areas	1 800	3 100	-1 300	1 400	2 900	-1 500	4 200	10 300	-6 100
	Other man-made areas	2 800	3 600	-800	2 000	3 300	-1 300	4 200	5 600	-1 400
	Sub-total	4 900	7 600	-2 700	3 500	7 300	-3 800	8 700	17 300	-8 600
Farmland	Arable land	10 400	5 700	4 700	6 100	5 500	600	5 700	7 700	-2 000
	Permanent crops	1 800	1 000	800	1 100	1 200	-100	2 200	2 500	-300
	Other cropland associated with agricultural production	800	500	300	300	500	-200	600	600	0
	Permanent grassland	26 900	4 800	22 100	16 000	5 400	10 600	14 200	12 500	1 700
	Sub-total farmland	39 900	12 000	27 900	23 500	12 600	10 900	22 700	23 300	-600
Natural areas	Other woodland*	30 400	14 300	16 100	14 800	8 800	6 000	37 600	22 000	15 600
	Heathland, fallows, maquis, garrigues**	78 000	15 800	62 200	38 800	13 500	25 300	53 300	52 500	800
	Natural bare areas	3 900	1 200	2 700	2 900	1 200	1 700	1 800	3 800	-2 000
	Wetlands and underwater areas	1 300	1 200	100	1 100	1 100	0	1 600	1 700	-100
	Sub-total natural areas	113 600	32 500	81 100	57 600	24 600	33 000	94 300	80 000	14 300
Prohibited araes		100	300	-200	100	200	-100	5 100	0	5 100
Total		**158 500**	**52 400**	**106 100**	**84 700**	**44 700**	**40 000**	**130 800**	**120 600**	**10 200**
Percentage of total in France		**0.29**	**0.10**	**0.19**	**0.15**	**0.08**	**0.07**	**0.24**	**0.22**	**0.02**

Source: SSP - Teruti-Lucas. Annual mean in ha.

The landuse changes noted in the landuse surveys were minor phenomena and the associated confidence interval was often in the same range as the measured change. Moreover, changes in samples and nomenclature could have biased the comparison of patterns between periods, with the accuracy declining as the comparison becomes more detailed.

Beyond the main trends showing gradual stabilisation of the forest area as of the mid-2000s, and the permeability of the limits between forests, other woodland, heathland, fallows and farmland, these figures should be considered with caution.

* Other woodland includes hedges, thickets and scattered trees.

**Heathland, fallows, maquis, garrigues:

These areas are characterised by the presence of shrubs and low woody or semi-woody plants (generally less than 5 m tall) on more than 20% of the area. Scattered trees can account for less than 10% of the cover (projection of crowns on the ground).

Transfer matrices (Teruti 1 between 1982 and 1990, Teruti 2 between 1992 and 2003 and Teruti-Lucas since 2006) based on these three data series can shed light on landuse changes between two years provided that the sample is identical between the first and last year of the survey. Moreover, the period has to be long enough to eliminate bias due to 'noise' caused by temporary changes (e.g. a forest sampling point affected by windfalls is recorded in a heathland until reforestation occurs). Conversely, the period should not be too long in order to be able to detect trend variations over time. We therefore considered the three following periods which showed significant trend variations: 1992-1997, 1997-2003 and 2006-2010.

The forest area (including poplar plantations) increased by 106,000 ha/year during the first period, 40,000 ha/year during the second, and 10,000 ha/year during the third. The marked increase in forest area which was still under way in the early 1990s gradually levelled off around the end of the decade. Currently, considering the confidence interval attached to these values, it could be reasonably concluded that the forest area is now steady.

This net balance noted in the above paragraph is the result of two contrary patterns. The gains in forest area, i.e. 159, 85 and 131 thousand ha/year, were offset by losses of 52, 45 and 121 thousand ha/year, respectively. Gains slowed down substantially between the first and second period, whereas losses only moderately declined. There seemed to be a new acceleration in this change pattern over the 2006-2010 period. This latter point should be balanced against the fact that the adoption of a new sampling procedure always leads to monitoring errors during the initial years, but the situation is then gradually stabilised by correction.

Gains in forest coverage mainly concern heathland, fallows, maquis and garrigues, then farmland and finally other forested lands, mainly thickets. Over the periods, there is very little change in the proportions when taking the deviations induced by the change in sampling and nomenclature in 2005 into account:

– heathland and fallows: 49% from 1992 to 1997, 46% from 1997 to 2003, 41% from 2006 to 2010,
– farmland: 25% from 1992 to 1997, 28% from 1997 to 2003, 17% from 2006 to 2010,
– other forested lands: 19% from 1992 to 1997, 17% from 1997 to 2003, 29% from 2006 to 2010.

Forest area losses are also concentrated within these three categories:

– heathland and fallows: 30% from 1992 to 1997, 30% from 1997 to 2003, 44% from 2006 to 2010,
– farmland: 23% from 1992 to 1997, 28% from 1997 to 2003, 19% from 2006 to 2010,
– other forested lands: 27% from 1992 to 1997, 20% from 1997 to 2003, 18% from 2006 to 2010.

The net balance in exchanges between the forest, on one hand, and heathland, fallows, farmland and other forested lands, on the other, decreased substantially over time but still remained positive for the forest: + 106,000 ha/year from 1992 to 1997, + 42,000 ha/year from 1997 to 2003, and + 16,000 ha/year from 2006 to 2010. The main category in which exchanges were negative concerned man-made areas (areas with structures, coated or stabilised areas and other man-made areas) where the negative, yet limited, balance expanded over time: - 3,000 ha/year from 1992 to 1997, - 4,000 ha/year from 1997 to 2003, and – 9,000 ha/year from 2006 to 2010.

A detailed analysis of landuse transition matrices during the three periods sheds greater light on these trends (cf. Appendix IX) :

– the variations in heathland and fallows are in line with typical transitions that occur in periods of agricultural abandonment: farmland —> fallows —> heathland —> forest. The result of these transitions shows that:
• farmlands turned into heathlands and fallow lands at a rate of 32,000 ha/year from 1992 to 1997, 11,000 ha/year from 1997 to 2003, 29,000 ha/year from 2006 to 2010.
• heathlands and fallows were transformed into forest at a rate of 62,000 ha/year from 1992 to 1997, 25,000 ha/year from 1997 to 2003, 1,000 ha/year from 2006 to 2010.

– other forested lands generally turned into forest at a rate of 16,000 ha/year from 1992 to 1997, 6,000 ha/year from 1997 to 2003, 16,000 ha/year from 2006 to 2010. This positive shift is due to two contrasting trends:
• thickets gradually expanded to more than 50 ares, i.e. the threshold of the forest classification, at a rate of 30,000 ha/year from 1992 to 1997, 15,000 ha/year from 1997 to 2003, 38,000 ha/year from 2006 to 2010.
• compact forests over 50 ares were fragmented into thickets at a rate of 14,000 ha/year from 1992 to 1997, 9,000 ha/year from 1997 to 2003, 22,000 ha/year from 2006 to 2010.

Indicator 1.1.2

Forest area and afforestation rate by large ecoregion

Box 2: Large ecoregions and silvoecoregions

The 11 large ecoregions (GRECO) were delineated on the basis of a combination of macroclimatic, geological and topographical data for France and they correspond to the European ecoregion division for France. These GRECO are subdivided into 86 silvoecoregions (SER). Five recent azonal alluvia SER were also determined (NFI, 2011).

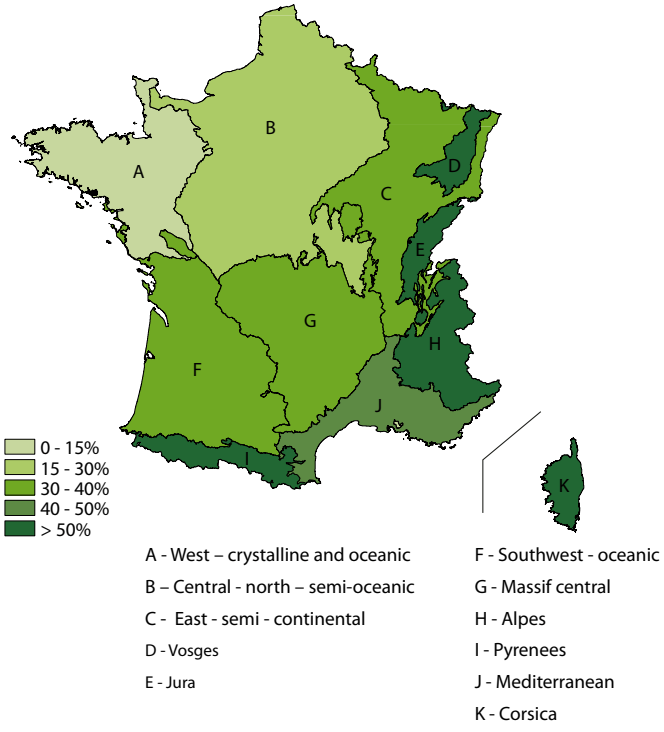
One silvoecoregion is the largest geographical zone within which factors that determine forest production, or the distribution of large types of forest habitat, fluctuate uniformly between accurate values according to a combination of factors that differ from combinations that characterize adjacent SERs.

SER and GRECO represent geographical divisions of the country based on ecological factors. They serve as a national reference for forest management framework documents. They are also useful for drawing up guidelines for selecting tree species, and thus are suitable for use by forest managers.

Forests available for wood supply

Large ecoregion	1 000 ha	Percentage forest area
A - West – crystalline and oceanic	597 ± 23	10
B - Central-north – semi-oceanic	2 840 ± 50	20
C - East - semi-continental	2 135 ± 49	31
D - Vosges	573 ± 26	63
E - Jura	484 ± 25	53
F - Southwest-oceanic	2 428 ± 47	31
G - Massif central	2 712 ± 54	38
H - Alps	1 151 ± 40	52
I - Pyrenees	742 ± 31	51
J - Mediterranean	1 267 ± 48	41
K - Corsica	390 ± 31	54
Total	**15 319 ± 104**	**30**

Source: NFI, survey years 2006 to 2009.
Relevant domain: FAWS.



Map 2: Percentage forest area by GRECO.
Source: NFI.

The highest percentages forest areas were noted in medium and high mountain regions (Vosges, Jura, Alps and Pyrenees) and in the Mediterranean region (Corsica, Mediterranean). In contrast, the large northwestern French region is less wooded with more farmland.

Vosges, Jura, Alps and Pyrenees GRECOs account for 19% of the French forest area, while Corsica and Mediterranean regions represent 11%, with the remaining 70% found in the other, mainly lowland, regions.

Indicator 1.1.3

Area by forest structure

Forests available for wood supply

ISFM 2005 Edition

Data retrieval year Average year		1989 1981		1994 1986		1999 1991		2004 1996	
Forest structure		*1000 ha*	*%*	*1000 ha*	*%*	*1000 ha*	*%*	*1000 ha*	*%*
Poplar plantations	Regular high forest	202	1	202	1	207	1	220	2
Forests	Regular high forest	5 753	42	6 021	44	6 423	46	6 768	47
	Irregular high forest	729	5	707	5	671	5	639	4
	Coppice	2 393	18	2 258	16	2 124	15	2 098	15
	Mixed coppice/high forest	4 368	32	4 322	31	4 241	30	4 201	29
	Temporarily unstocked*	93	1	137	1	139	1	115	1
	Unspecified	0	0	127	1	269	2	269	2
Total		**13 538**	**100**	**13 774**	**100**	**14 074**	**100**	**14 310**	**100**

* clear cutting or accident less than 5 years previously

Stands with unspecified structures correspond to stands not inventoried in the Mediterranean region.
Source: NFI.
Relevant domain: FAWS, including thickets.

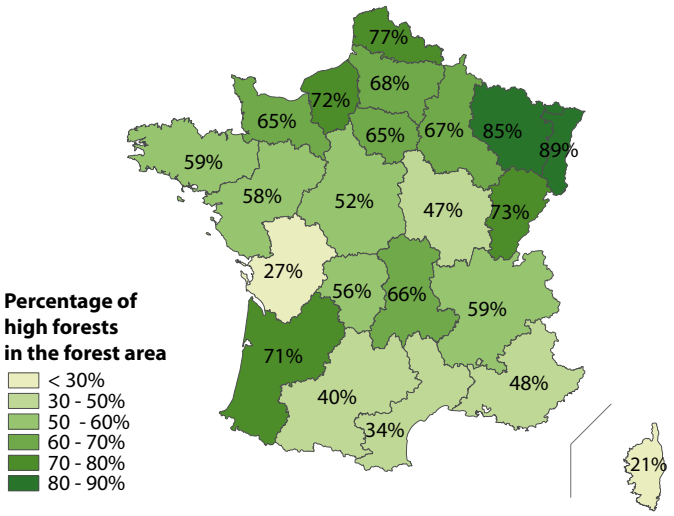
ISFM 2010 Edition

Data retrieval year Survey years		2010 2006 to 2009	
Forest structure		*1000 ha*	*%*
Poplar plantations	Regular high forest	196 ± 20	1
Forests	Regular high forest	7 556 ± 104	49
	Irregular high forest	638 ± 40	4
	Coppice	1 736 ± 65	11
	Mixed coppice/high forest	4 304 ± 93	28
	Temporarily unstocked	42 ± 12	0
	Open forest	848 ± 56	6
Total		**15 319 ± 104**	**100**

Source: NFI.
Relevant domain: FAWS.

