Criteria for identifying damage

Identifying the wild animal species responsible for damage to trees and shrubs is essential before attempting to establish any plantation of trees in forest or farmland, and it is the only effective way to choose a suitable method of protection. This analysis must be performed prior to planting: afterwards it will be too late. Learning to recognise the signs left by animals on natural vegetation helps to identify the culprit.

Diagnosing the risks

Once they are aware of the risks of damage to trees, the next logical step for forest managers is a preliminary diagnosis to assess the possible presence of wildlife in the vicinity of the future plantation, the size of the animal population, and in particular the pressure that it exerts on the environment.

Attributing the damage observed on a tree to a particular insect or fungus requires rather sophisticated diagnostic methods and, except in some very familiar cases, specialist advice is usually needed. With ruminants and hares, however, the diagnosis is generally much easier, even with only basic knowledge of their way of life and particular anatomical features.

The best way to draw up a list of potentially damaging species with any certainty is through field observations, and in particular by looking for and analysing the signs left by animals on the natural vegetation.

Examining the injuries inflicted on woody plants of young peripheral plantations and neighbouring mature stands provides valuable pointers, as the pattern of the injury varies according to the animal species. This examination requires careful observation of browsed shoots, rubbed or stripped stems and trunks, and gnawed bark.

There are usually plenty of specimens of damaged plants to hand, so it would be unusual not to find one exhibiting the most typical signs of damage.

To confirm the diagnosis with as much certainty as possible without actually having seen the animals, it is advisable to check with foresters and farmers in the vicinity of the proposed plantation site. Local hunters should also be able to provide information on which species are hunted, their level of abundance and population trends.

Browsed shoots

Aspect of injuries

The removal and consumption of buds, tender green young shoots and woody branches located within reach of animal teeth leaves wounds that differ in appearance, according to the species responsible.

Deer

Deer teeth do not make clean cuts, as they have no upper incisors.

5.1

5.2

6.1

6.2

5 - A horizontal (5.1), more or less chewed browsing injury (5.2) (here on *Cornus mas*) is the work of a roe deer.

6 - Damage to on a woody plant by a browsing rabbit is easily identified by the clean (6.1), oblique (6.2) cut.

7 - The damage to the maritime pine (7.1) is the work of a browsing roe deer. The spruce (7.2) has been browsed by a red deer. How can we know for sure?

8 - Browsing damage to red oak (8.1 and 8.2) and Norway maple (8.3) at a height of 120 cm to 145 cm.

In order to browse the most tender parts of plants to which they are attracted, such as buds, young shoots, leaves, and flowers, they pinch them between their very mobile upper lip (horny pad) and the incisors of their lower jaw, and then tear them off with a quick head jerk.

With this type of bite, the surface of the wound, which is almost perpendicular to the vertical axis of the shoot, looks torn or shredded, with no clean cut and no teeth marks **(Photo 5)**.

Deer can also chew tough branches of a larger diameter with their premolars. The wound will then have a chewed-up appearance. Sometimes the needles growing on conifer stems (pine, Douglas fir) are browsed off one by one down to the base of the plant.

Rabbits and hares

Unlike ruminants, rabbits and hares have large, specialised, extremely sharp incisors on both jaws.

As the animal grasps and cuts its food, the incisors rub against each other and chafe at an oblique angle (giving them a bevelled surface).

8.1

8.2

8.3

7.1

7.2

The resulting injury on a woody shoot is a very clean and distinct cut (like that of a razor), which is oblique in relation to the axis of the shoot **(Photo 6)**. This characteristic appearance allows careful observers to avoid any confusion with the marks left by deer.

Sometimes teeth marks can be seen on the cut with the aid of a magnifying glass. The slight difference in size between the incisors of a rabbit (2.5 mm) and a hare (3 mm) makes it difficult to identify which is responsible.

It is not uncommon to find cut, uneaten shoots lying at the base of a tree. This is probably because hares and rabbits bite off young branches to wear down their incisors, which grow continuously like human fingernails.

