# Summary of trends
# Per public policy issue

## Indicators for forest-related issues double entry summary

**Criteria (C)** and indicators have gradually been introduced in forestry since the 1992 Rio conference to define, monitor, guide and assess sustainable forest management. Their publication for metropolitan France since 1995 clearly pursues this goal and analyses the situation of forests from several viewpoints based on resources (C1) and their state of health (C2) to envisage their major productive (C3), ecological (C4), protective (C5) and lastly socio-economic and cultural (C6) functions. Nevertheless, these criteria do not give a global view of the main **issues (E)** relating to the forest spaces (Peyron, Bonhême, 2012), namely: (E1) lasting management of timber resources, (E2) health of forests, (E3) forest biodiversity, (E4) combating the greenhouse effect, (E5) vulnerability and adaptation of forests to climate change, (E6) contribution of the forest-timber sector to the economic activity, (E7) contribution of the forest to social well-being and lastly (E8) implementation of the multi-functionality of forests. This summary attempts to respond to this by relying preferably on the 2015 edition of Indicators for the Sustainable Management for Metropolitan French Forests as well as, where appropriate, on previous editions (Map, 1995; Map, NFI, 2001; Map, NFI, 2006; Maaprat, NFI, 2011), similar European approaches or additional sources.

This summary therefore has a dual focus (Diagram 1): firstly, it applies the sustainable forest management indicators explicitly to analyze the situation of the forest-timber sector for policymakers and, secondly, it structures this information according to the major forest issues. It is mainly a national exercise which it reiterates, however, succinctly in its European, biogeographical, forestry or land framework. It makes every effort to refer to the trends in recent decades (since 1980).

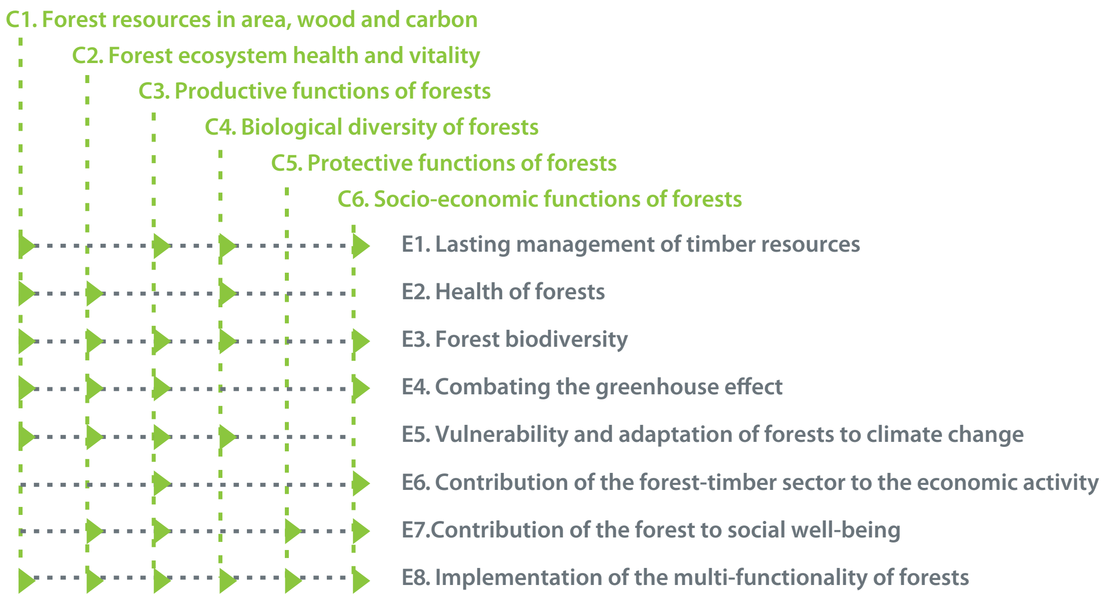



***Diagram 1.*** *Cross-reference between sustainable forest management criteria (C1 to C6) and major forest issues (E1 to E8). The green triangles show that at least one indicator for the criterion that tops it is used to characterize the issue to which it relates.*

***Warning***

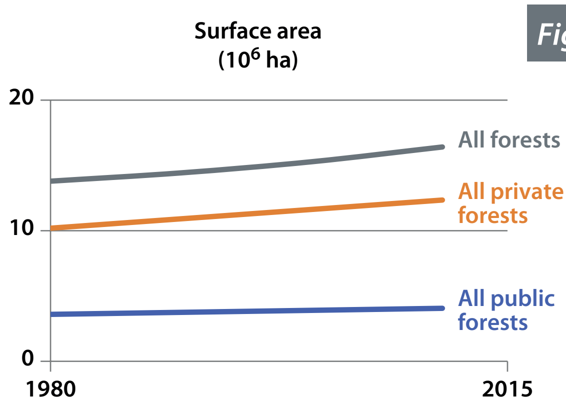
*The text refers systematically to the indicators (**the numbers are stated in bold and italics in brackets**). The precise sources of data used for the graphics are given in an appendix. In the graphs (**which are also shown as bold and italics in the text**), the solid lines are taken directly from data sources comparable over time whereas peer-reviewed, corrected or improved information required to establish chronological series, or which is very useful but deemed less robust, appears as a dotted line.*

# E1. Lasting management of timber resources

The renewable nature of timber resources in the long-term suggests that particular attention should be given to the change in surface area and volume per hectare, preferably by types of stand and growth stages. Analyzing natural and man-made decisive factors in this change, such as the net colonization of lands, growth, mortality and felling, can help in interpreting the dynamics of these resources better. Among these decisive factors, felling is governed by the characteristics of timber markets both in terms of supply from owners and managers (technical operability, regulatory framework and socio-economic context) and demand from industries and households (outlets, consumption and innovation).

This brings out the increasing importance of metropolitan French forests (***1.1***; Pignard, 2000; ***Fig. 1***), with an afforestation rate that has jumped from 25% in 1980 to 30% in 2010 (+0.6% per year). Beyond a change in definition extended to forests with formations 5 to 7 meters high when mature *in situ*, these changes are explained by limited land clearance and agricultural abandonment, which has led to expanded plantings and above all spontaneous afforestation. It is lower for public forests (+0.4% per year) than for private ones (+0.6% per year) whose share has increased to 75%.

*Fig. 1*




Forests available for timber production are 95% dominant and following the same evolution (***1.1***). Their growing stock increases more than their surface area, both on average (+1.3% per year) and for all species and size classes, except for small conifers, above all the maritime pine, which was severely affected by the 1999 and 2009 storms (***1.2***; ***1.3***; ***Fig. 2***). The result is a major expansion in the average volume per hectare (+0.8% per year), which is more apparent in private forests (***1.2.2***; ***Fig. 3***).

This increased volume relates to the fact that the net biological production (after deducting natural mortality) is

*Fig. 2*

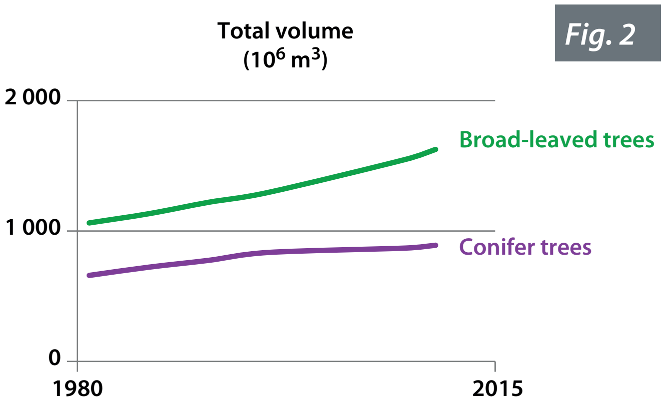
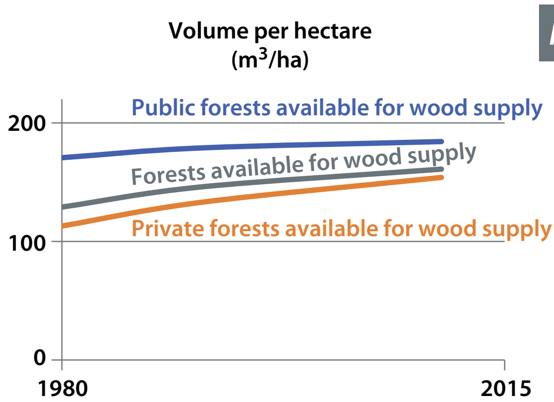



*Fig. 3*




higher than the timber felling (intended for harvesting, except for residual trees). Equal felling and net biological production brings to 100% the felling rate which relates the first to the second and keeps the growing stock constant. The felling rate is 50% on average in metropolitan France - 64% for conifers, 45% and more for the large broadleaved species (sessile oak, pedunculated oak, beech, chestnut and poplar) but around 25% for all miscellaneous broadleaved species (***3.1***). Given changes in the growing stock described previously, the felling rate is on average lower in private forests (45%) than in public ones (63%) (IGN, 2015). It varies between regions and proves to be high in the Landes massif for the maritime pine or in the North-East for both broadleaved species and conifers (***3.1***). A felling rate of less than 100% can be attributed to several causes: the young age of part of the stands, changes in structure or composition of forests tending towards a higher average level of standing material, lack of silviculture or reduced logging, whether or not deliberate.