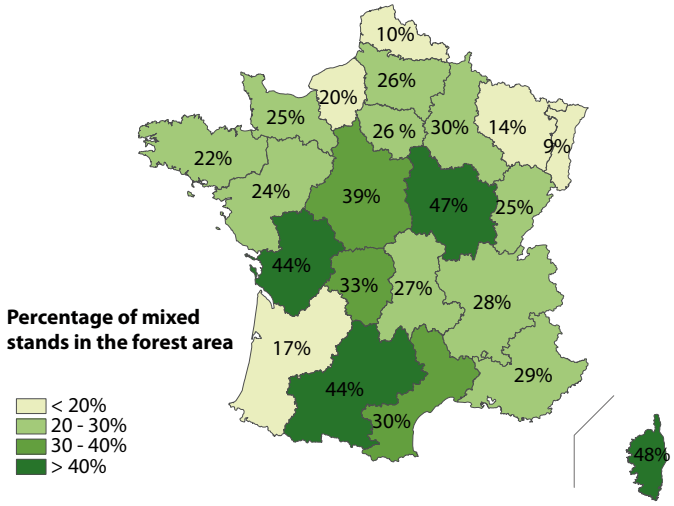
The forest structure (cf. definition in Appendix III) includes the vertical organisation of the stand, the origin of the trees within the structure and their size. It no longer includes any silvicultural considerations, which concern management or intended management.

Temporarily unstocked stands, as defined by NFI, are henceforth considered as completely nil forest areas with tree canopy, regardless of whether the focus is on trees eligible or not for inventory. This definition differs slightly from that used in the ISFM 2005 edition, where a temporarily unstocked area corresponded to a forest area that had undergone clear cutting or accident less than 5 years previously, and on which live trees eligible for inventory had a total absolute cover of less than 10%, with regeneration being nil or uncertain.



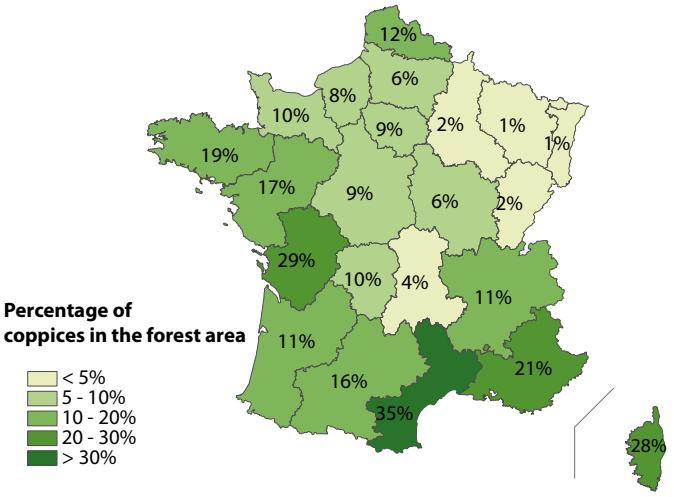
Map 3: Percentage of regular and irregular high forests in the closed* FAWS area.

Source: NFI, survey years 2006 to 2009.



Map 4: Percentage of mixed coppice/high forests in the closed* FAWS area.

Source: NFI, survey years 2006 to 2009.



Map 5: Percentage of coppices in the closed* FAWS area.

Source: NFI, survey years 2006 to 2009.

High forest accounts for most of the French FAWS: regular high forests (forest or poplar plantations) represent half of the area while irregular high forests represent 4% of this area.

The increase in **regular high forest** noted in previous editions is still under way. However, caution is needed because the real pattern cannot be distinguished from the impact of methodological changes. This increase is likely the result of natural growth and ageing of coppices and mixed coppice/high forest stands. Pedunculate oak is the most common tree species in coppice, covering an area of slightly over 1 Mha, followed by sessile oak, maritime pine and beech, each of which covers over 900,000 ha.

The two French regions with the largest irregular high forest area are Rhône-Alpes with 201,000 ha ± 22,000 (14% closed FAWS* in this region) and Provence-Alpes-Côte d'Azur with 133,000 ha ± 18,000 (12%). Midi-Pyrénées, Aquitaine, Languedoc-Roussillon and Franche-Comté regions also have substantial regular high forest areas, ranging from 44,000 ha ± 10,000 for Franche-Comté to 53,000 ha ± 11,000 for Midi-Pyrénées.

The region with the largest regular high forest area (excluding poplar plantations) is Aquitaine, with 1.2 Mha. Regular high forest accounts for 68% of the closed FAWS area in this region (excluding poplar plantations). The percentage of regular high forest (excluding poplar plantations) in the closed FAWS area varies markedly depending on the region, ranging from 85% in Alsace to only 15% in Corsica. Generally, all regions in most of northern France, from Nord-Pas-de-Calais to Centre, have over 50% of regular high forest (including two-thirds of broadleaved stands). Conversely, most regions with a low percentage of regular high forest are in the vicinity of the Mediterranean, including Provence-Alpes-Côte d'Azur, Midi-Pyrénées, Languedoc-Roussillon and Corsica, as already mentioned. Poitou-Charentes region also has one of the lowest percentages of regular high forest.

Mixed coppice/high forest stands represent over a quarter of the FAWS stands, a pattern that is specific to France, in contrast with most other European forests. Coppices account for over 10% of the FAWS area. Open forests* represent 6% of all FAWS.

The regions with the highest percentage of mixed coppice/high forest stands are Corsica, Bourgogne, Poitou-Charentes and Midi-Pyrénées, while the lowest percentage is in Alsace and Nord-Pas-de-Calais.

The most common tree species in **coppice stands** are pubescent oak with 410,000 ha (± 33,000), holm oak with 360,000 ha (± 32 000) and chestnut with 239,000 ha (± 24 000). The following tree species are also found in high forest stands: pedunculate oak with over 115,000 ha, sessile oak, birch, beech, willow and false acacia, which cover an area ranging from 50,000 to 80,000 ha, respectively, as well as ash, hornbeam and large alder, covering an area of 30,000 to 50,000 ha.

* definition in Appendix III

Regions with the most coppices are mainly in the Mediterranean area: Languedoc-Roussillon (334,000 ha ± 27,000 or 35% of the closed FAWS area), Corsica (28% - 80,000 ha ± 18 000) and Provence-Alpes-Côte d'Azur (227,000 ha ± 25,000 – 21%). Poitou-Charentes region also has a high percentage of coppices (29%).

The total popular plantation area in France is 196,000 ha (± 20 000), including 28,000 ha (± 7,000) in Picardie, 22,000 ha (± 6,000) in Champagne-Ardenne and almost 20,000 ha (± 6,000) in Pays-de-la-Loire. The Garonne River basin (Midi-Pyrénées and Aquitaine) accounts for around 33,000 ha of poplar plantations. The statistical data for all other regions are not significant.

Temporarily unstocked areas only represent a low percentage of the FAWS area. These areas are mainly found in Aquitaine, Limousin, Lorraine and Poitou-Charentes regions.

Oak coppice at Lamastre (Ardèche region) in autumn 2008.

Regeneration cut in a high forest in Indre department.

Indicator 1.1.4

Forest area by main tree species and composition

Forest area by main tree species

ISFM 2005 Edition

Data retrieval year	1989		1994		1999		2004	
Average year	1981		1986		1991		1996	
Main tree species	*1 000 ha*	*% of total area*	*1 000 ha*	*% of total area*	*1 000 ha*	*% of total area*	*1 000 ha*	*% of total area*
Pedunculate oak	2 382	18	2 424	18	2 333	17	2 200	16
Sessile oak	1 762	13	1 777	13	1 868	14	1 835	13
Undifferentiated oak*	-	-	-	-	-	-	148	1
Beech	1 231	9	1 255	9	1 291	9	1 301	9
Pubescent oak**	846	6	860	6	920	7	981	7
Chestnut**	515	4	488	4	492	4	496	4
Holm oak**	367	3	390	3	432	3	432	3
Common ash	271	2	309	2	359	3	398	3
Hornbeam	202	2	197	1	198	1	204	1
Birch	199	1	163	1	156	1	164	1
False acacia	136	1	134	1	131	1	131	1
Large alder	94	1	85	1	82	1	83	1
Willow	57	0	52	0	61	0	71	1
Large maple	27	0	33	0	38	0	57	0
Aspen	60	0	60	0	61	0	63	0
Cork oak**	72	1	79	1	79	1	79	1
Other broadleaved species	264	2	245	2	268	2	290	2
Total broadleaved**	**8 484**	**64**	**8 552**	**63**	**8 769**	**64**	**8 935**	**64**
Maritime pine**	1 398	10	1 383	10	1 381	10	1 365	10
Scots pine	1 179	9	1 154	9	1 122	8	1 127	8
Common spruce	717	5	744	6	740	5	718	5
Silver fir	544	4	554	4	566	4	572	4
Douglas fir	231	2	296	2	332	2	368	3
Aleppo pine	232	2	236	2	241	2	254	2
Austrian pine	183	1	188	1	179	1	194	1
Corsican pine	92	1	109	1	133	1	153	1
Larch	95	1	94	1	96	1	109	1
Mountain pine	55	0	56	0	55	0	56	0
Other conifer species	118	1	139	1	153	1	148	1
Total conifers**	**4 845**	**36**	**4 953**	**37**	**4 999**	**36**	**5 063**	**36**
Subtotal	**13 329**	**100**	**13 505**	**100**	**13 768**	**100**	**13 998**	**100**
Unspecified	8		66		99		93	
Total**	**13 337**		**13 571**		**13 867**		**14 091**	

* pedunculate, sessile and pubescent oak.

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

Source: NFI.

Relevant domain: FAWS excluding poplar plantations and including thickets, criterion determined only for forests available for wood production and for which a main species could be specified.

The variation rate of the area under pedunculate, sessile and pubescent oak could not be calculated because these three oaks were aggregated in 2004 when doubt was raised as to the species determination.

ISFM 2010 Edition

Data retrieval year	**2010**			
Survey years	**2006 to 2009**			
Main tree species	*1000 ha*			*% of total area*
Pedunculate oak	1 975	±	67	13
Sessile oak	1 639	±	56	11
Beech	1 418	±	55	9
Pubescent oak	1 370	±	56	9
Chestnut	739	±	42	5
Holm oak	706	±	45	5
Common ash	576	±	39	4
Hornbeam	561	±	35	4
Birch	308	±	28	2
Cultivated poplar	224	±	22	1
False acacia	191	±	23	1
Large alder	139	±	20	1
Willow	121	±	18	1
Large maple	111	±	17	1
Aspen	105	±	16	1
Cork oak	89	±	17	1
Other broadleaved species	553	±	42	4
Total broadleaved	**10 826**	**±**	**115**	**71**
Maritime pine	1 106	±	48	7
Scots pine	896	±	46	6
Common spruce	590	±	37	4
Silver fir	565	±	35	4
Douglas fir	404	±	32	3
Aleppo pine	213	±	26	1
Austrian pine	197	±	23	1
Corsican pine	184	±	22	1
Larch	102	±	15	1
Mountain pine	56	±	12	0
Other conifer species	134	±	19	1
Total conifers	**4 448**	**±**	**93**	**29**
Subtotal	**15 274**	**±**	**104**	**100**
Temporarily unstocked	45	±	13	0
Total	**15 319**	**±**	**104**	**100**

Source: NFI.
Relevant domain: FAWS.

Since the adoption of the new inventory method, the main tree species is considered to be the species with the greatest cover eligible for inventory in the stand (noted within an area of 25 m around a sampling point) or, when there is no cover eligible for inventory, the tree species with the greatest cover not eligible for inventory (noted within an area of 15 m around a sampling point). This definition coincides with that used until 2004, except in reference to mixed coppice/high forest stands where the main species was the one with the greatest cover in the high forest layer (i.e. the reserve). This change could help to explain the increase in the areas of high forest species, such as hornbeam, that are commonly found in mixed coppice/high forest stands. However, changes concerning holm oak and, to a lesser extent, pubescent oak, are due to a real increase in area, as well as adaptations to the international definitions mentioned in the Cautionary Note which, in particular, modified the minimal height thresholds that trees must reach *in situ* (cf. Appendix III).