9.1

9.2

Which animal is responsible?

Simply observing the aspect of a browsing injury on a tree will not be enough to identify the species responsible within a given family (roe deer vs. red deer, rabbit vs. hare). The height of the wound also needs to be measured, as this provides valuable clues to the identity of the animal.

Trees are likely to be browsed until their leaders and lateral branches are high enough to be out of the reach of animals. Rabbits are known to reach branches as high as 60 cm, and hares as high as 70 cm. Roe deer, mouflon, Pyrenean and Alpine chamois and Reeves muntjacs can reach branches as high as 120 cm, whereas red deer, Sika deer, and fallow deer can reach to 180 cm **(Table 3)**.

These "maximum" accessible heights may be even greater under certain conditions. A steep slope, thick or hard snow cover (especially in the mountains), and wet snow weighing down lower lateral branches also place branches within easier reach of animal teeth.

Cases where animals bend or break stems to reach otherwise inaccessible but particularly attractive shoots are becoming more common. Such cases are undoubtedly linked to excessive densities in certain nutrient-poor territories and to lower planting densities of appetizing mineral-rich plants.

Roe deer often manage to bend young trees over by standing up and leaning against them, in order to reach buds as high as 1.5 m **(Photo 8)**. Nor is it uncommon for red deer to stand on their hind legs to reach appetising shoots nearly 2 m high. Sometimes they also snap trees several meters tall at a height of 1.5 m (which corresponds to about 1 cm in diameter) to reach the upper leaves, which are richer in nutrients and lower in fibre.

In areas where roe deer and red deer coexist, it is difficult to identify the species responsible when most of the trees are browsed at heights of 10 to 130 cm, in other words, when the damage is close to the ground **(Photo 7)**.

Only careful and patient examination of other signs of presence (tracks, faeces, hairs, etc.) in the vicinity of recently browsed tree will allow the damage to be attributed to one of the species when both are present.

Table 3 - Maximum height (cm) of wounds to trees caused by animals

	Rabbit	Hare	Roe deer	Red deer
Browsing	< 60	< 70	< 150	< 200
Rubbing	-	-	50 - 100	100 - 200
Bark stripping	-	-	-	30 - 200
Bark gnawing	< 50	< 60	-	-

When does the damage occur?

Deer

Browsing damage occurs all year round. Peak periods depend on tree species and can occur either during the dormant period (mainly conifers) or during the growing season (mainly leaves and green shoots of hardwoods).

Browsing in the winter (no sap flow) is more common in January-February when nutrient resources are scarce and other sources of food (brambles, dead leaves, mast, etc.) are covered by snow. Animals will browse woody shoots and terminal buds emerging from the snow cover, especially of conifers, which are generally a last resort in times of shortage **(Photo 9)**.

Browsing in the summer (during sap flow) occurs throughout the active growing season **(Photo 10)**, although the most intense damage occurs during spring budding. Breaking buds and unfolding leaves **(Photo 11)**, from which tender young shoots then emerge, are prime sources of fresh food **(Photo 12)** after a poor winter diet of woody conifer branches.

Hares and rabbits

Rabbits feed on buds all year round, whenever they are available. No tree species is spared.

Damage to young plantations is most common and most dramatic in the winter, when food is scarce and energy needs are high. During this period, the vulnerability of forest plantations to damage increases in proportion to the size of animal populations.

Browsing can rapidly lead to the near-total destruction of trees (40 to 90 %, depending on species) when rabbit densities are high (12 to 15 individuals per ha).

10.1

10.2

Vulnerability of different tree species

Deer

The vulnerability of a tree to browsing by roe deer and red deer varies according to season, tree species, the food available in the habitat, and silvicultural practice.

9 - These spruces were browsed by red deer during the winter. The main stem of the older tree (9.1) had fortunately grown past the maximum accessible height.

10 - A 120 cm mesh tree guard will not protect red oaks from browsing damage by red deer in the summer (during sap flow) (10.1). Few trees will remain unharmed (10.2).