The French situation is in line with fairly similar changes on average throughout Europe (except for Russia) in terms of the annual increase in surface areas (+0.4%), growing stock (+1.2%) and volume per hectare (+0.8%) (SoEF, 2015). But the European felling rate (66 %) is higher than the French rate (50 %).

When the analysis focuses on large- and very large-diameter trees, it shows that the felling rate in these size categories is on average no more than their net biological production and therefore they only have limited renewal (***3.1***). Although French forests has been expanding for a long time, they feature a proportion of fewer small-diameter trees and more large- or very large-diameter trees, both in conifers and broadleaved species (***1.3***; ***Fig. 4***).

The forest inventory has only been providing all felling rate components since 2011. It cannot therefore be monitored strictly over the last decades. It is, however, possible to understand the changes in its various components (***Fig. 5***): since 1980, except for the nearest climate accident, felling has increased and then stagnated (marketed harvest) or even decreased (informal, non-marketed harvest (***3.2***); natural mortality has increased (***4.5***), but so has the gross biological production, so that the net production has continued to grow under the delayed effect of increased surface areas and gradual aging. Thus, the balance of flows that takes account of the accumulation of the volume of growing stock (***1.2***) has been sustained to increase in recent years. Ultimately, the felling rate has experienced a downward trend during the period.

Several decisive factors can be used to analyze the timber supply in the markets. This suffers mainly from more physical logging constraints due to less accessibility to forests caused by natural colonization and should, on the contrary, benefit from increased surface areas covered by a management document (***3.1.1***; ***3.5***; ***Fig. 6***). It also seems to be broadly correlated with the certification that covers one third of forest areas in metropolitan France and more than half the marketed volumes of round wood (***3.2***; ***6.1.3***; ***Fig. 7***). Demand for French timber has increased in the past before stagnating and being supported nowadays by the energy market (***3.2***; ***Fig. 5***).

Although the observation should be adjusted according to categories of ownership, regions and species, French forest resources seem to be booming and capable, given that they are renewable, of contributing more than ever to the sustainable development of the economy and the regions.

***Fig. 4***

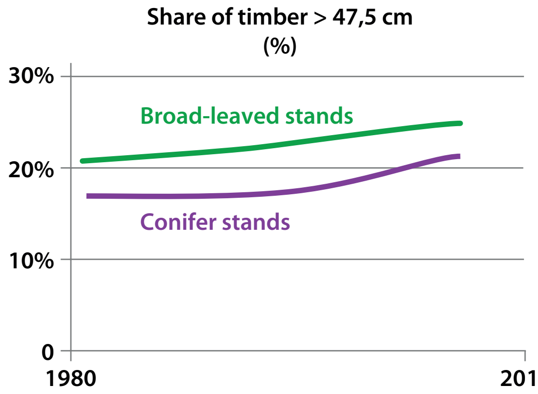



***Fig. 5***

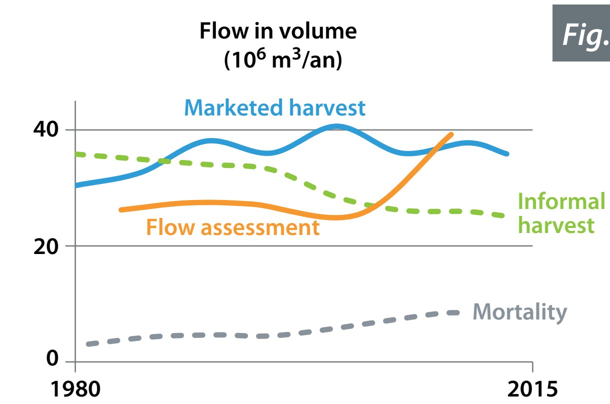



***Fig. 6***

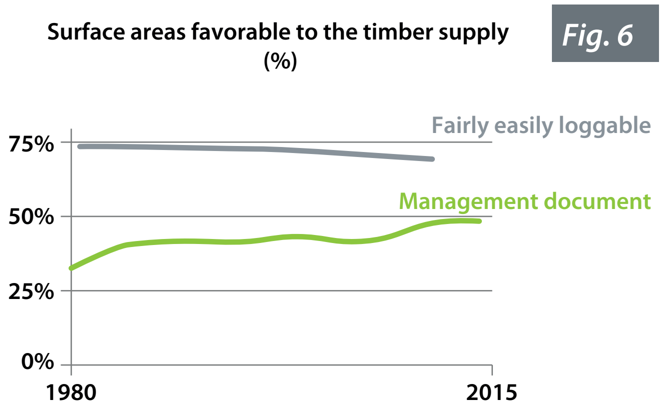
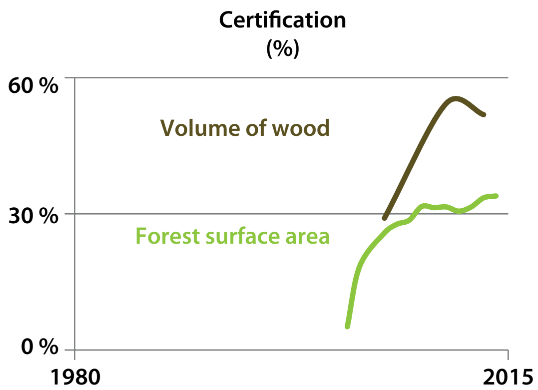



***Fig. 7***



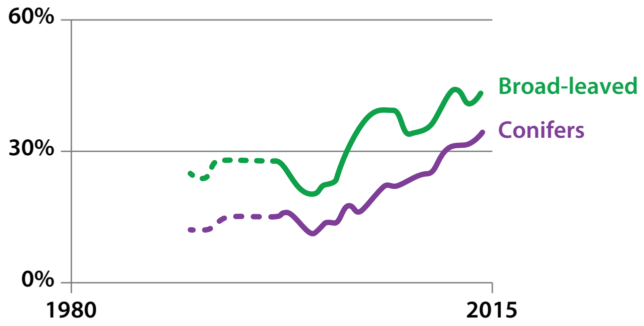
## E2. Health of forests

The preceding analysis shows an expanding timber resource, especially in surface area and growing stock. It does not however confirm that the forests are in good health and free of pressure. It is therefore important to state firstly their state of health (defoliation, mortality), then to note the action of climate, biotic or human factors which all represent risks for them and lastly to examine the measures likely to keep the forests in good health.

Monitoring the defoliation of dominant and co-dominant trees (***2.3***; ***Fig. 8***) shows an increase in both broadleaved species and conifers. This is particularly true in the Mediterranean South-East. These changes follow on from the storms (1999, 2009) and droughts (mainly 2003) in the last two decades. Here also is one explanation for the increase in tree mortality, to which is added, beyond the growth effect of the growing stock, the increase in sparse local felling (***1.2***; ***4.5***; ***Fig. 9***).

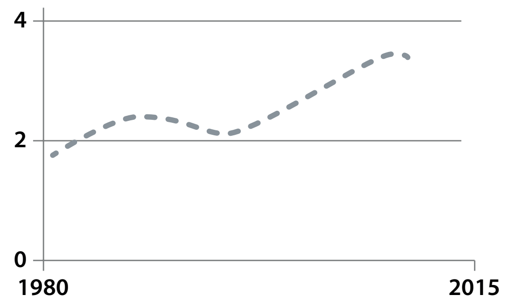
**Defoliation > 25 %**
**(% trees)**

***Fig. 8***




**Annual mortality rate**
**($m^3$/1000 $m^3$ growing stock)**

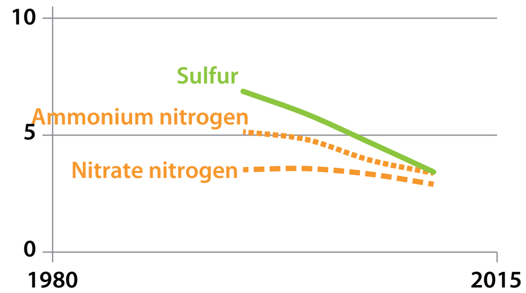
***Fig. 9***




Atmospheric depositions continue to fall on forest stands (***2.1***) although they are weaker in nitrogen compounds and even more so in sulfur (***Fig. 10***). Similarly, rainfall is tending to be less acid. Mineral inputs are also clearly relatively stable. Despite these changes for the better, the acidification of the most sensitive soils continues (reduced pH and base saturation level) but without depleting reserves of exchangeable nutrients (***2.2***).