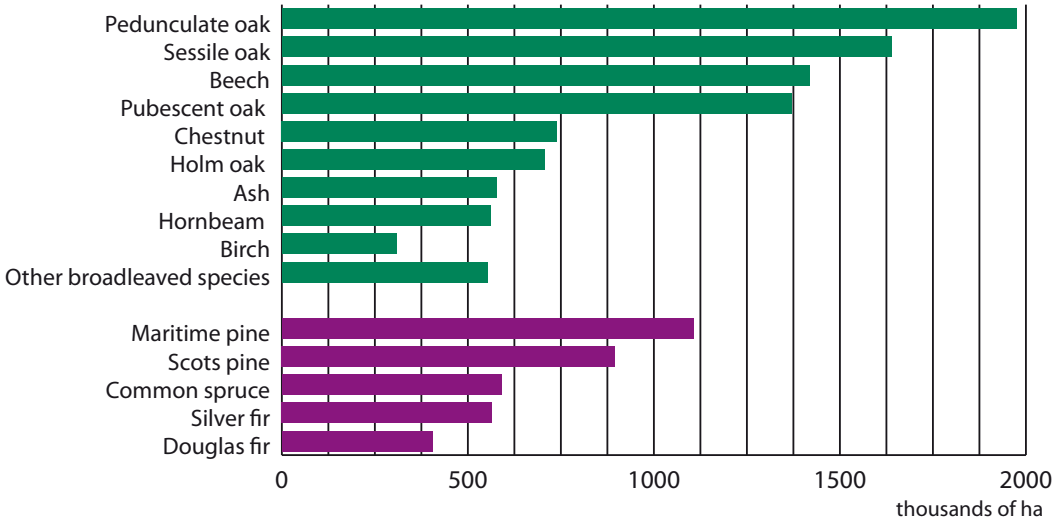


Figure 2: Forest area of the main broadleaved and conifer species.
Source: NFI, survey years 2006 to 2009.

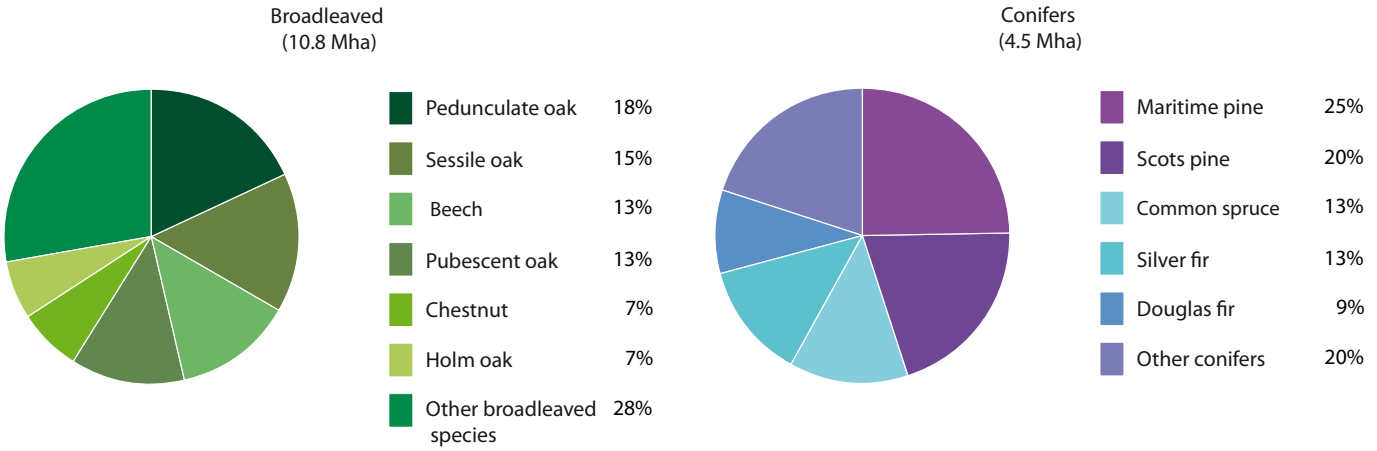


Figure 3: Forest area per main tree species.
Source: NFI, survey years 2006 to 2009.

Predominantly broadleaved stands are in the majority, covering 71% of the FAWS area, or 10.8 Mha. Pedunculate and sessile oaks are the two most represented tree species in metropolitan France, with an area of more than 3.6 Mha. Beech covers 1.4 Mha and is the third ranking species in terms of forest area (9%).

In conifers, maritime pine is the most common species with 1.1 Mha (7% of the French FAWS area), despite a decrease that could partly be due to the storms of December 1999 and January 2009. The forest area remained constant overall on the Landes massif between the 2004 and 2010 surveys, but the area of the main broadleaved species increased whereas the maritime pine surface area declined (Colin, 2010). The explanation for this phenomenon is the substitution of the main species in stands in which a broadleaved sublayer existed in a mixed stand with maritime pine prior to the storm. In these stands, pine tree windfalls caused by the storm were common, whereas the broadleaved trees remained standing, subsequently becoming the main species at the sampling point.

Scots pine is the second ranking conifer species, covering an area of 896 thousand ha, followed by fir and spruce, with each representing 4% of the FAWS area. The spruce forest area continues to decrease, reflecting the process of gradual substitution of spruce by other reforestation species. There has been a very marked twofold increase in the Douglas fir area over the last 25 years. This increase is the result of the very high demand for this species for reforestation in Bourgogne, Limousin and Auvergne regions.

The change in the main species determination method could explain some land classification changes, such as the decline in the area of stands classified as main conifer species, and the conversion of these areas in favour of main broadleaved species, especially coppices.

Detailed composition-oriented forest area calculation

Data retrieval year Survey years			2010 2006 to 2009	
Stand type		*Composition*	*1000 ha*	*% of total area*
Stands available for inventory	Pure broadleaved	Pure oak stand	2 282 ± 71	15
		Pure beech stand	618 ± 38	4
		Pure holm oak stand	366 ± 32	2
		Pure chestnut stand	326 ± 29	2
		Cultivated poplar plantation	171 ± 19	1
		Pure ash stand	149 ± 20	1
		Pure indigenous broadleaved stand	274 ± 28	2
		Other pure broadleaved stand	214 ± 23	1
	Pure conifers	Pure pine stand	1 722 ± 63	11
		Pure spruce stand	333 ± 29	2
		Pure fir stand	284 ± 25	2
		Pure Douglas fir stand	258 ± 25	2
		Other pure conifer stands	135 ± 18	1
	Mixed broadleaved	Beech-oak stand	736 ± 40	5
		Oak-hornbeam stand	720 ± 40	5
		Oak-ash stand	501 ± 36	3
		Mixed oak stand	476 ± 35	3
		Oak-chestnut stand	406 ± 32	3
		Mixed ash stand	284 ± 27	2
		Mixed holm oak stand	263 ± 28	2
		Mixed oak stand	241 ± 24	2
		Oak-birch stand	162 ± 20	1
		Other mixed broadleaved stand	807 ± 45	5
	Mixed broadleaved- conifers	Pine-oak stand	456 ± 36	3
		Mixed pine stand	414 ± 33	3
		Beech-fir stand	209 ± 22	1
		Other beech and conifer stands	177 ± 21	1
		Other mixed stands	598 ± 40	4
	Mixed conifers	Mixed pine stand	158 ± 20	1
		Other mixed conifer stands	259 ± 26	2
Subtotal			**13 999 ± 107**	**91**
Stands ineligible for inventory	Broadleaved not available for inventory		812 ± 43	5
	Conifers not available for inventory		373 ± 29	2
	Mixed stands not available for inventory		90 ± 22	1
Temporarily unstocked stands			45 ± 13	0
Total			**15 319 ± 104**	**100**

Source: NFI.
Relevant domain: FAWS.

N.B.: in this table, 'pure' is used for simplification, but actually refers to stands in which a species is pure or predominant (cf. definitions in Appendix V).

The composition-oriented stand classification is based on the cover calculations described in Appendix V. The main species has the greatest free cover in the stand, whereas the composition is determined by the species predominance or balance within the stand in terms of cover. The species diversity of the stand is first determined on the basis of the cover in order to distinguish stands of pure species or with one predominant species from mixed stands with two, three or more species. Then the single species or several species present, ranked in decreasing order of their importance in the cover, are associated with this diversity, thus highlighting the composition type.

N.B.: the so-called 'pure' compositions in this table are stands in which one species has a relative free cover rate of over 75%, as well as stands in which a species has a relative free cover rate of over 50%, whereas no other species has more than 15%.

Pure and mixed stands are almost equally distributed over the forest area, with 7 Mha for pure or predominant stands and 6.9 Mha for mixed stands. Mixed broadleaved stands are more numerous, accounting for 33% of the area of stands available for wood supply and eligible for inventory. They are followed by pure broadleaved stands (31%), and pure or predominantly conifer stands (20%). Mixed species or mixed conifer stands only represent 13 and 3% of the eligible for inventory FAWS area.

Pure or predominantly oak stands are the most widespread (2.2 Mha ± 71,000 ha), followed by pure or predominantly pine stands (1.7 Mha ± 63,000 ha), immediately followed by mixed oak-beech and oak-hornbeam stands, each with over 700,000 ha ± 40 000.

These data may be compared with those presented under Indicator 4.1.1.

Example of a mixed stand.

Indicator 1.2

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

Forests available for wood supply

The volume presented here is the NFI stem volume (7 cm top diameter), excluding branches (cf. Appendix III).

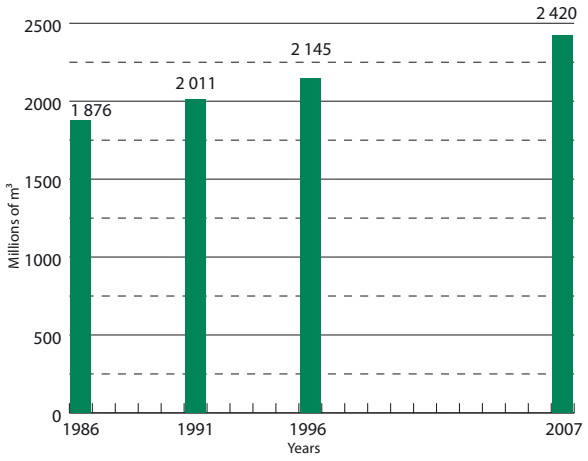


Figure 4: Growing stock patterns in FAWS.

Source: NFI, data for 1986 to 1996 obtained by former method, while the 2007 data were from the 2006 to 2009 surveys (new method). Relevant domain: FAWS (including poplar plantations). Note that thickets were included until 1996, but excluded in 2007.

The total growing stock in forests and poplar stands continues to regularly increase. This could be explained by the expansion of forest areas, as well as by the capitalisation of current stands. This latter phenomenon is noted in many forested European countries and is the result of the increase in forest area throughout the 20th century following agricultural abandonment, the capitalisation of stands due to the decline in coppice felling and generally to the lower felling rate relative to the increment. The increase in forest area affects the growing stock several decades later, when the stands have reached maturity (NFI, 2011). Another potential cause of the increase in growing stock is the rise in forest stand productivity (Bontemps, 2006). This growing stock increase is very marked in private forests, whereas it has levelled off in public forests, except in small and medium woodlands which are becoming more numerous in communal forests.

The growing stock in poplar plantations was 25.9 Mm^3 (± 6.9) in 2007, including 23.7 Mm^3 (± 6.2) poplars. The remaining 2.3 Mm^3 were other species that were growing in these plantations, such as ash, large alder and willow.

The per-hectare growing stock in closed forests reached 167 m^3/ha (± 2.5), but only 19 m^3/ha (± 3.8) in open forests. This difference could be explained by the much lower absolute coverage for open forests (less than 40%) as compared to closed forests. It thus clearly makes sense that this difference would be reflected in the growing stock.

Data retrieval year	**2010**		
Survey years	**2006 to 2009**		
	Mm³	*%*	*m³/ha*
State-owned forests	264 ± 15	11	182 ± 9
Other public forests	425 ± 16	18	180 ± 7
Private forests	1 731 ± 35	72	150 ± 3
Total	**2 420 ± 41**	**100**	**158 ± 2**

Source: NFI.
Relevant domain: FAWS.

The growing stock distribution differs slightly from the area distribution: private forests account for slightly under 75% of the growing stock. Its per-hectare average growing stock is therefore lower than the average for all FAWS. These private forests are mainly the result of recent natural and human induced afforestation.