11 - These young leaves and branches emerging on a plant damaged by browsing the previous year are a prime food source.

12 - The main stem of this red oak in full summer growth was browsed by a roe deer at a height above 120 cm.

11

12

By season

Deer eat conifer shoots and hardwood foliage and shoots all year round, but their preferences may vary with the seasons. Evergreen conifer species are browsed in the autumn and especially in winter when food is scarce. When it snows, terminal buds and shoots emerging from the snow cover are even more easily consumed and may then make up 45 % of the diet.

Hardwoods are generally consumed throughout the growing season, particularly in late spring, just after budbreak and when the shoots have not yet become woody. At this time of year, red deer prefer deciduous hardwoods and larches to evergreen conifers, whereas roe deer browse on a larger proportion of hardwoods than their abundance in the flora would suggest. They do not display this preference in the autumn and winter, indicating that roe deer prefer foliage to bare branches.

By species

Deer have a preference for silver fir, yew, oak, maple, ash, cherry, elm, locust, willow, and mountain ash. They are less attracted to pines (Scots, Corsican, maritime), spruce, Douglas fir, larch, beech, aspen, chestnut, walnut and white birch.

Some species such as silver birch, alder, and linden are rarely browsed and their consumption is considered an indication of excessive wildlife density.

By habitat

These preferences may vary considerably with localities. The level of consumption of a given tree species depends greatly on its habitat and in particular on:

- its abundance in the environment. When hardwood species are introduced into pure stands of conifers, the browsing problem may become acute;
- whether or not it is part of the animal's normal diet. This is particularly true for maritime pine, a dominant species in the Landes forest (SW France) where it is frequently browsed;
- the relative proportions of the main groups of food plants (hardwoods, conifers, grasses, herbaceous plants and shrubs such as raspberry, bramble, heather, blueberry), which determines the overall food supply for animals from that environment **(Photo 13)**. Browsing on species that are rarely or not normally sought out as food may be significant if the natural surrounding vegetation is not sufficiently abundant and attractive. Thus, plantations on bare ground (logged-over forest subsequently ploughed, cropfields, former meadows) are highly vulnerable, even if the tree species are not particularly attractive.

13

Silvicultural practices

Silvicultural practices can also have an effect on the scale of damage.

Regeneration method

Nursery-grown trees of any given species are more frequently browsed during the first few years after planting than natural seedlings and stump shoots.

Many hypotheses have been put forward to explain this particular vulnerability of nursery-grown plants. Differences in nutritional quality could explain these discriminatory choices, implying that animals have the ability to choose trees according to the richness of the shoots in nutrients. According to another and perhaps more likely theory, this preference for artificially-grown trees could be explained by the fact that, because they were grown under better conditions, their shoots are longer, more accessible, and therefore more attractive.

Forest management techniques

If a forester promotes natural regeneration by creating temporary openings in the forest canopy to increase the amount of light, deer will have an abundance of plants from which to choose. In contrast, in stands where very little thinning is done, relatively few natural seedlings are produced and the impact of browsing becomes significant. Some permanently open environments with no forest cover, such as glades, turf, bogs, and some scree slopes are used as feeding zones and should be encouraged.

In artificial plantations, the quality of the installation and maintenance work determines how easily animals can reach the trees and is therefore of great importance.

In the first two to three years after planting on bare, deeply ploughed soil, the trees are easily accessible and extremely attractive to wild animals. There is also a close correlation between the vulnerability of the trees and the frequency of clearing to destroy competing herbaceous and semi-woody vegetation. During periods of food scarcity (end of winter), excessive or improper maintenance gives animals easy access to the young trees.

14

13 - Encouraging and maintaining brambles in fields is recommended to reduce the impact of roe deer on hardwoods and to promote natural regeneration of oak.

14 - Open corridors in stands of natural regrowth are trails for wildlife. It is important for the desired tree species to be well protected by companion species.

15 - If all of its shoots are removed, a plant has little (15.1) or no chance of survival (15.2).