**Depositions in open field**
**(kg/ha/an)**

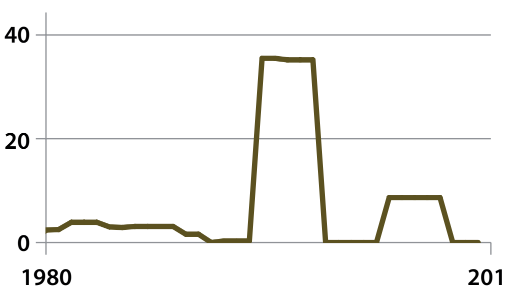
***Fig. 10***




Climate risks are mainly comprised of storms and droughts. Storms constitute the greatest threat given their suddenness and scale, as seen in the 1999 and 2009 storms (***2.4***; Schelhaas, 2015; ***Fig. 11***). The effects of drought are more difficult to quantify even if they are clearly identified (2003 drought). They are likely to become more intense with climate change (global warming and shortage of summer rainfall) and deserve improved monitoring. They influence especially forest fires which are curbed relatively easily, mainly near the Mediterranean and in Aquitaine, except in drought years (***2.4***; ***Fig. 12***). Special attention must be paid under climate change to fire risk areas; they are likely to be more extensive and the threat from them depends

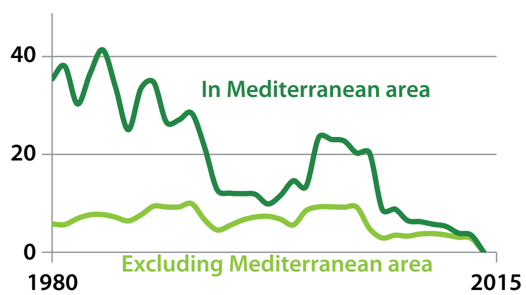
**Volume destroyed by the wind**
**($10^6$ $m^3$/year, av. moving 5 years)**

***Fig. 11***




**Burnt surface areas**
**(ha/year, av. moving 5 years)**

***Fig. 12***



not only on weather conditions but also on regional development and human behavior.

Biotic damage from insects and fungi fluctuates and frequently worsens the abiotic damage due basically to climate accidents (***2.4***; ***Fig. 13***). They show signs of worsening due to emerging problems (ash dieback, chestnut gall wasp, etc.). These are limited but still prone to the introduction of harmful organisms such as the pine wilt nematode, oak wilt agent, ash and birch borers, etc. Damage caused by large ungulates is not always easy to quantify, especially in forests. But it has been aggravated in recent decades with a clear increase in populations monitored, above all throughout hunting (***2.4.1***; ***Fig. 14***). The result is pressure on the environment, agricultural crops and the regeneration of forest stands. In some cases, this can compromise the adaptation of forests to climate change, affect the biodiversity (Martin, 2013), increase the lack of road safety and risk zoonosis or even human diseases (Lyme borreliosis especially). Potential effects of this type nevertheless demand analysis depending on the regions.

*Fig. 13*

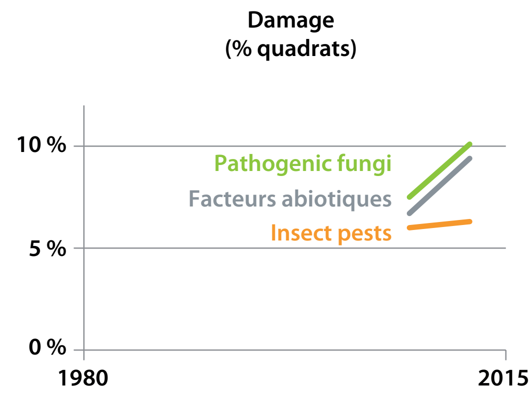
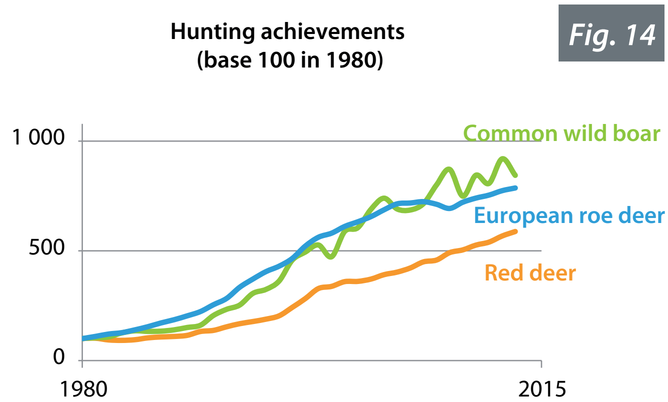



*Fig. 14*




Adaptation of species, provenances or varieties at the station where they are planted figures high on the list of measures likely to keep the forests in good health and consolidate the natural resistance and resilience of stands. This means taking into account the current and future vulnerabilities and potential and ensuring quality management which includes soils as well as stands diversity and structure (strata and dimensions). Target measures for such and such a problem must be set up in addition to these general principles.

Progress has been made in recent decades in reducing atmospheric depositions of acidifying chemical compounds and in controlling forest fires. There are still a causes for concern, however, with defoliation, mortality and damage on an upward trend, populations of large ungulates which are developing without hindrance in many massifs and climate risks with measurable recent effects and premonitions of future repercussions under global warming. The health of forests remains therefore under surveillance.

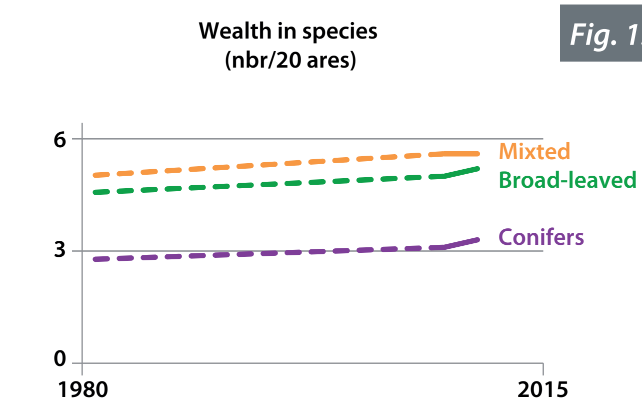
## E3. Forest biodiversity

French forests stand out for bioclimatic contexts and varied practices which give them a broad global diversity. But what can be said about a more local biodiversity in terms of composition of species and varieties, structure and operation? What pressures and other influences are applied to it under global changes in terms of habitats (variation in wooded areas, fragmentation or aggregation of massifs, human influence or natural quality of stands) or indeed species? What measures lastly are taken to protect the biodiversity or encourage good practices?

There is clear local diversity in varieties of trees or species: nearly five on average per quadrat of twenty ares, mainly broadleaved (***4.1***; ***Fig. 15***). This diversity is tending to grow due to both silviculturists favoring support species and the moderated selection resulting from a lack of felling. It is more extensive in mixed stands. This diversity does not prevent the main species in stands from being 64% dominant in terms of volume and basal area when it is broadleaved and respectively 85% and 80% for conifers, average proportions stable over time (***3.1***; ***4.1.1***). Despite a measuring protocol that varies from one country to the next, this average local diversity appears greater than in Europe, where 80% of stands have fewer than four species (against 36% in metropolitan France).

Several strictly forest species of vascular plants (7), birds (11), mammals (2) and invertebrates (3) are

*Fig. 15*



considered to be threatened, but the indicator (***4.8***) cannot yet judge an evolution over time.

By restricting the species and habitats of community interest, i.e. "In danger of disappearing, vulnerable, rare or endemic" within the European Union and by taking a good state of conservation as a reference, 38% of forest species are in a favorable condition and 16% in poor condition, whilst 17% of forest habitats are assessed as favorable and 25% in poor condition. This leaves a large proportion of habitats in intermediate situations (Lévêque, Bensettiti et Puissauve, 2014). Overall, the forests appear to be in a significantly less degraded state that other ecosystems, above all given the situation of species.

Developments relating to the health of forests have shown that atmospheric depositions have dropped significantly in the last decades (***2.1***) without interrupting, however, any action, mainly acidifying (***2.3***), that is bound to affect the biodiversity. It is still difficult to highlight the effects of climate change on the biodiversity (see E5).