ISFM 2005 Edition

Data retrieval year Average year	1989 1981		1994 1986		1999 1991		2004 1996	
Composition	*Mm³*	*%*	*Mm³*	*%*	*Mm³*	*%*	*Mm³*	*%*
Broadleaved stands	1 004	58	1 070	58	1 148	58	1 219	57
Conifer stands	559	32	612	33	649	33	697	33
Mixed stands	160	9	171	9	194	10	211	10
Total	**1 723**	**100**	**1 854**	**100**	**1 991**	**100**	**2 127**	**100**
Composition	*m³/ha*		*m³/ha*		*m³/ha*		*m³/ha*	
Broadleaved stands	119		126		133		139	
Conifer stands	150		163		172		184	
Mixed stands	137		145		158		164	
Total	**129**		**138**		**146**		**154**	

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

The total growing stock of FAWS in metropolitan France is one of the highest in Europe (excluding Russia), along with Germany and Sweden (Forest Europe, 2011). However, the growing stock per ha (158 m^3/ha) is much lower than the average values for Switzerland (over 300 m^3/ha), Austria, Slovenia, Germany and Czech Republic (250 to 350 m^3/ha), whereas it is higher than average in Mediterranean countries (Italy 151 m^3/ha, Spain 50 m^3/ha, Greece 47 m^3/ha) and Scandinavian countries (Norway 98 m^3/ha, Sweden 119 m^3/ha, Finland 99 m^3/ha - Peyron, pers. com. and FAO, 2010). France's intermediate position could be explained especially by its position at a biogeographical crossroads, with marked interregional heterogeneity and the nationwide predominance of broadleaved stands (contrary to countries with a high growing stock per ha). On a European scale, the most capitalised forests are in Central Europe, mainly in mountainous areas (Gallaun et al., 2010), while the least capitalised are in the Iberian Peninsula (50 m^3/ha for Spain and 54 m^3/ha for Portugal – FAO, 2010).

In France, Alsace is the only region where the growing stock is above 250 m^3/ha. Overall, the northeastern regions (Alsace, Franche-Comté, Lorraine, Rhône-Alpes) and Massif Central regions (Auvergne, Limousin) have the highest average per-hectare growing stock (over 185 m^3/ha).

In metropolitan France, broadleaved stands (including poplar stands) account for over 60% of the total growing stock. However, these stands have the lowest average growing stock per ha, especially due to the fact that the production potential for broadleaved species is lower than that of conifers, and because silviculture recommendations favour higher conifer densities. The per-hectare growing stock is higher for conifers, which represent slightly over 25% of the total growing stock.

The increase in growing stock is due to the overall capitalisation of existing stands that are newly considered as forest.

ISFM 2010 Edition

Data retrieval year Survey years	2010 2006 to 2009		
Composition	*Mm³*		*%*
Broadleaved stands	1 471	± 31	61
Conifer stands	658	± 30	27
Mixed stands	291	± 19	12
Total	**2 420**	**± 41**	**100**
Composition	*m³/ha*	*IC (%)*	
Broadleaved stands	145	nd	
Conifer stands	189	nd	
Mixed stands	177	nd	
Total	**158**	**± 2**	

Source: NFI.
Relevant domain: FAWS.

Although it is hard to accurately assess, there is clearly a long-term increase in growing stock in mixed and conifer stands. This increase is the result of the increase in areas for these categories and high capitalisation in these stands, especially in medium and high mountain areas. The highest growing stock is noted for conifer stands located between 600 and 1,000 m elevation, followed by stands between 400 and 600 m elevation and between 1,000 and 1,400 m elevation. For mixed stands, the highest growing stock is found between 1,000 and 1,400 m elevation, then at over 1,400 m elevation, and subsequently between 600 and 1,000 m elevation. Highland stands are generally harder to log because of physical factors such as steep slopes and a lack of roads that hamper access to the resource.

The per-hectare growing stock of broadleaved stands is much lower than that of conifer and mixed stands. Here again the highest growing stock per ha values are recorded in highland stands (1,000 to 1,400 m), which are usually less accessible. However, under 1,000 m elevation, there is a decrease in growing stock in broadleaved stands as the elevation increases, likely due to the harsher growing conditions.

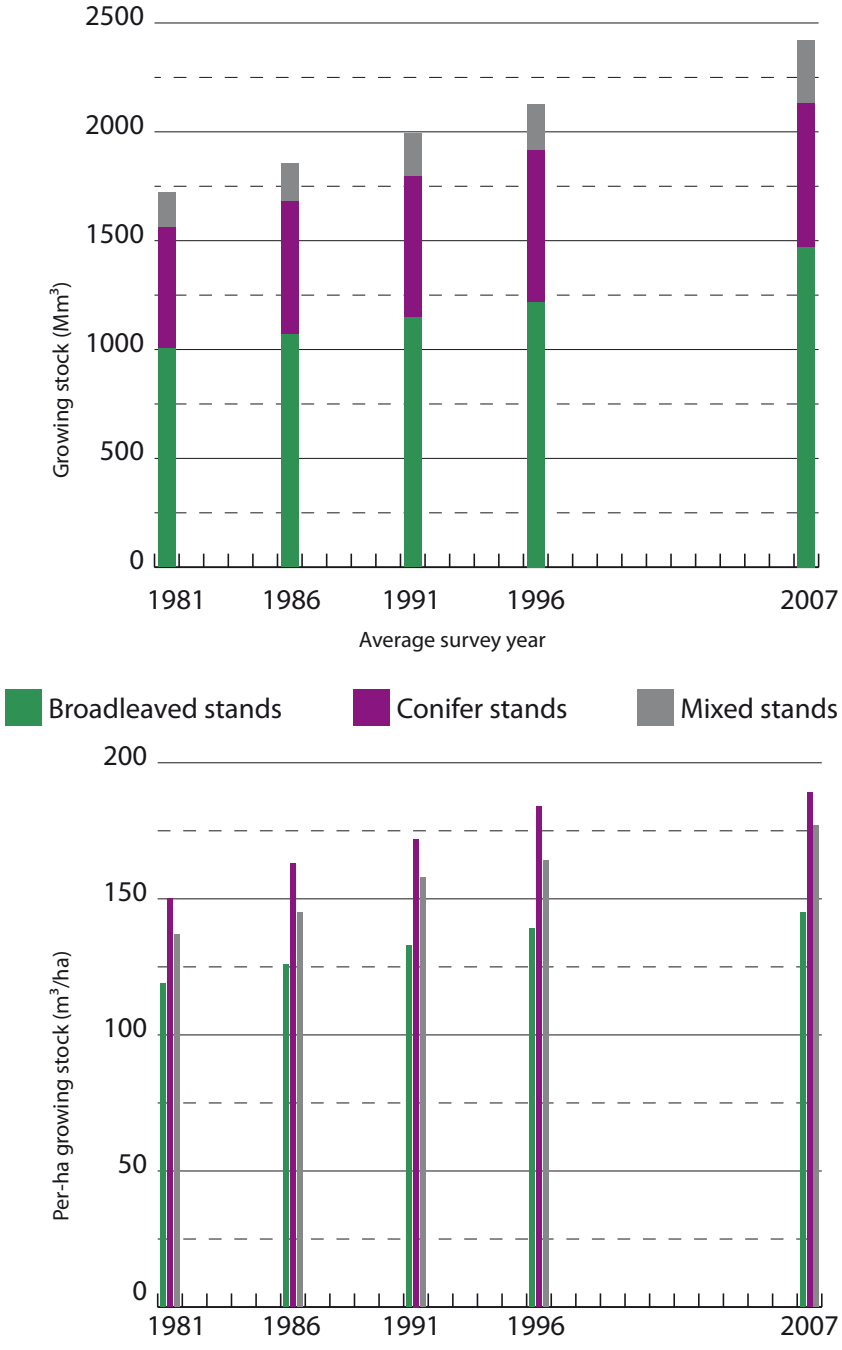


Figure 5: Growing stock and per-hectare growing stock per forest type.

Source: NFI. Note: poplar plantations excluded and thickets included until 1996, the opposite in 2007. Survey years 2006 to 2009 used to determine the average year 2007.

Indicator 1.2.1

Growing stock by NFI forest structure

Forests available for wood supply

The volume presented here is the NFI stem volume (7 cm top diameter), excluding branches (cf. Appendix III).

ISFM 2005 Edition

Data retrieval year		1989			1994			1999			2004		
Average year		1981			1986			1991			1996		
Forest structure		*Mm³*	*%*	*m³/ha*	*Mm³*	*%*	*m³/ha*	*Mm³*	*%*	*m³/ha*	*Mm³*	*%*	*m³/ha*
Forests	Regular high forest	932	54	162	1 046	56	174	1 164	58	181	1 285	60	190
	Irregular high forest	109	6	149	109	6	154	112	6	167	107	5	168
	Coppice	138	8	58	137	7	61	138	7	65	140	7	67
	Mixed coppice-high forest	543	32	125	561	30	131	577	29	137	595	28	143
Total forests		**1 723**	**100**	**129**	**1 854**	**100**	**138**	**1 991**	**100**	**146**	**2 127**	**100**	**154**
Poplar plantations	Regular high forest				23		149	21		137	18		121

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

ISFM 2010 Edition

Data retrieval year		2010		
Survey years		2006 to 2009		
Forest structure		*Volume (Mm³)*	*% of the volume*	*m³/ha*
Poplar plantations	Regular high forest	26 ± 7	1	133
Forests	Regular high forest	1 540 ± 37	64	204
	Irregular high forest	109 ± 11	4	169
	Coppice	115 ± 9	5	66
	Mixed coppice-high forest	613 ± 20	25	143
	Open forest	16 ± 3	1	19
Total		**2 420 ± 41**	**100**	**158**

Source: NFI, survey years 2006 to 2009.
Relevant domain: FAWS, excluding temporarily unstocked stands.

The changes made in the 'forest structure' variable are pointed out for Indicator 1.1.3. Note that, here again, differences between the 2004 and 2010 data should not be interpreted as actual variations in the growing stock as they could also be the result of the definition changes that were applied.

Regular high forests, excluding poplar plantations, had the highest growing stock. These structures pooled 64% of the growing stock, whereas they only accounted for 49% of the forest area. This high growing stock value, which increased in recent years, is the result of a shift in growing stock derived from mixed coppice-high forest conversion stands, and the increment potential of conifer afforestation and reafforestation.

Rhône-Alpes region alone accounted for 35% of the regular high forest growing stock.

Concerning poplar plantations, Picardie accounted for 14% of the total growing stock of these stands, Pays-de-la-Loire 11% and Champagne-Ardenne 10%. Moreover, Aquitaine, Poitou-Charentes, Centre and Nord-Pas-de-Calais regions had a relatively high percentage of poplar plantation growing stock.

Most of the coppice growing stock is found in the South of France: Languedoc-Roussillon, Aquitaine, Midi-Pyrénées and PACA regions, as well as in Poitou-Charentes and Rhône-Alpes regions.

Indicator 1.2.2

Growing stock by tree species

Forests available for wood supply

Growing stock

The volume presented here is the NFI stem volume (7 cm top diameter), excluding branches (cf. Appendix III).

ISFM 2005 Edition

Data retrieval year	1989		1994		1999		2004	
Average year	1981		1986		1991		1996	
Tree species	*Mm³*	*%*	*Mm³*	*%*	*Mm³*	*%*	*Mm³*	*%*
Pedunculate oak	230	13	249	13	249	12	257	12
Sessile oak	204	12	219	12	251	13	267	12
Undifferentiated oaks	-	-	-	-	-	-	2	0
Beech	214	12	223	12	235	12	242	11
Chestnut**	86	5	90	5	98	5	101	5
Pubescent oak**	41	2	46	2	54	3	68	3
Hornbeam	62	4	68	4	76	4	82	4
Common ash	41	2	46	2	52	3	58	3
Birch	39	2	39	2	40	2	39	2
False acacia	17	1	18	1	18	1	20	1
Holm oak**	11	1	13	1	14	1	16	1
Aspen	21	1	22	1	22	1	22	1
Large alder	17	1	17	1	17	1	19	1
Large maple	10	1	11	1	13	1	16	1
Small maple	11	1	11	1	13	1	15	1
Cherry or wild cherry	11	1	12	1	14	1	16	1
Linden	10	1	11	1	12	1	13	1
Other broadleaved	39	2	39	2	42	2	45	2
Total broadleaved**	**1 062**	**62**	**1 133**	**61**	**1 221**	**61**	**1 297**	**61**
Common spruce	124	7	138	7	152	8	164	8
Silver fir	145	8	148	8	157	8	165	8
Scots pine	136	8	138	7	140	7	143	7
Maritime pine**	165	10	186	10	189	9	200	9
Douglas fir	15	1	28	2	41	2	54	3
Corsican pine	12	1	15	1	19	1	22	1
Austrian pine	22	1	23	1	24	1	26	1
Larch	16	1	15	1	15	1	20	1
Aleppo pine	10	1	11	1	11	1	14	1
Other conifers	14	1	21	1	27	1	30	1
Total conifers**	**660**	**38**	**723**	**39**	**776**	**39**	**836**	**39**
Total	**1 723**	**100**	**1 857**	**100**	**1 996**	**100**	**2 133**	**100**

** including estimated growing stock in the types of formations not inventoried in 1994 and 1999.
Source: NFI.
Relevant domain: FAWS excluding poplar plantations and including thickets.

Data retrieval year	2010	
Survey years	2006 to 2009	
Tree species	*Mm³*	*%*
Pedunculate oak	289 ± 11	12
Sessile oak	277 ± 12	11
Beech	262 ± 13	11
Chestnut	122 ± 9	5
Pubescent oak	97 ± 6	4
Hornbeam	93 ± 5	4
Common ash	89 ± 6	4
Birch	40 ± 3	2
Cultivated poplar	31 ± 6	1
False acacia	26 ± 4	1
Holm oak	26 ± 3	1
Aspen	26 ± 3	1
Large alder	25 ± 4	1
Large alder	24 ± 3	1
Small maple	21 ± 2	1
Cherry or wild cherry	20 ± 2	1
Linden	15 ± 2	1
Other broadleaved	68 ± 4	3
Total broadleaved	**1 550 ± 32**	**64**
Common spruce	185 ± 16	8
Silver fir	181 ± 15	7
Scots pine	143 ± 9	6
Maritime pine	139 ± 11	6
Douglas fir	94 ± 12	4
Corsican pine	33 ± 7	1
Austrian pine	25 ± 5	1
Larch	21 ± 5	1
Aleppo pine	16 ± 3	1
Other conifers	34 ± 6	1
Total conifers	**870 ± 30**	**36**
Total	**2 420 ± 41**	**100**

Source: NFI.
Relevant domain: FAWS, excluding temporarily unstocked stands.

The growing stock considered here is calculated for each individual tree and not only for the main tree species of the stand. For instance, at a sampling point where sessile oak is the species with the greatest cover (main species), other species may also be present. The growing stock of each tree of these other species is allocated to the considered species.

The top 10 species in terms of growing stock represent 74% of the total growing stock, or around 1.8 billion m^3. An increase in growing stock was noted for all species, except maritime pine, whose growing stock suddenly dropped as a result of cyclone Klaus (cf. also Indicator 2.4 on storm damage). The increase in growing stock was greater in broadleaved stands (NFI, 2011). For pubescent oak, the increase reached +3.5%/year as a result of a spontaneous increase in the area of this species in the South of France, as also was the case with holm oak (NFI, 2011). In conifers, the greatest increase was noted in Douglas fir (+ 7.25%/year). This was due to the massive use of this species in afforestation initiatives within the framework of the Fond forestier national. Douglas fir and spruce together account for 70% of the increase in conifer growing stock (NFI, 2011).

Broadleaved species account for a major part of the growing stock, i.e. 64% of the total volume. The three main broadleaved species, pedunculate oak, sessile oak and beech, represent 34% of the total growing stock, with around 830 Mm^3. Broadleaved species were found to be in majority in most French regions, except in Auvergne, Rhône-Alpes and PACA regions. The growing stock in Île-de-France and Picardie regions is almost exclusively broadleaved (94 and 93%, respectively, of their growing stock is broadleaved). Nord-Pas-de-Calais, Champagne-Ardenne, Poitou-Charentes, Haute-Normandie, Centre and Bourgogne have over 80% broadleaved growing stock.

Maritime pine, the main conifer species in terms of growing stock in prior ISFM editions, now has a lower growing stock than that of spruce, fir and Scots pine, which account for 8%, 7% and 6% of the total growing stock, respectively. As already mentioned, this decline was due to the impact of the 1999 and 2009 storms.

The storms had an immediate impact on the growing stock, via windfalls, in addition to a delayed impact. The presence of windfalls leads to a drop in felling in stands unaffected by the storms, while sapling stand growth might be influenced in the short and medium term by storm damage.

The conifer growing stock in Rhône-Alpes region is over 150 Mm^3, followed by Aquitaine with 94 Mm^3, and then Auvergne with around 87 Mm^3.

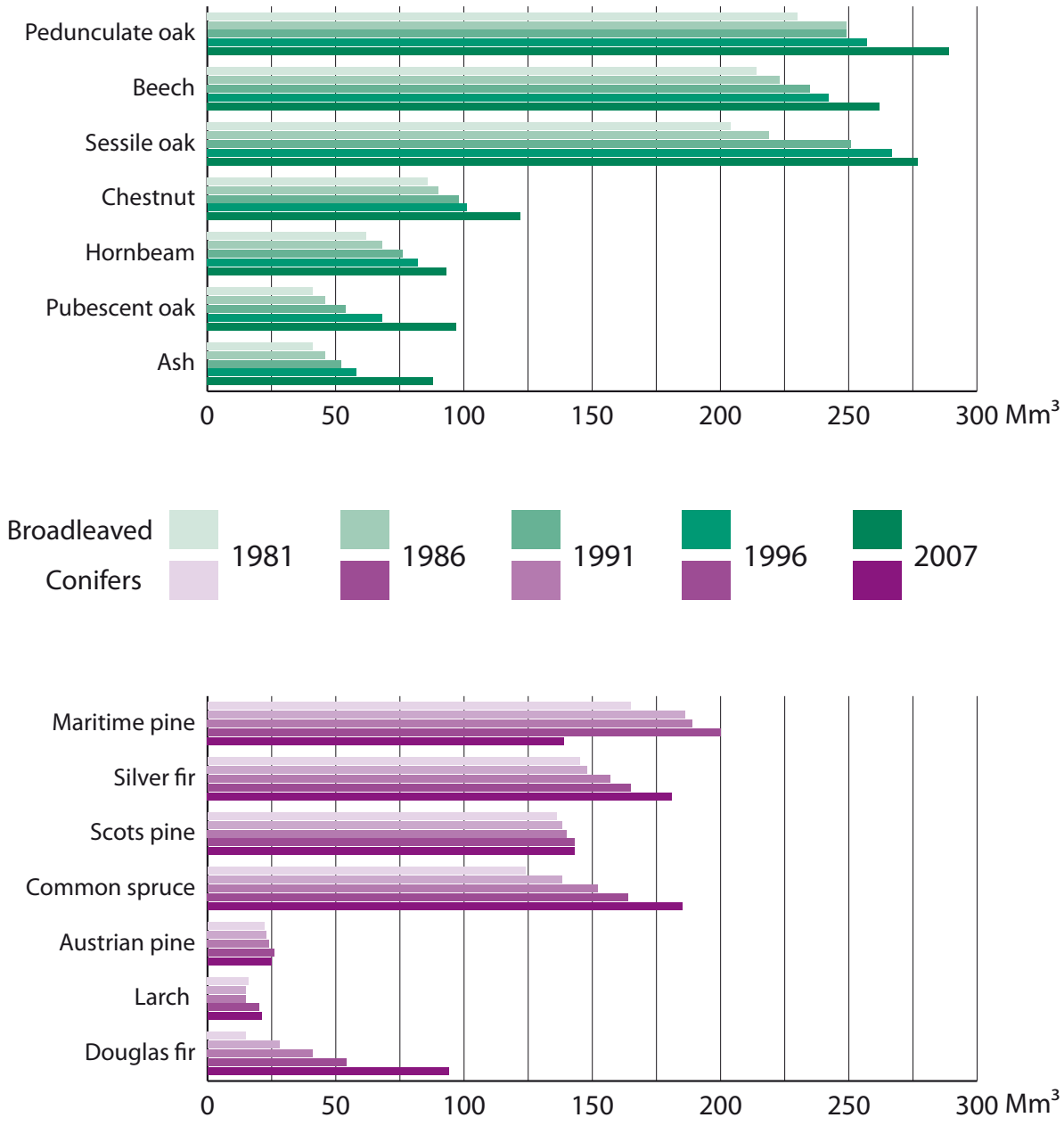
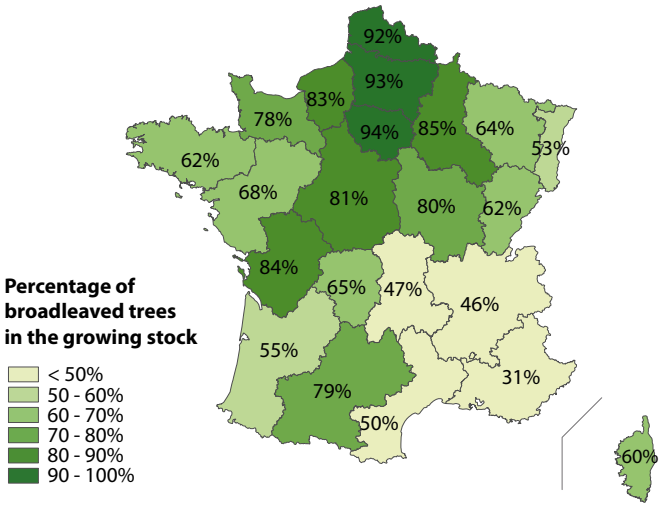
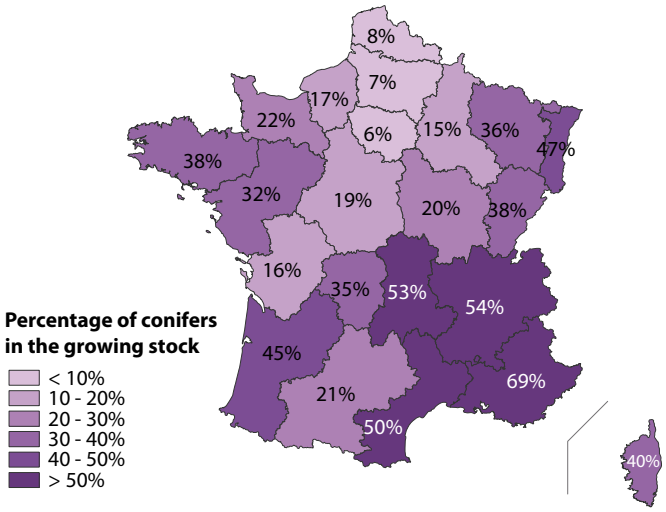


Figure 6: Growing stock of the main broadleaved and conifer species.
Source: NFI.



Map 6: Percentage of broadleaved trees in the growing stock by administrative region.



Map 7: Percentage of conifers in the growing stock by administrative region.

Source: NFI, survey years 2006 to 2009.

Growing stock per hectare

Average growing stock per hectare of a species in stands where it represents the main species (m^3/ha).

ISFM 2005 Edition

Data retrieval year	1989	1994	1999	2004
Average year	1981	1986	1991	1996
Main tree species	*m^3/ha*			
Pedunculate oak	90	96	102	103
Sessile oak				
Beech	130	131	134	136
Chestnut	87	89	99	100
Pubescent oak	41	46	50	56
Hornbeam	55	57	64	67
Common ash	73	75	76	76
Birch	46	47	49	51
False acacia	64	71	73	78
Holm oak	23	26	28	30
Aspen	64	65	69	68
Large alder	95	98	104	115
Large maple	53	56	60	66
Small maple	30	28	28	27
Cherry or wild cherry	35	37	35	38
Linden	71	74	75	83
Other broadleaved	45	48	48	48
Total broadleaved	**83**	**88**	**93**	**94**
Common spruce	141	152	170	187
Silver fir	228	226	230	239
Scots pine	99	101	105	105
Maritime pine	113	130	132	142
Douglas fir	54	82	109	129
Corsican pine	119	124	127	129
Austrian pine	108	110	116	117
Larch	129	128	127	146
Aleppo pine	42	44	44	51
Other conifers	63	84	104	116
Total conifers	**119**	**128**	**135**	**143**
Total	**96**	**102**	**108**	**112**

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

Only the growing stock of the main tree species relative to the inventoried area of this species was taken into account in the data presented in the previous editions. The growing stock of other species was not included, whereas in the 2010 edition it is included in the column 'Growing stock per hectare for all species'.

In broadleaved species, the average growing stock per ha for all species combined is highest in stands having beech, sessile oak or linden as main species. In contrast, holm oak stands are amongst the least capitalised stands.

ISFM 2010 Edition

Data retrieval year	**2010**	
Survey years	**2006 to 2009**	
Main tree species	*Growing stock of species per ha (m^3/ha)*	*Total growing stock per ha (m^3/ha)*
Pedunculate oak	105 ± 4	164 ± 6
Sessile oak	136 ± 5	195 ± 7
Beech	136 ± 7	204 ± 9
Chestnut	115 ± 11	171 ± 13
Pubescent oak	59 ± 4	79 ± 5
Common ash	85 ± 10	162 ± 16
Hornbeam	66 ± 6	152 ± 10
Cultivated poplar	122 ± 27	143 ± 32
Holm oak	32 ± 4	44 ± 5
Birch	42 ± 8	88 ± 16
False acacia	85 ± 19	135 ± 25
Large alder	108 ± 28	164 ± 39
Large maple	68 ± 25	151 ± 44
Aspen	74 ± 24	144 ± 40
Linden	83 ± 31	187 ± 65
Small maple	32 ± 24	68 ± 25
Cherry or wild cherry	35 ± 33	66 ± 44
Other broadleaved	47 ± 8	73 ± 10
Total broadleaved	**94 nd**	**146 ± 3**
Common spruce	250 ± 20	306 ± 23
Silver fir	253 ± 20	321 ± 23
Scots pine	118 ± 9	147 ± 11
Maritime pine	111 ± 10	120 ± 10
Douglas fir	199 ± 26	232 ± 28
Corsican pine	156 ± 38	178 ± 40
Austrian pine	110 ± 28	129 ± 30
Larch	162 ± 37	193 ± 41
Aleppo pine	58 ± 12	63 ± 13
Other conifers	135 ± 32	163 ± 37
Total conifers	**158 nd**	**189 ± 6**
Total	**113 nd**	**158 ± 2**

Source: NFI.
Relevant domain: FAWS, excluding temporarily unstocked stands.