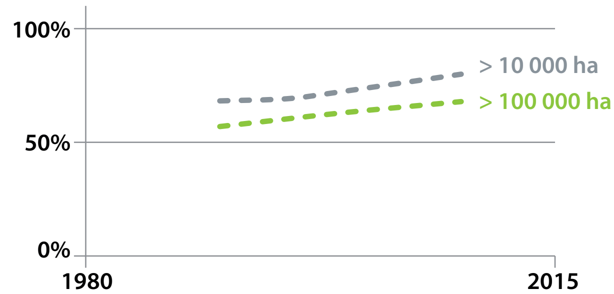
As they extend (***1.1***), so the forests move the area of the biodiversity associated with the forest habitats forward. It would be useful to assess the components of this net extension better, which is not currently the case (***1.1.1***), as land clearance is not offset hectare for hectare by reforestation, especially in terms of the biodiversity. The spatial distribution of forests is also a major factor for the biodiversity for the ecological continuities. Data per size class suggest that the surface area of large massifs not only increases in absolute value but also in proportion to the forest areas, with the massifs of more than 10,000 ha henceforth covering 80% of forests and those over 100,000 ha covering 68% (***4.7***; ***Fig. 16***). An aggregation movement of forest massifs is thus observed on average.

The natural quality of forests is a major characteristic for their biodiversity. But the vast majority of metropolitan French forest stands are semi-natural; they include a 13% proportion of planted trees which has remained relatively stable over the last three decades (***4.2***; ***4.3***; ***Fig. 17***). Surface areas dominated by non-indigenous species, whether or not introduced deliberately, are increasing but are less than 10% (***4.4***; ***Fig. 17***).

The volumes of aging or dead wood safeguard species when silviculture tends to reduce the habitats. They have increased significantly (***1.3***; ***4.5***; ***Fig. 18***). As deadwood lying and standing for more than five years has only been assessed since 2008, this statement is mainly based on monitoring very large-diameter trees and standing deadwood for less than five years. The noted increase results widely from climate accidents (1999, 2003, 2009) and the low renewal of stands (see E1). More comprehensive assessments of the

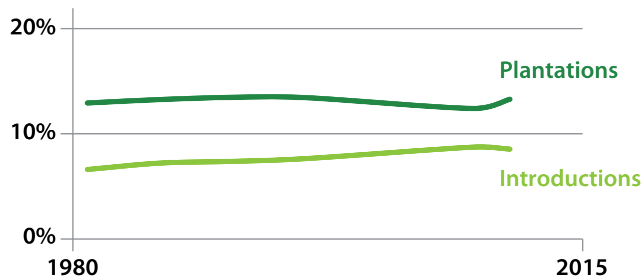
**Surface area of large massifs**
**(%)**

***Fig. 16***



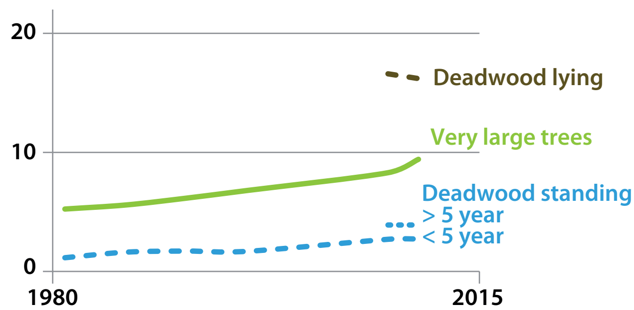

**Surface areas with planted**
**or introduced species**
**(%)**

***Fig. 17***




**Very large diameter trees or deadwood**
**($m^3$/ha)**

***Fig. 18***

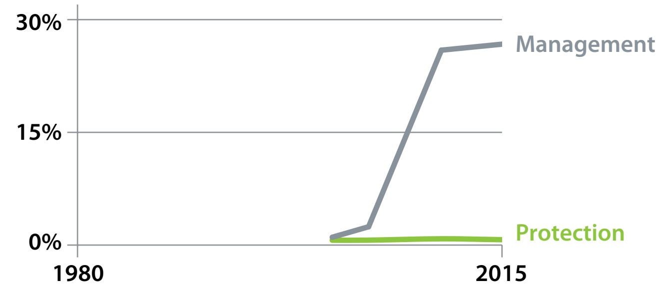


deadwood henceforth in metropolitan French forests produce results in line with the European average.

Apart from developing good sustainable forest management practices (***3.5*** ; ***6.1.3***), preserving the biodiversity justifies protective and management measures. Surface areas where it is strictly protected (integral biological reserves, central areas of national parks) are increasing but remain at less than 1% and are still distributed unevenly. Areas with active biodiversity management have expanded hugely under the European Natura 2000 program, with the development of special protection and special conservation areas (***4.9***; ***Fig. 19***). In addition, huge efforts to conserve genetic resources have been made in recent years (***4.6***) and financing of biodiversity measures has gained in visibility (***6.4***).

***Fig. 19***

**Biodiversity protection or management surface areas (%)**




Biodiversity is a significant issue. Metropolitan forests generally have major advantages with an extensive, increasing local wealth of species, a majority of large massifs which are constantly expanding, a large proportion left to indigenous species regenerated naturally, growing numbers of very large-diameter trees and deadwood and far more attention being paid to it. The main points to look out for are some vulnerable habitats, progress required to strive towards the goals of the national protected area creation (SCAP) strategy and the current shortage of taxonomic monitoring data.

## E4. Combating the greenhouse effect

The forest-timber sector contributes to combating the greenhouse effect and thus the mitigation of climate change in many ways. It interacts with the atmosphere, basically through the carbon dioxide. Its contribution is twofold: increased stocks of biogenic carbon (in and outside forests) and prevention of fossil carbon emissions by using wood instead of fossil energy and materials more energy-hungry than wood (Madignier *et al.*, 2014). The first contribution is based on the fact that about half the dry wood material is made up of carbon; it is analyzed by monitoring carbon reservoirs forming the living biomass, the dead biomass, the organic matter in the soil and the timber products. The second is based on the substitution effect, which measures the savings in carbon dioxide emissions through using wood compared with competitive materials and alternative energies; it also depends on the possibility of accumulating several substitution effects by successful recycling of the raw material (ancillary products, recycling, salvage) and, in addition, benefits from energy savings created by the insulating qualities of the wood.

The continuous expansion of forests and increased volume of growing stock in the metropolitan forests results "mechanically" in increased carbon stocks in the above- and underground living biomass of trees (***1.4***; ***Fig. 20***). This is estimated to be approximately 19 million tC/year or 71 $tCO_2eq$/year (Colin, 2014). Increased mortality during the period, which has been discussed previously (E1, E2 and E3), also suggests the development of a carbon sink in the dead biomass of some 10 million $tCO_2eq$/year. Increased organic matter in the soils is also anticipated based on measurements in the Renecofor network for monitoring forest ecosystems run by the ONF (***2.2***; ***Fig. 20***). Forest soil carbon sinks could therefore be around 15 million $tCO_2eq$/year. The carbon stock in forest products depends on changes in production, their consumption over time and their lifetime. For sawing and panels, which essentially are the products to be considered here, these changes have not seemed very favorable for several years (***6.7***; ***Fig. 21***), which suggests the current absence of a substantial carbon sink in the forest products.

***Fig. 20***

**Carbon stock ($10^6$ tC)**

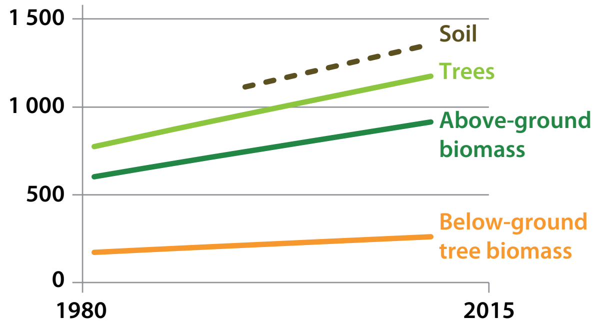
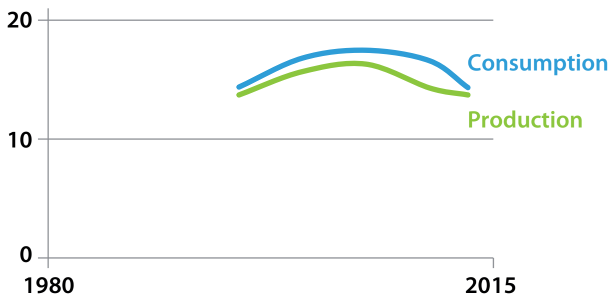



***Fig. 21***

**Sawing and panels ($10^6$ $m^3$)**



Substituting timber products for other manufactures generating greenhouse gas emissions is a continuation of previous developments. In this case, the important thing is not the variation in the stock of products but their consumption, which avoids emissions from using materials competing with wood that are less efficient in terms of carbon dioxide emissions. This substitution effect deserves to be assessed further, but an estimated 1.1 $tCO_2eq$ is avoided on average per cubic meter of timber contained in the finished products, excluding end-of-life energy recycling (Ademe, 2015). This effect can therefore be assessed at approximately 16 million $tCO_2eq$/year.