Stands in which the main species is a conifer have the highest average growing stock per hectare. Of these, fir and spruce stands are the most capitalised, with over 300 m^3/ha on average. This could be explained by the management recommendations for these stands, which are often kept very dense, but also partly by the lower level of logging due to the locations of these stands, i.e. often in mountainous regions. Sixty-nine percent of the spruce area and 78% of the fir area are above 600 m elevation, which corresponds to 72% and 81%, respectively, in terms of growing stock. The highest per-hectare growing stock is found at this elevation, i.e. over 290 m^3/ha for spruce and 310 m^3/ha for fir.

Conversely, Aleppo pine has a very low growing stock, i.e. 63 m^3/ha. In broadleaved species, the highest average per-hectare growing stock is found in beech or sessile oak stands, with around 200 m^3/ha.

The per-hectare growing stock of the main species represents 71% of the total stand growing stock on average. This average is 65% for broadleaved species and 84% for conifers.

Growing stock per detailed stand type

Data retrieval year			2010		
Survey years			2006 to 2009		
Stand type			*Mm³*	*%*	*m³/ha*
Stands eligible for inventory	Pure broadleaved	Pure oak stand	336 ± 16	14	147
		Pure beech stand	131 ± 12	5	212
		Pure chestnut stand	59 ± 8	2	181
		Pure ash stand	25 ± 7	1	166
		Cultivated poplar plantation	26 ± 7	1	151
		Pure indigenous broadleaved	29 ± 6	1	105
		Other pure broadleaved	42 ± 6	2	73
	Pure conifers	Pure pine stand	244 ± 16	10	142
		Pure spruce stand	110 ± 15	5	330
		Pure fir stand	101 ± 13	4	357
		Pure Douglas fir stand	72 ± 12	3	275
		Other pure conifers	29 ± 8	1	214
	Mixed broadleaved	Beech-oak stand	156 ± 11	6	212
		Oak-hornbeam stand	129 ± 9	5	179
		Oak-ash stand	92 ± 10	4	182
		Oak-chestnut stand	72 ± 8	3	178
		Mixed oak stand	61 ± 8	3	128
		Mixed ash stand	45 ± 7	2	159
		Mixed oaks	44 ± 6	2	182
		Oak-birch stand	23 ± 5	1	141
		Other mixed broadleaved	136 ± 11	6	127
	Mixed broadleaved-conifers	Mixed pine stand	68 ± 9	3	164
		Pine-chestnut stand	55 ± 8	2	121
		Beech-fir stand	55 ± 8	2	263
		Beech-spruce stand	34 ± 7	1	286
		Beech-fir-spruce stand	18 ± 5	1	324
		Other mixed stand	111 ± 13	5	186
	Mixed conifers	Fir-spruce stand	41 ± 10	2	335
		Mixed pine stand	31 ± 7	1	198
		Other mixed conifers	37 ± 8	2	273
Subtotal			**2 412 ± 38**	**100**	**172**
Stands not eligible for inventory			7 ± 2	0	6
Total			**2 420 ± 41**	**100**	**158**

Source: NFI
Relevant domain: FAWS, excluding temporarily unstocked stands.

Stands in which one species is pure or predominant represent half of the total growing stock. Pure or predominantly broadleaved stands account for 27% of the total growing stock, while pure and predominantly conifer stands represent 23%. Mixed broadleaved stands represent 31% of the total growing stock.

N.B.: in this table, 'pure' is used for simplification, but actually refers to stands in which a species is pure or predominant (cf. definitions in Appendix V).

The two stand types that pool the greatest growing stock are pure or predominantly oak stands (14% of the total growing stock) and pure or predominantly pine stands (10% of the total growing stock).

Indicator 1.2.3

Basal area per tree species

Average basal area for all tree species in stands where the species is the main one

ISFM 2005 Edition

Data retrieval year Average year	1989 1981	1994 1986	1999 1991	2004 1996
Main tree species	*Basal area for all species in stands where the species is the main one (m^2/ha)*			
Pedunculate oak Sessile oak	18.5	19.6	20.8	21.4
Beech	22.4	22.9	24.0	24.4
Chestnut	20.8	21.2	23.0	23.1
Pubescent oak	11.5	12.7	13.7	14.6
Hornbeam	16.6	17.1	19.2	19.8
Common ash	18.5	18.9	18.9	18.9
Birch	13.0	13.4	14.0	14.6
False acacia	13.5	14.5	15.5	16.4
Holm oak	8.8	9.9	10.8	11.4
Aspen	16.7	17.1	17.6	18.0
Large alder	19.5	19.7	20.4	21.9
Large maple	17.3	18.2	18.1	19.9
Small maple	12.9	12.7	13.0	12.4
Cherry or wild cherry	13.4	13.6	13.2	13.8
Linden	20.9	21.0	22.1	22.8
Other broadleaved	13.0	13.7	13.8	13.8
Total broadleaved	**17.6**	**18.5**	**19.6**	**20.1**
Common spruce	21.4	23.5	26.2	28.2
Silver fir	28.1	28.4	30.3	31.3
Scots pine	20.1	20.9	22.1	22.4
Maritime pine	16.5	18.1	18.4	20.3
Douglas fir	10.8	14.6	18.2	20.4
Corsican pine	17.1	19.6	20.7	21.0
Austrian pine	19.3	20.0	21.4	21.7
Larch	20.2	20.1	19.9	22.9
Aleppo pine	11.4	11.9	12.0	13.9
Other conifers	14.2	17.6	20.5	21.9
Total conifers	**19.0**	**20.3**	**21.7**	**23.0**
Total	**18.1**	**19.2**	**20.4**	**21.2**

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

Data retrieval year Survey years	2010 2006 to 2009
Main tree species	*Basal area for all species in stands where the species is the main one (m^2/ha)*
Pedunculate oak	21.7 ± 0.7
Sessile oak	23.4 ± 0.6
Beech	25.5 ± 0.9
Chestnut	27.0 ± 1.5
Pubescent oak	15.8 ± 0.8
Common ash	21.2 ± 1.6
Hornbeam	21.0 ± 1.2
Cultivated poplar	15.3 ± 2.3
Holm oak	13.4 ± 1.4
Birch	14.3 ± 2.0
False acacia	19.7 ± 3.0
Large alder	22.9 ± 4.4
Large maple	20.2 ± 4.6
Aspen	19.8 ± 4.2
Linden	25.8 ± 7.5
Small maple	13.8 ± 4.3
Cherry or wild cherry	11.2 ± 5.7
Other broadleaved	14.2 ± 1.6
Total broadleaved	**20.6 ± 0.3**
Common spruce	33.7 ± 1.9
Silver fir	33.6 ± 1.8
Scots pine	23.0 ± 1.3
Maritime pine	16.2 ± 1.1
Douglas fir	25.5 ± 2.1
Corsican pine	24.4 ± 4.1
Austrian pine	20.1 ± 3.5
Larch	24.6 ± 3.9
Aleppo pine	12.5 ± 2.2
Other conifers	23.2 ± 3.8
Total conifers	**23.8 ± 0.6**
Total	**21.5 ± 0.3**

Source: NFI.
Relevant domain: FAWS, excluding temporarily unstocked stands.

Trends highlighted in the per-hectare growing stock are also noted in the basal area data. On average, stands of main broadleaved species have a basal area of 21 m^2/ha. This average basal area is higher in conifers (24 m^2/ha). Moreover, stands with the highest basal area (all main species combined) are spruce and fir.

In broadleaved stands, Auvergne and Limousin regions have the highest average basal areas, with 26 and 24 m^2/ha, respectively. In contrast, the lowest average basal areas are in Mediterranean regions (PACA, Languedoc-Roussillon, Corsica). The most common species in these regions (especially holm oak and pubescent oak) seldom have large stem diameters because they are often found in coppices or the growing conditions are harsh.

In conifer stands, Alsace, Auvergne, Franche-Comté and Rhône-Alpes regions have the highest basal areas, i.e. over 30 m^2/ha. Aquitaine is the region with the lowest conifer basal area, with 14 m^2/ha. This could be explained by the lower plantation densities for maritime pine than for other conifer species, but also by the impact of the 1999 and 2009 storms which, in particular, opened gaps in the oldest stands.

Basal area by main tree species and holding type

Data retrieval year	2010		
Survey years	2006 to 2009		
Holding type	**State-owned forest**	**Other public forest**	**Private forest**
Main tree species	*m²/ha*	*m²/ha*	*m²/ha*
Pedunculate oak	20 ± 4	21 ± 2	22 ± 1
Sessile oak	23 ± 2	23 ± 1	24 ± 1
Pubescent oak	17 ± 6	14 ± 4	16 ± 1
Holm oak	n. s.	14 ± 4	13 ± 1
Beech	22 ± 2	25 ± 1	28 ± 2
Common ash	n. s.	18 ± 6	22 ± 2
Hornbeam	18 ± 4	20 ± 2	22 ± 2
Other broadleaved	16 ± 5	16 ± 3	20 ± 1
Total broadleaved	**21 ± 1**	**21 ± 1**	**21 ± 0**
Maritime pine	22 ± 6	16 ± 5	16 ± 1
Scots pine	22 ± 4	26 ± 4	23 ± 1
Corsican pine	26 ± 14	n. s.	23 ± 4
Austrian pine	22 ± 5	n. s.	19 ± 6
Common spruce	31 ± 4	34 ± 3	34 ± 3
Silver fir	30 ± 5	33 ± 2	36 ± 3
Douglas pine	n. s.	25 ± 8	26 ± 2
Other conifers	21 ± 8	21 ± 3	18 ± 2
Total conifers	**25 ± 2**	**28 ± 1**	**23 ± 1**
Total	**22 ± 1**	**23 ± 1**	**21 ± 0**

Source: NFI.
Relevant domain: FAWS excluding temporarily unstocked stands.

The average basal area in main broadleaved species stands is relatively steady, irrespective of the regime of the considered holding, except for beech, which has a much higher average basal area in private forests than in public forests. The reverse pattern applies to conifers, where the average basal area in private forests is lower than the average values in public forests. This average for all combined conifers disguises the high between species heterogeneity.

Indicator 1.3

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

Forests available for wood supply

Age distribution of regular high forest stands

ISFM 2005 Edition

Data retrieval year Average year	1989 1981		1994 1986		1999 1991		2004 1996	
Age class (years)	*1000 ha*	*%*	*1000 ha*	*%*	*1000 ha*	*%*	*1000 ha*	*%*
0-19	1 163	20	1 133	19	1 105	17	1 118	17
20-39	1 152	20	1 190	20	1 356	21	1 351	20
40-59	881	15	930	15	1 001	16	1 134	17
60-79	753	13	817	14	882	14	956	14
80-99	585	10	644	11	715	11	779	12
100-119	397	7	432	7	468	7	519	8
120-139	330	6	363	6	383	6	395	6
140-159	292	5	309	5	308	5	313	5
160-179	61	1	69	1	76	1	71	1
180-199	47	1	48	1	48	1	46	1
200-219	36	1	34	1	33	1	35	1
220-239	36	1	34	1	33	1	35	1
240 and over	18	0	18	0	15	0	16	0
Total	**5 753**	**100**	**6 021**	**100**	**6 423**	**100**	**6 768**	**100**

Source: NFI.
Relevant domain: FAWS excluding poplar plantations, including only stands whose age could be determined. Regular high forests excluding poplar plantations and including thickets.

With the new inventory method, the age assigned to the stand is determined on the basis of the ages of two trees selected from the six largest trees in the stand overstorey, and the two most representative species of these six trees (or the species most represented, if its cover surpasses 75% of the cover of the six trees). When the two measured trees are different species, it is the age of the most representative species that is used, otherwise it is the average of the two ages. Trees growing on the edge of the stand that differ from trees within the stand are excluded. When two stands of different generations are overlapped (regeneration phase of regular treatments), the age of the future stand is taken into account, without considering potential residual trees from the previous stand.

Tree age is measured by core sampling using an increment borer at 1.3 m height. Calculated ages are corrected to determine the age at the trunk base (baseline age).

The age assigned to the stand can thus generally be interpreted as the age of the main species in the stand overstorey.

Regular high forest oak stand in Vienne department.

Regular high forest stands currently cover almost 7.8 Mha in France, representing half of the FAWS area. Only 31% of broadleaved high forests are under 60 years of age. In contrast, this percentage is 69% of the area for conifer high forests. Only 12% of conifer regular high forests are over 100 years of age, whereas broadleaved regular high forest stands of this age represent 36% of the total broadleaved regular high forest area.

Variations from one age class to the next cannot alone be explained by the ageing of existing stands. Areas newly considered as being regular high forest areas, e.g. natural growth or areas resulting from the conversion of coppice or coppice with standards stands, or even areas now taken into account following the change in inventory method, have been added to the areas already present. These new areas are not necessarily young, so the variations noted between the ISFM 2005 and 2010 editions cannot be considered as only being due to the evolution in stand age.

ISFM 2010 Edition

Data retrieval year	2010	
Survey years	2006 to 2009	
Age class (years)	*1000 ha*	*%*
0-19	1 136 ± 53	15
20-39	1 220 ± 56	16
40-59	1 363 ± 58	17
60-79	1 153 ± 53	15
80-99	956 ± 48	12
100-119	760 ± 43	10
120-139	530 ± 35	7
140-159	312 ± 27	4
160-179	167 ± 20	2
180-199	96 ± 15	1
200-239	62 ± 12	1
240 and over	38 ± 10	0
Total	**7 793 ± 104**	**100**

Source: NFI.
Relevant domain: regular high forest (including poplar plantations) and temporarily unstocked stands in closed forest (considered as regular since these areas are totally unstocked).

Forest age classes (all forest structures combined)

Data retrieval year	2010	
Survey years	2006 to 2009	
Age class(years)	*1000 ha*	*%*
0-19	2 245 ± 79	15
20-39	2 415 ± 77	16
40-59	2 896 ± 83	19
60-79	2 611 ± 78	17
80-99	1 833 ± 66	12
100-119	1 359 ± 57	9
120-139	886 ± 47	6
140-159	484 ± 34	3
160-179	264 ± 26	2
180-199	154 ± 20	1
200-239	98 ± 16	1
240 and over	74 ± 14	0
Total	**15 319 ± 104**	**100**

Source: NFI.
Relevant domain: FAWS

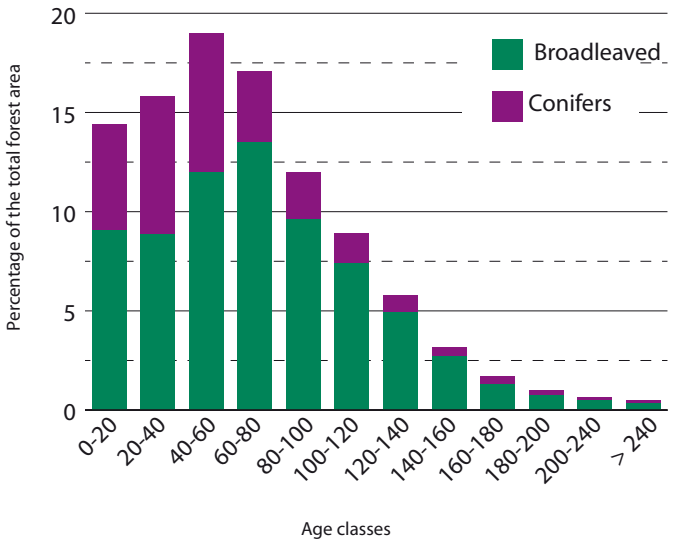


Figure 7: Forest area per age class.
Source: NFI, survey years 2006 to 2009.

By assessing age class distributions throughout the entire forest area, it is possible to determine whether or not the entire French forest is affected by an ageing phenomenon, without having to separate areas converted from one forest structure to another from the analysis.

Forty-nine percent of the FAWS is under 60 years old and 22% is over 100 years old. This distribution includes 42% of the area under 60 years old and 25% over 100 years old for broadleaved stands, and 66% and 13%, respectively, for conifer stands. For broadleaved stands, the 60–80 year age class is the most represented and it accounts for 19% of the forest area, while for conifer stands it is the 40–60 year age class, which covers 24% of the area.

It should be noted that interpretation of the area distribution by age class (all species combined) has some shortcomings. This approach can overlook marked differences depending on the species. It is nevertheless possible to interpret the low forest area of the first age classes relative to conventional distributions as being the result of a regeneration and plantation defect and of coppice and mixed coppice-high forest ageing.

Tree diameter classes (for all structures combined)

The diameter classes used are:

- Small diameter trees: 7.5 ≤ d < 22.5 cm
- Medium diameter trees: 22.5 ≤ d < 47.5 cm
- Large diameter trees: 47.5 ≤ d < 67.5 cm
- Very large diameter trees: 67.5 ≤ d

ISFM 2005 Edition

Data retrieval year		1989		1994		1999		2004	
Average year		1981		1986		1991		1996	
Composition	*Diameter class*	*Mm³*	*%*	*Mm³*	*%*	*Mm³*	*%*	*Mm³*	*%*
Broadleaved stands	Small diameter trees	370	37	381	36	397	35	406	33
	Medium diameter trees	424	42	462	43	500	44	537	44
	Large diameter trees	161	16	175	16	192	17	211	17
	Very large diameter trees	48	5	51	5	59	5	65	5
Total broadleaved		**1 004**	**100**	**1 070**	**100**	**1 148**	**100**	**1 219**	**100**
Conifer stands	Small diameter trees	139	25	154	25	164	25	163	23
	Medium diameter trees	324	58	356	58	380	59	413	59
	Large diameter trees	80	14	86	14	87	13	102	15
	Very large diameter trees	15	3	17	3	17	3	19	3
Total conifers		**559**	**100**	**612**	**100**	**649**	**100**	**697**	**100**
Mixed stands	Small diameter trees	44	28	47	28	53	27	56	27
	Medium diameter trees	84	52	88	52	100	51	109	51
	Large diameter trees	25	16	29	17	33	17	37	17
	Very large diameter trees	6	4	7	4	8	4	10	5
Total mixed		**160**	**100**	**171**	**100**	**194**	**100**	**211**	**100**
All stand types	Small diameter trees	554	32	582	31	614	31	626	29
	Medium diameter trees	832	48	906	49	979	49	1 059	50
	Large diameter trees	267	15	290	16	312	16	349	16
	Very large diameter trees	70	4	75	4	84	4	94	4
Subtotal		**1 722**	**100**	**1 853**	**100**	**1 990**	**100**	**2 127**	**100**
Unspecified (not tallied)		0		1		1		0	
Total		**1 723**		**1 854**		**1 991**		**2 127**	

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

ISFM 2010 Edition

Data retrieval year		2010			
Survey years		2006 to 2009			
Composition	*Diameter class*	*Mm³*			*%*
Broadleaved stand	Small diameter trees	422	±	11	29
	Medium diameter trees	690	±	16	47
	Large diameter trees	266	±	8	18
	Very large diameter trees	93	±	5	6
Total broadleaved		**1 471**	**±**	**31**	**100**
Conifer stands	Small diameter trees	120	±	7	18
	Medium diameter trees	408	±	19	62
	Large diameter trees	107	±	8	16
	Very large diameter trees	22	±	4	3
Total conifers		**658**	**±**	**30**	**100**
Mixed stands	Small diameter trees	65	±	5	22
	Medium diameter trees	162	±	11	56
	Large diameter trees	51	±	5	18
	Very large diameter trees	13	±	2	4
Total mixed		**291**	**±**	**19**	**100**
All stand types	Small diameter trees	608	±	12	25
	Medium diameter trees	1 260	±	22	52
	Large diameter trees	425	±	11	18
	Very large diameter trees	127	±	6	5
Total		**2 420**	**±**	**41**	**100**

Source: NFI
Relevant domain: FAWS, excluding temporarily unstocked stands.

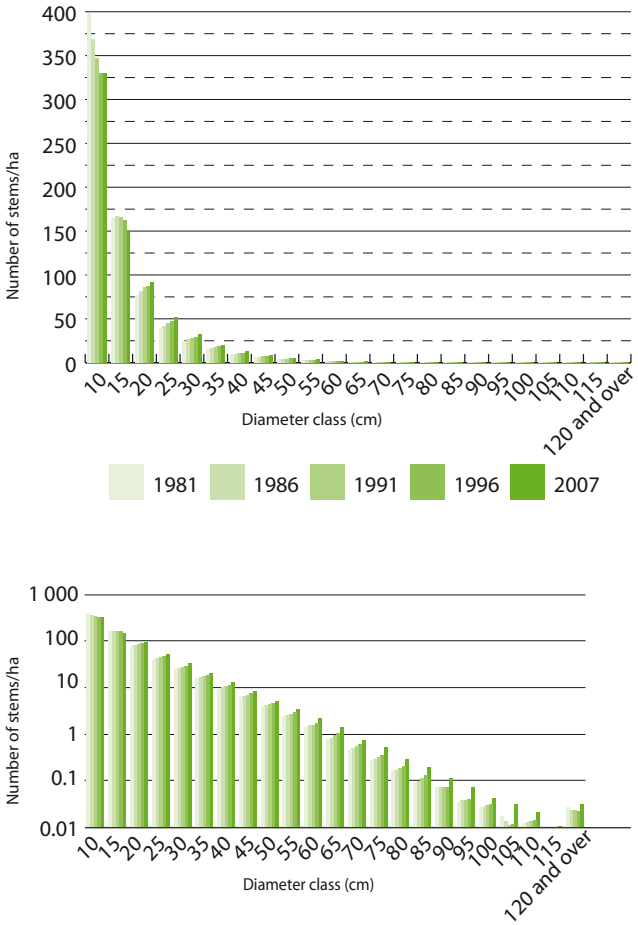


Figure 8: Variations in the number of stems per ha and diameter class. Logarithmic scale for the second graph

Source: NFI, survey years 2006 to 2009.

The medium diameter tree class has the highest growing stock regardless of the forest type considered. It accounts for 52% on average. This average is lower for broadleaved stands (47%), but is higher when the stand contains more conifer species.

Large and very large diameter trees account for 23% of the growing stock on average (all stand types combined). Medium and large diameter trees together have pooled most of the growing stock increase over the last two decades (61% and 22%, respectively - NFI, 2011).

In pedunculate and sessile oaks, small diameter growing stock represents no more than 15% of the growing stock of the species, whereas medium diameter trees represent almost half of this stock. Almost 10% of the growing stock of these two species comes under the very large diameter tree class.

For some broadleaved species, such as holm oak and pubescent oak, the small diameter tree class accounts for the greatest percentage of the growing stock (75% and 54% of the growing stock of the species). Trees of these species are seldom ranked in large stem diameter classes.

The cultivated poplar growing stock is very irregularly distributed in the diameter categories, with only 7% of the growing stock in the small diameter class, while medium diameter trees account for 64% of the total poplar growing stock.

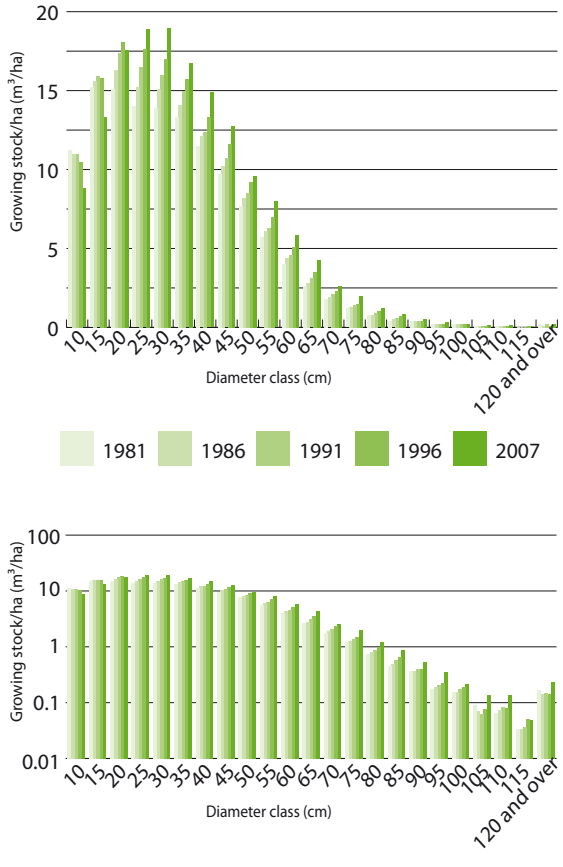


Figure 9: Variations in the growing stock per ha and diameter class. Logarithmic scale for the second graph.

Source: NFI, survey years 2006 to 2009.

Conifer species such as maritime pine, Scots pine, Aleppo pine, spruce, Douglas fir and larch generally have 15 to 20% of their growing stock in the small diameter tree category, with over 60% in the medium diameter category.