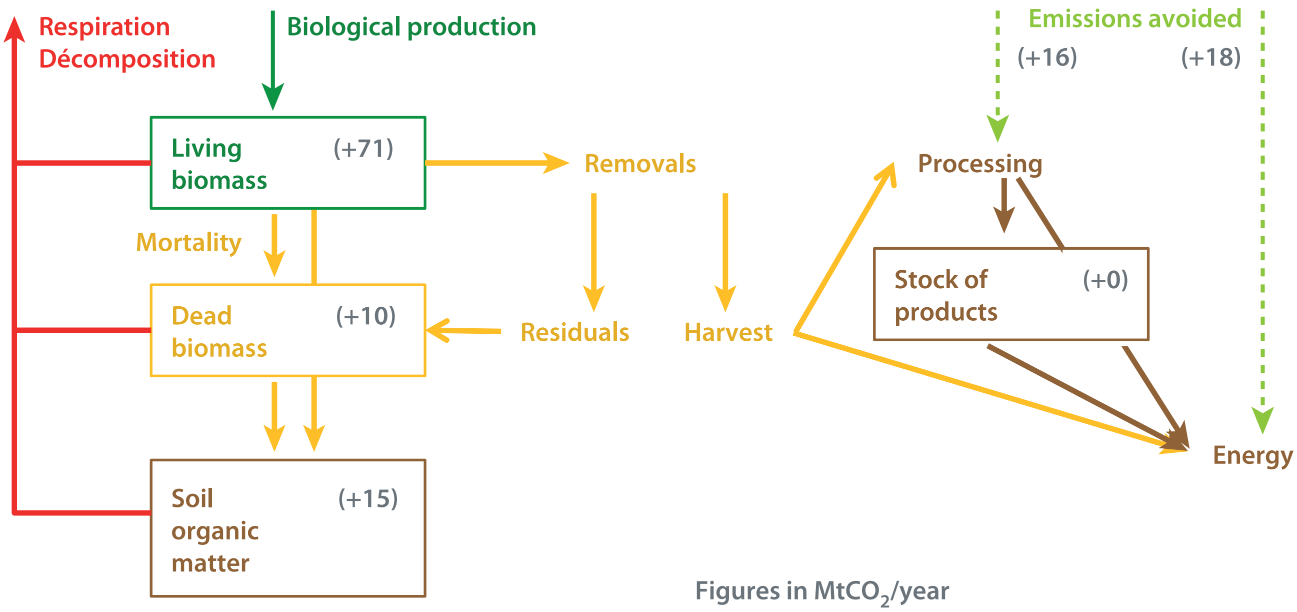



***Diagram 2.*** *Summary of estimates, in million tons of $CO_2$ equivalent, of the main contributions to the carbon balance by metropolitan French forests with stock variations (living and dead biomass, organic matter in the soil, timber products) and the emissions avoided by the consumption of wood-based products and energy.*

Substituting wood directly for fossil energies sends greenhouse gases into the atmosphere, but these would in any case have been emitted by natural decomposition processes. Using wood as energy instead of fossil resources avoids additional greenhouse gas emissions estimated at 0.5 $tCO_2$ eq per cubic meter of wood burned by the industrial and collective sectors (Ademe, 2015). The coefficient is undoubtedly less for domestic use, so that a coefficient of 0.4 $tCO_2$ eq per cubic meter of wood burned is used here. The largest part (some 75%) of the harvested wood (***3.2***) is destined for energy use at end-of-life, otherwise as soon as it is available. This would represent about 45 million $m^3$/year, avoiding a total of 18 million $tCO_2$ eq/year.

Adding absorptions, storage and avoided emissions together would therefore give a total forest-timber sector assessment of some 130 million $tCO_2$ eq/year at a rate of over half due to the increase in the living forest biomass and of nearly a quarter by substitution effect of the wood for other energies or materials. Stating this estimation in the future would be useful as an approved indicator to characterize this contribution by the forest-timber sector to combat the greenhouse effect. It can be depicted as net emissions by France of some 490 million $tCO_2$ eq/year (Citepa, 2014). Taking the phenomena over time, it would merit being predicted under miscellaneous future scenarios relating to the environment (climate) and management (forestry strategy).

## E5. Vulnerability and adaptation of forests to climate change

Boosting the greenhouse effect and its resulting climate change alter the general forest environment and the occurrence of such events as heatwaves, droughts and heavy seasonal rain (winter and spring). The assumed effects relate to the distribution, growth, survival and regeneration of species and the state of health of the trees. They continue to be difficult to observe due to the still limited modifications, the inertia of numerous phenomena and interactions with other factors. Analyzing the adaptation capacity in an area requiring prevention and precaution can prove especially useful in addition to observing current phenomena.

Global warming means changes in the hydric state of the vegetation under the effect of temperature, air moisture, wind speed and rainfall. The meteorological forest fire index (Météo-France, Meem/Onerc; ***Fig. 22***) reports annually on the proportion of metropolitan France which has been prone to forest fires on a daily basis for more than one month. It highlights especially dry years, mainly around 1990 and 2003. It also shows an upwards trend over time and makes people aware of the expansion of fire-risk areas (Chatry *et al.*, 2010). Similar indices can be established on the basis of the hydric soil assessment (Biljou© model).

Forest sensitivity to drought appears clearly in the monitoring of foliage conditions and the mortality of trees (***2.3***) or in wooded areas that have been destroyed by fire during exceptionally hot and dry years (***2.4***), as presented previously (E2). The impact of global warming is also highlighted by observing the emission of pollen or a species specific to forests like the pine processionary caterpillar (Thaumetopoea pityocampa). The birch pollen indicator estimates the average annual quantity of pollen in the air around six large French cities (National Aerobiological Monitoring Network, Meem/Onerc; ***Fig. 23***). It relates especially to changes in temperature, which stimulates the emission of pollen and lengthen the relevant period. It is also a useful indicator of human health given the allergy potential of birch pollen. The pine processionary caterpillar (Thaumetopoea pityocampa) benefits from the lifting of thermal constraints that kept it firmly implanted until now south of the Loire and its area is expanding northwards at an average rate of 4 km/year Inra, Meem/Onerc; ***Fig. 24***). This indicator is of interest not just for the forest (defoliation), but also for human and animal health (allergies, urtication and anaphylactic shock).

*Fig. 22*

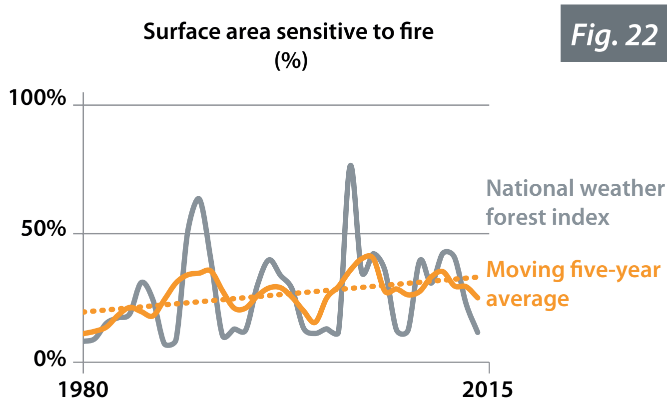



*Fig. 23*

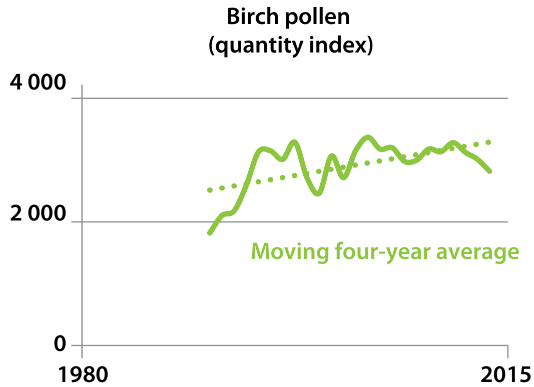
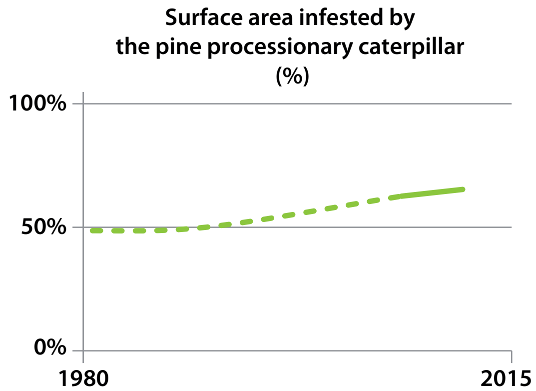
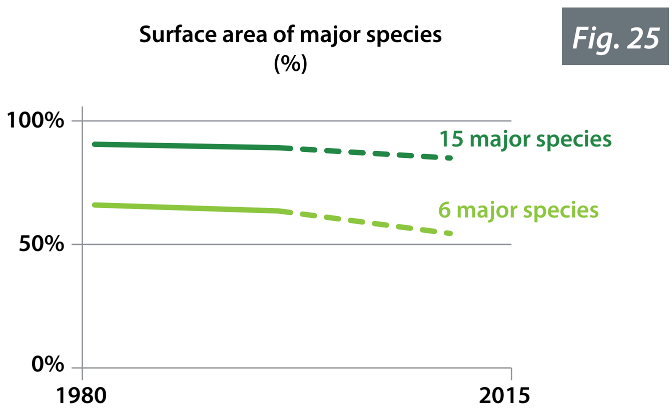


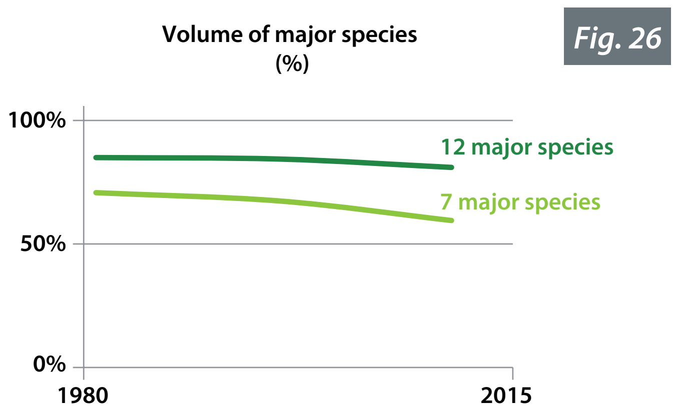

*Fig. 24*




Practices must be adapted to face up to these proven impacts of climate change - and there are many more examples. Indeed global warming is known to be continuing for several decades and most trees will have to suffer it without all of them being able to withstand it. An initial way to adapt is to encourage forest diversification. As discussed previously (E3), the average increase in the local diversity of species plays a part in this (***4.1***). On a broader scale, it is also useful to examine the proportion of major species in French forests. This is on a downward trend, whether the surface (***1.1.4***; ***Fig. 25***) or volume (***1.2.2***; ***Fig. 26***) is being monitored. The surface reduction is accentuated by changing the method of identifying the main species in stands, but the direction of the trend has not altered. In addition, the resulting global diversification is not unrelated to the expansion of recent decades which encourage pioneering and southern species.

Another possible adaptation affects the adjustment of the magnitude of the growing stock capital. This can limit the level of the challenge from climate change and hazards in general (storm, drought, fire, pathogenic organisms, etc.). It also reduces the sensitivity to some of these hazards, by avoiding the presence of vulnerable trees, restricting the total height of stands, their water requirements and the mass of fuel in the fire-risk areas. It increases the share of stand renewal and thus the speed of the possible adaptation. It encourages the structural development of industries and nurseries where dynamics are generally important and also the crisis management




for potential crises. The current increase in the standing capital (***1.2***) which was highlighted above (E1), makes it currently difficult to apply this adaptation method by increasing the age or size of trees (***1.3***) and limiting the renewal (***3.1***).

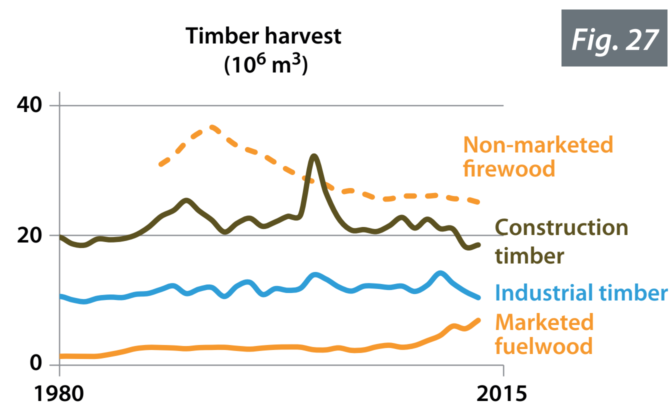
Similarly, the increase in large ungulate populations (***2.4.1***) previously analyzed (E2) is likely to disturb the renewal of stands, and therefore also their adaptation to climate change, in massifs with an imbalance between forest and game.

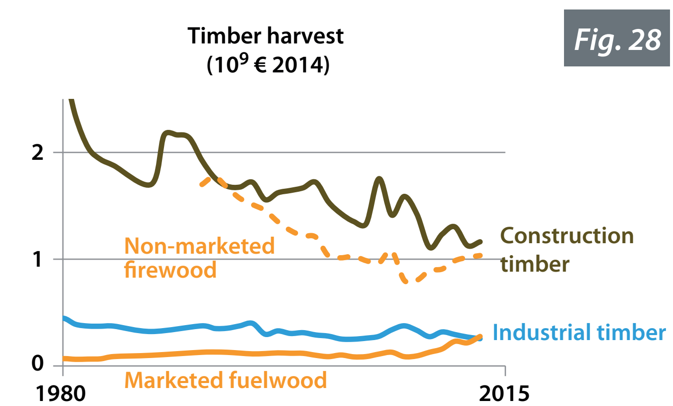
Lastly, signs of climate change have already been seen in forests which is a strong incentive for adaptation in vulnerable areas. From this viewpoint, a certain diversification seems to work as well locally as overall. Conversely, the current changes in French forests are proving less favorable to the application of strategies based on controlling the growing stock in stands and mainly those which are not currently managed despite their potential for this.

## E6. Contribution of the forest-timber sector to the economic activity

The forest-timber sector supplies economic activities with timber, non-woody products and services. It generates an added value that increases the gross domestic product, remunerates jobs and regulates external trade.

Harvesting of lumber has remained globally constant since 1980 except for a lull at the end of the 1980s and the effects of the 1999 and 2009 storms (***3.2***; ***Fig. 27***). It varies between species, rising for conifers (+0.6%/year) and dropping for broadleaved species (-1.3%/year). Harvesting of industrial timber and fuelwood increased regularly until 2007 (+0.5%/year and +2.7%/year respectively), before becoming variable due to the storm, for the industrial timber, and increasing strongly, for the fuelwood (+15%/year), with the boom in demand for renewable energy. According to the surveys of households (SOeS), harvesting non-marketed firewood decreased in the 1990s

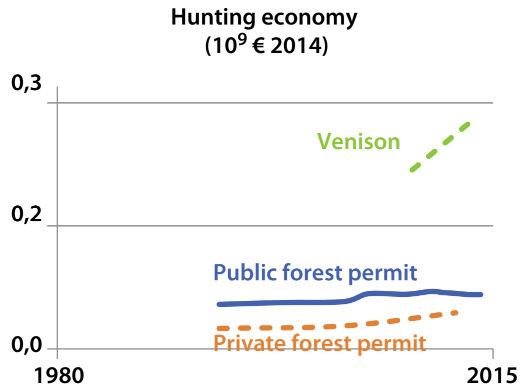



(-3.3%/ year) before stabilizing during the 2000s. Harvesting is also monitored in value (***3.2***; ***Fig. 28***). In the early stages of the period at least, with the exception of marketed fuelwood, the value of timber in constant currency dropped substantially. This is partly explained by a high price during the second oil crisis in 1979-1980 (for both lumber and fuelwood). These changes therefore reflect in large measure a return to the value before the first oil crisis in 1973.

Forest products other than timber are potentially marketable: venison, truffles, cork, honey and forest seeds and seedlings, etc. The same is true of services like hunting permits or permission for a variety of felling or harvesting operations. Hunting falls under both aspects (***3.3***; ***3.4***; ***Fig. 29***): it mobilizes fewer, but nevertheless significant and growing, financial amounts than timber for both the value of venison removed and for permits.

*Fig. 29*




The added value of the forest-sector has been eroded in recent years ***6.2*** ; ***Fig. 30***), including in relation to the primary (natural resources) and secondary (industry) sectors alone which are themselves losing ground in the services. In 2012, the forest-timber sector contributed no more than 0.55% to the gross domestic product (GDP) against 0.95% in 1999, an average annual reduction of more than 4%. In the forest-timber sector, 72% of the added value is used to cover salaries and social charges (***6.3.a***). In related fashion, therefore, total employment of branches of the forest-timber sector declined by nearly 30% in the same period, i.e. 3% average annual reduction for the various branches, with nevertheless slightly less reduction for the woodworking/furniture branch (***6.5*** ; ***Fig. 31***), The sector thus has 0.83% of the active population to generate 0.55% of the gross domestic product. The difference between these two figures reflects the low level of job qualification in the sector. These elements exclude, however, emerging and complex jobs in the leisure industry and nature protection. A regional analysis would also reveal large heterogeneity between regions and show the importance of the north-east and west of France.