Overall, there seems to have been a shift in small diameter growing stock towards larger diameters–the growing stock of first three diameter classes declined, whereas it increased in all other classes. This decline in growing stock in the first classes could be explained by the reduction in trees observed in these classes. In conifers, the growing stock decreased after cyclone Klaus, so the growing stock distribution by diameter class reflects more the impact of the storm than indicating a general trend.

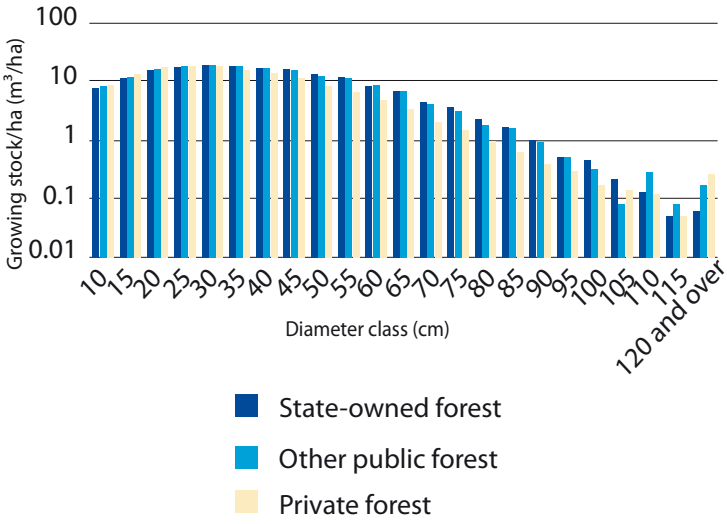


Figure 10: Growing stock per ha and holding type (logarithmic scale).

Source: NFI, survey years 2006 to 2009.

Growing stock per tree species and holding type

Broadleaved

Data retrieval year	2010					
Survey years	2006 to 2009					
Holding type	State-owned forest		Other public forest		Private forest	
Diameter class (in cm)	*Mm³*	*m³/ha*	*Mm³*	*m³/ha*	*Mm³*	*m³/ha*
Small diameter trees	34 ± 3	24	62 ± 4	26	370 ± 10	32
Medium diameter trees	69 ± 5	47	114 ± 5	48	542 ± 13	47
Large diameter trees	38 ± 4	26	55 ± 3	23	174 ± 6	15
Very large diameter trees	16 ± 2	11	19 ± 2	8	57 ± 4	5
Total	**156 ± 12**	**108**	**251 ± 12**	**106**	**1 143 ± 28**	**99**

Source: NFI.
Relevant domain: FAWS, excluding temporarily unstocked stands.

Conifers

Data retrieval year	2010					
Survey years	2006 to 2009					
Holding type	State-owned forest		Other public forest		Private forest	
Diameter class (in cm)	*Mm³*	*m³/ha*	*Mm³*	*m³/ha*	*Mm³*	*m³/ha*
Small diameter trees	18 ± 3	12	25 ± 3	11	98 ± 5	9
Medium diameter trees	62 ± 6	43	98 ± 8	42	374 ± 15	33
Large diameter trees	22 ± 3	15	39 ± 4	17	97 ± 6	8
Very large diameter trees	6 ± 2	4	12 ± 2	5	18 ± 3	2
Total	**107 ± 11**	**74**	**174 ± 14**	**74**	**588 ± 25**	**51**

Source: NFI.
Relevant domain: FAWS, excluding temporarily unstocked stands.

Indicator 1.4

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

Forests available for wood supply excluding poplar plantations

ISFM 2005 Edition

Data retrieval year	Carbon stock (million t)								Carbon sink (million t/year)
	1989		1994		1999		2004		1994-2004
Average year	1981		1986		1991		1996		1986-1996
Compartment	*MtC*	*tC/ha*	*MtC*	*tC/ha*	*MtC*	*tC/ha*	*MtC*	*tC/ha*	*MtC/an*
Tree above-ground biomass	603	45	654	49	714	52	765	55	11
Tree below-ground biomass	172	13	187	14	204	15	219	16	3
Subtotal forest tree biomass	775	58	841	63	917	67	984	71	14
Forest soils (including litter)		NA		NA	1 074	79		NA	NA
Total		**NA**		**NA**	**1 991**	**146**		**NA**	**NA**

ISFM 2010 Edition

Data retrieval year	Carbon stock (million t)		Carbon sink (million t/year)
	2010		1999-2010
Survey years	2006 to 2009		1996-2007
Compartment	*MtC*	*tC/ha*	*MtC/an*
Tree above-ground biomass	885	62	11
Tree below-ground biomass	252	18	3
Subtotal forest tree biomass	1 137	80	14
Forest soils (including litter)	NA	NA	NA
Total	**NA**	**NA**	**NA**

Source: NFI, results from the old inventory method for years 1986 to 1996 and survey years 2006 to 2009 for the average year 2007. DSF 1993-94 was used to estimate carbon stocks in forest soils from the European network for forest damage monitoring (540 plots).

Relevant domain: FAWS excluding poplar plantations. The estimate of the carbon stock in forest soils includes carbon in the litter and in the 0-30 cm horizon; as the update was not available at the time of publication, the 1999 value is given.

The tree above- and below-ground biomass was calculated using volume tables that consider the total above-ground biomass so as to include branches (Vallet, 2006) and 'root expansion factor' coefficients to include roots, and the 'wood density' and 'carbon levels' noted in the final report of the CARBOFOR research project, published in 2004 (Loustau, 2010). The carbon sink was calculated as the difference in carbon stocks over the number of lapsed years.

N.B.: These data are not comparable to those presented in France's official responses to the UN Framework Convention on Climate Change and the Kyoto Protocol, which were prepared by CITEPA.

Forests represent the most important carbon storage ecosystem in the world and are thus a key lever in policies designed to reduce greenhouse gas emissions. In forests, carbon is mainly stored in soilborne organic matter and tree biomass.

Stock analysis

Living biomass

Carbon contained in tree biomass amounts now to 1.1 billion t in forests available for wood supply (excluding poplar plantations), or 80 t/ha. Below-ground tree biomass accounts for 22% of this total amount. These estimations are based on the conclusions of the final report of the CARBOFOR project, published in 2004, which improved the quantification of branches and roots allocated to the NFI volumes (Box 3).

The highest carbon stocks are found in eastern France (Alsace, Franche-Comté), in Auvergne and in the north (Picardie, Haute-Normandie, Nord-Pas-de-Calais, Île-de-France), with stocks exceeding 90 tC/ha, and even 100 tC/ha for the eastern regions. The lowest values, less than 50 tC/ha, are found in the Mediterranean region (PACA, Languedoc-Roussillon). These results are linked with the tree dimensions and the proportion of branches. Broadleaved stands thus have a higher per-hectare carbon stock than conifers (78 tC/ha for broadleaved versus 69 tC/ha for conifers), even though their per-hectare NFI volume is lower (cf. Indicator 1.2).

The proportion of living biomass in the woody or nonwoody understorey and foliage could not be taken into account for this indicator due to a lack of reliable elements to calculate the carbon stock in this compartment. Moreover, other forest formations, poplar plantations and other wooded lands (heathland) and trees not eligible for inventory were not counted.

Deadwood

NFI now inventories lying or standing deadwood, but the corresponding carbon stock is not currently calculated.

Soils and ground litter

In 1993-94, the carbon stock in forest soils was assessed in 540 plots of the European network for forest damage monitoring (cf. Indicator 2.3). This soil carbon stock was estimated to be 79 t/ha, or 54% of the total forest carbon stock in 1999. As these data have not been updated, temporal variations in this stock are still unknown. It seems certain that soilborne carbon increases with the tree age in new stands (natural colonisation or afforestation of farmland and heathland), but the patterns are less clear in long-established forests. This stock has not been determined in poplar plantations or other wooded lands (heathlands).

The net annual carbon storage, or 'sink' in the tree biomass is estimated at 14.3 million t per year for the 1986-1996 period (data retrieval years 1994-2004). This sink represents 13% of national gross carbon emissions, without taking land-use, land-use changes and forestry into account. An update of the sink evaluation is presented for the 1996-2007 period (data retrieval years 2004-2010). The storage remained stable over the period.

Forests contribute to curbing the greenhouse effect, but this contribution not only involves their carbon stock. The use of timber produced by forests from atmospheric CO_2 increases the carbon sustainably stored in forest products (buildings, constructions), while also reducing fossil fuel consumption. In addition to using fuelwood as an alternative to fossil fuel, timber use—at equivalent performance—consumes less energy than other competing raw materials (steel, concrete, PVC, etc.). This contribution is, however, hard to quantify.

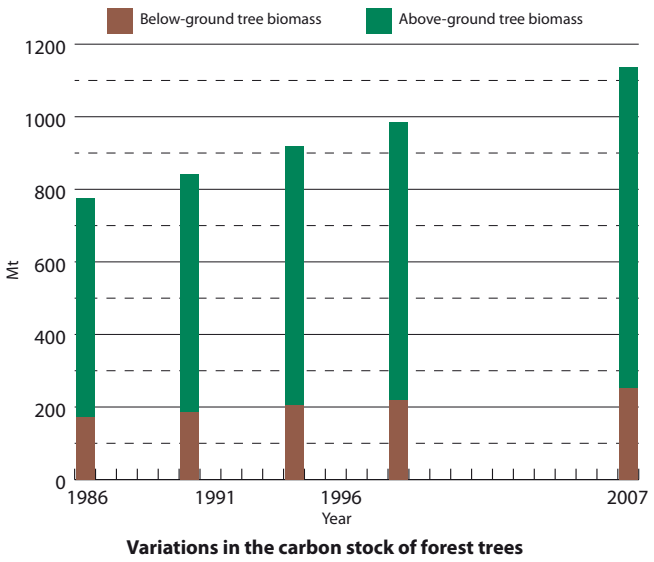


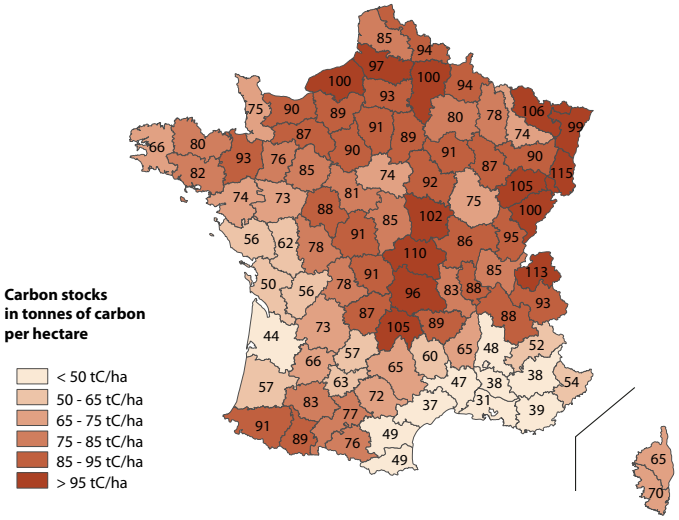
Figure 11: Variations in the carbon stock of forest trees.

Source: NFI, survey years 2006 to 2009.

Box 3: CARBOFOR research project

The CARBOFOR project on carbon sequestration in large-scale forest ecosystems in France was jointly conducted from 2002 to 2004 by many partners and funded by the French Ministry of Ecology and Sustainable Development and the Forestry Ministry via the ECOFOR public interest group. This research project compared ecosystem responses to a regionalised climatic scenario (1960-2100) with respect to the carbon cycle, biogeography and susceptibility to major pests and diseases.
The French National Institute for Agricultural Research (INRA), the French National Forest Inventory (NFI) and the Laboratoire d'études des ressources forêt-bois (LERFOB) have developed a new method for calculating carbon stocks in tree biomass on a national scale:
– the total above-ground carbon volume of trees is based on volume tables drawn up by LERFOB from French forest research archival data, so the mean branch biomass expansion factor is 1.61 for broadleaved species and 1.33 for conifers;
– the root biomass expansion factor, wood density and carbon content were evaluated on the basis of a bibliographical analysis. The root biomass expansion factors were evaluated at 1.28 for broadleaved species and 1.30 for conifers. The wood density was estimated at 0.55 tDM/m^3 fresh material for broadleaved species and 0.44 tDM /m^3 fresh material for conifers. Finally, the carbon content in dry matter was determined at 0.475 tC/tDM.

These estimations resulted in an overall ratio (tC/m^3 NFI) of 0.53 for broadleaved species and 0.36 for conifers. The difference generally concerns the use of the LERFOB volume tables per main species types.
The EMERGE research project, underway in 2011, should result in an update of volume tables that can be used with NFI data for different tree diameters and for a broader range of species and stand types.



Map 8: Above- and below-ground carbon stocks in forest trees (excluding poplar plantations).

Source: NFI, survey years 2006 to 2009.