*Fig. 30*

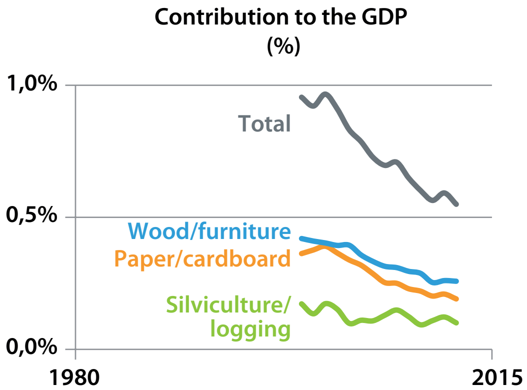
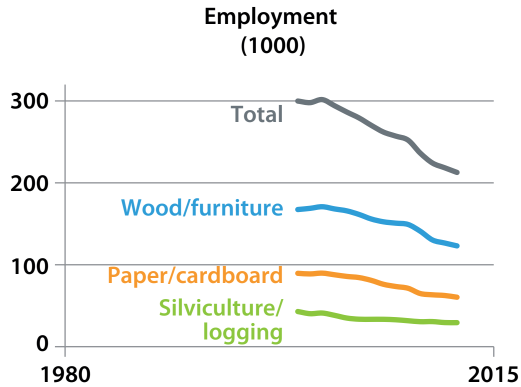



*Fig. 31*




The foreign trade deficit of the forest-timber sector has remained globally fairly stable over the last fifteen years, despite fluctuations dependent on the general economic context and the forestry contest (mainly climate accidents). In round wood equivalent (EQ) volume, it seems to have achieved a balance in favor of increased exports (***6.8*** ; ***fig. 32***) whilst holding its value (***6.8*** ; ***fig. 33***) under the effect of a double contraction of exports and imports. This deficit oscillated between 4 and 6 billion euros in 2014. It is explained initially today by furniture (45% in 2014 against 27% in 2000) and relates therefore to high added-value products. It is still significant but has declined radically in the paper sector (23% in 2014 against 56% in 2000). It is widening in the construction and building sector (14% in 2014 against 3% in 2000) and remains stable in sawing (at 12 or 13%).

*Fig. 32*

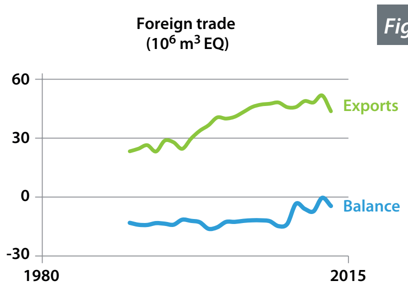
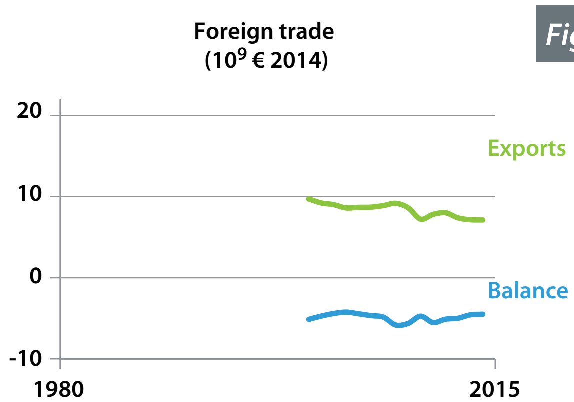



*Fig. 33*



The French foreign trade deficit prompts an additional comment on the size of the energy bill. Although the forest-timber sector can prevent fossil carbon emissions, as seen previously (E4), it produces energy savings and therefore helps to mitigate not only climate change but also imports (Bouvarel, 2015). This effect can be estimated roughly by recalling (see E4) that the use of wood can prevent the emission of around 34 million $tCO_2eq$/year, i.e. the use of about 11 million toe/year of oil. In 2014, 96 million toe were imported at a cost of €45 billion, i.e. Nearly €470/toe. At this price, the energy savings helped by the forest-timber sector in 2014 represent an amount of some 5 billion euros in 2014, i.e. the equivalent of the sector's foreign trade deficit.

The economy of the forest-timber sector is therefore marked by stagnation in wood harvesting and some development in other goods and services mainly in terms of game. Its contribution to the national wealth and traditional jobs is declining whilst new "green" jobs are still complex and there is still potential for recovery in imperfectly promoted resources (***3.1***). The French forest-timber sector has for many years been marked by a deficit in its foreign trade which nevertheless remains stable. The sector also compensates for this by helping to reduce the energy bill.

## E7. Contribution of the forest to social well-being

The forest holds a large place in the hearts of French people for its landscapes and contemplative environment, its leisure spaces, the products it supplies, the jobs and occupations it procures, the protection against risks it provides, etc.

Forests constitute a living environment and cultural heritage through their outstanding elements (***6.11***) and others that are more ordinary. Every inhabitant has approximately a quarter hectare of forest surface area on average (***6.10*** ; ***fig. 34***). This level has relatively stable over time as forest expansion (+0.6%/year) is close to demographic growth (+0.5%/year). There are, however, major disparities between regions, with 2 ares/inhabitant in Ile-de-France and Nord-Pas-de-Calais and up to 77 ares/inhabitant in Limousin and Corsica (***6.10.b***).

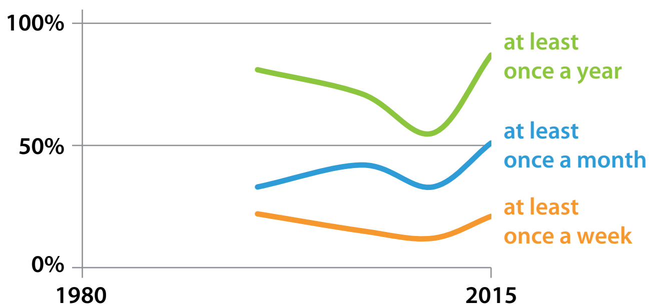
**Forest surface area per inhabitant (ares)**

*Fig. 34*


The French look on forests as the ideal leisure space, with nearly half of them visiting a forest at least once a month. These visits encompass sundry activities like walking, sports, nature watching, picking (mushrooms, fruit, etc.), hunting and collecting firewood. Forest visits have recently picked up again after declining, perhaps after the 1999 storms. (***6.10***; ***Fig. 35***). The hunting bag has increased hugely during the last decades (***2.4.1*** ; ***fig. 36***) as already mentioned (E2). This now shows on average 3.5 roe deer, 3.5 wild boar and 0.4 stags for one hundred wooded hectares. Non-marketed firewood harvesting has been on a downward trend (***3.2*** ; ***fig. 37***)whilst still accounting for a significant volume.

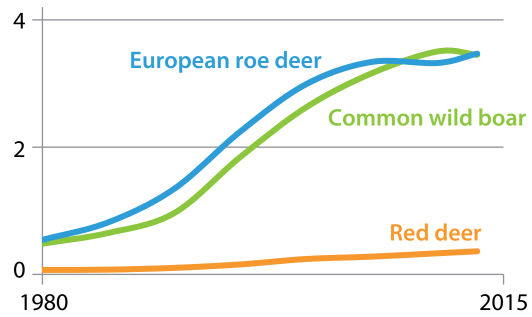
**Frequency of forest visits (%)**

*Fig. 35*




**Hunting bag (nb/100 ha)**

*Fig. 36*



In addition to direct harvesting in forests, French consumers purchase both French and imported wood products. The timber requirements of French consumers and the contribution of foreign trade to satisfying them can be measured by adding net imports of timber and by-products estimated in cubic meters of roundwood equivalent (EQ) to the metropolitan marketed roundwood harvest (***3.2***; ***6.8***; ***Fig. 37***). Like the consumption of non-marketed firewood, the commercial consumption of timber products has dropped to about 0.7 $m^3$ EQ per inhabitant. Recourse in volume to international trade has also dropped.

Forest owners have a special place in society. Numbering 3.3 million (***6.1.a***), they account for 12% of households. They possess very varied surface areas. The share of different size classes is stable after a period when large properties increased to the detriment of small ones (***fig. 38***). Private forests remain divided up, which handicaps them to an extent (Maaf-SSP, 2014) and justifies efforts to bring them under grouped management. In addition, owning a forest is not a profession but a quality: forest development, training and information are therefore fundamental in private forests (***6.1.2***).

As a source of afflictions and hazards and yet essential means of protection, forests enjoy an ambivalent relationship with society in terms of human health and safety.

Precautions must be taken for forest excursions, even for residents living near a wooded space, to avoid such annoyances as ticks (Lyme borreliosis), urticant caterpillars (see E5), pollen (see E5) or falling dead branches or trees, especially in windy conditions. In addition, although forest employment plays an important social role (see E6), working conditions can be difficult with accidents and diseases occurring more frequently than in most other professions. This situation is gradually improving for the accidents (***6.6*** ; ***fig. 39***). The reported number of occupational illnesses has jumped thanks to changes in recognizing joint disorders before stabilizing in recent years. Forest fires can similarly be considered as a risk to society, even if outbreaks of fire are mainly due to malicious acts or human carelessness (source Prométhée). Hence the major, effective efforts by the State to prevent the risks and combat fires (***6.4***; ***Fig. 40***).

**Fig. 37**

Timber product consumption ($m^3$ EQ/inhab.)

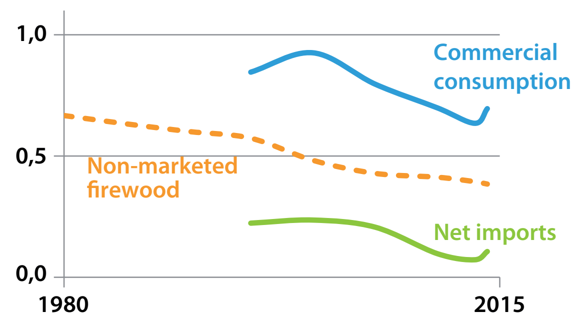



**Fig. 38**

Private forest surface area per size class (%)

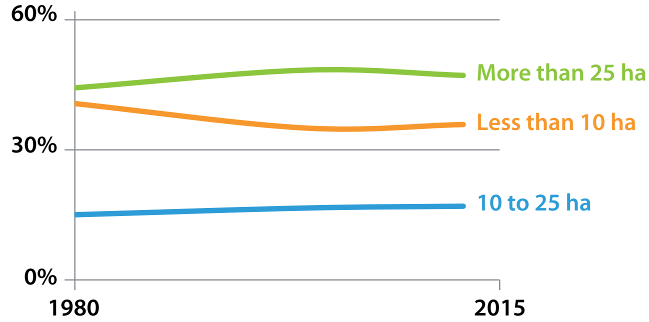



**Fig. 39**

Accidents and diseases (nbr./year)

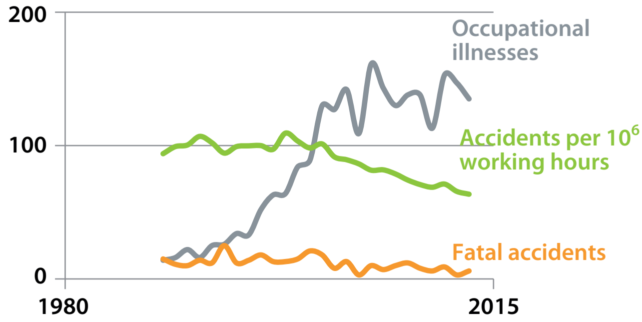
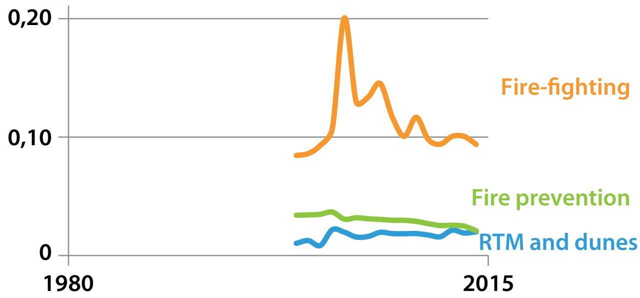



**Fig. 40**

Prevention and protection expenses ($10^9$ € 2014)



Conversely, forests are a means of protecting the biodiversity (and plants with occasional therapeutic virtues), the atmosphere (see E4), water and soils (***5.1***). Metropolitan forests help to control the erosion of mountain lands, Atlantic sand dunes and the rocky Mediterranean coastline (ONF, 2015). Mountain areas at medium or strong risk cover about 125,000 wooded hectares within mountain land restoration perimeters or protective forests. Dune areas struggling to cope with the invasion by water and sand account for about 13,000 wooded hectares. This issue is mobilizing increasing resources (***6.4***; ***Fig. 40***). In terms of water, 45,000 ha of State-owned forests are helping with the immediate or close protection of drinking water catchments whilst continuous information is lacking for the other ownership categories.

Forests therefore fulfill a fundamental social and cultural role for their owners, for people working in them, for the vast majority of French people who visit them at least once a year and on average far more frequently, for the inhabitants who no doubt do not always grasp the importance of the protective forest cloak and lastly for anyone who uses wood as paper, energy or material.

## E8. Implementation of the multi-functionality of forests

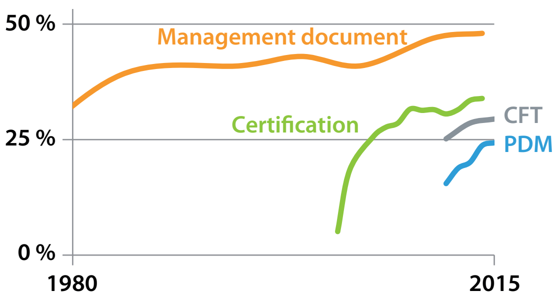
This analysis has made it clear that the metropolitan French forests procure numerous services - control and supply and also socio-cultural. Balances can vary between the various functions depending on context and even era. Multi-functionality is not a standardized concept but a plural notion envisaged at sufficient space or time scale and adapted to the status of ownership and the challenges and players of the region in question. It is linked directly to sustainable forest management and can be assessed by all the relevant criteria and indicators. It is implemented mainly using management documents and both regional and voluntary initiatives.

The State contributes generally to the sustainable and multi-functional management of private and public forests by supervising forestry actions (forest regulations, incentives, taxation, restoration of the forest canopy, knowledge) to a supposedly stable level despite technical and short-term variations in recent years (***6.4***). It sets out the guidelines (national forest and timber program) and lists them at regional (regional forest and timber programs), management (management documents) and territorial levels, mainly as territorial forest charters (CFT) and massif development plans (PDM). Strategies are developed at these different levels (***3.5***; ***6.1.1***; ***Fig. 41***), but they leave a certain margin for progress: half the forest surface areas are managed in accordance with a management document and 40% are incorporated into a territorial initiative, given an overlap between territorial forest charters and massif development plans.

At the same time, voluntary certification initiatives have been developed during the last two decades (***3.2***; ***6.1.3***; ***Fig. 41***). More than 30% of metropolitan forest areas have been incorporated into a certification scheme. These initiatives have rapidly increased in popularity and still have room for improvement despite their significant foothold.

*Fig. 41*

Surface areas with a strategy (%)



Sustainability in managing metropolitan French forests benefits initially from an increase in forest surface areas and volumes of timber, from the maintaining, in formations available for production, of major characteristics for the biodiversity (local wealth of species, size of forest massifs, amount of large-diameter wood or deadwood) and from a state of health that remains satisfactory overall, despite some warnings.

Questions are raised with a timber felling rate that is sufficiently low to suggest that this situation is not simply due to the extension of surface areas, the immaturity of numerous stands or a stated forestry strategy. The result is a development potential still to be exploited, at least in part. Regarding biodiversity, some habitats are threatened and extending protected areas is not meeting the goals set. The state of health of forests has been marked by climate accidents in past decades which testify that adapting forests to future climate change remains a major challenge, despite and because of the uncertainties. The diversity of metropolitan forests is an advantage in this respect but ideally the volume of growing stock should be increased to deflect management, according to local conditions, towards risk prevention. Overall, forest health requires increased vigilance for the potential effects of presumed global warming and ever-possible introductions of invasive species, pathogens and forest pests.

An important goal in sustainable forest management is to procure for society a lasting set of ecosystem services. It appears clear first and foremost that forests play an essential social role for citizens, consumers, workers and forest owners alike. They then conceal a production potential that guarantees favorable fallout for the national wealth, employment and foreign trade balance. The analysis conducted indicates that such development is not necessarily incompatible with maintaining the biodiversity in the production areas and mitigating climate change through both forest carbon sequestration and swood substitution for other materials and energies.

Ultimately, the forest sustainable management indicators furnish a comprehensive analysis of the major metropolitan forest issues. This reveals paths for improvement both for the sustainable and multi-functional management of forests and for monitoring them over time using consolidated, supplements and partially more integrated indicators.

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