Maintaining natural regeneration

Woody and semi-woody vegetation near the trees **(Photo 14)** can serve as natural protection from browsing, but can also make browsing of the trees more likely.

Less attractive plants of the same or larger size have a better protective effect (visual protection). On the other hand, the proximity of attractive plants (such as mountain ash, *Cornus spp., Rubus spp*. or field maple) can substantially increase the frequency of browsing.

Rabbits and hares

All tree species are browsed by rabbits and hares, which have a preference for hardwoods (beech, oak). However, they also browse some conifers (spruce, Douglas fir, Scots and Corsican pine, firs).

Although browsing damage to woody plants may be greater and more visible in the winter, no tree species is immune, regardless of the season.

Consequences of browsing

Tree mortality

In extreme cases, browsing can lead to the death of the tree. Although this generally applies only to natural shoots and seedlings, it can happen after planting, before the plants have had a chance to become established.

They have little chance of survival when all of their shoots are removed by intense or repeated browsing **(Photo 15)** and if their height growth is reduced by more than 25 %.

The mortality rate of trees diminishes greatly as they age, rapidly dropping to zero in older trees.

15.1

15.2

16

17

16 - When browsed by roe deer, a bush can grow replacement shoots from the collar.

17 - Upward growth of a lateral branch of a young European spindle-tree (*Euonymus europaeus*) browsed by a roe deer.

18 - Upward growth of lateral branches of a spruce after the terminal bud was eaten by a red deer.

Tree growth

Browsing on buds and branches with foliage during the growing season is a significant stress factor for both deciduous and evergreen species, and especially for evergreen conifers in the winter.

During the period of active photosynthesis (after spring budbreak and until leaf drop in the autumn), a large portion of the assimilates produced by leaves and needles is consumed by the plant for its own growth. Towards the end of the growing season, the plant's energy demand drops and nutrients migrate from the foliage to the storage areas of the tree, where they remain until the next budbreak.

If the leaf mass (and consequently the production of these nutrients) is reduced by browsing (as summer pruning would do), fewer reserves will have been stocked by the autumn and the tree will therefore grow less vigorously the following year, in proportion to the severity of the damage.

In winter, evergreen conifers are often more severely affected than deciduous species and larches. This is because the needles of these conifers are the main sites where nutrient reserves are stored. When browsing causes significant defoliation, it is also contributing to a considerable loss of these reserves, with a resulting decline in tree growth in the following year.

In contrast, winter consumption of the shoots of deciduous trees has almost no impact on the future development of the tree, since these species store their nutrient reserves in the woody portions of the young trunk and in their roots, which rarely browsed, if at all.

Lastly, a tree does not have time to recover when it is subjected to repeated browsing damage. Its reserves steadily decline, leading to considerable retardation in its height growth, so that it may remain within the reach of animals for years to come.

Tree shape

The most common and most severe impact is that which affects the terminal bud of the leader, as the latter is responsible for height growth and determines the future shape of the tree.

18

19.1

19.2

19 - When one (19.1) or more (19.2) sub-terminal shoots fork, corrective pruning will be required to ensure the future silvicultural quality of these black walnuts.

20 - Repeated browsing of terminal and lateral shoots over several years will gradually transform hardwood (20.1) and conifer (20.2 and 20.3) saplings into shrubs.

If the leader is destroyed, the tree loses its apical dominance and may react:

- by forming replacement shoots (from the buds that normally form on the remaining portion of the damaged shoot or from dormant lateral buds, **Photo 16)**;
- by the upward growth of one **(Photo 17)** or more **(Photo 18)** upper lateral shoots.

This generally occurs over a single year and involves one or more upper branches.

If none of these new shoots becomes dominant, the tree will fork **(Photo 19)** or grow with several trunks **(Photo 20.1)**.

As a general rule, a single replacement stem will eventually become dominant, the others becoming ordinary branches. Nevertheless, this drastically alters the future silvicultural quality of the tree.

If these terminal and lateral shoots are repeatedly consumed over several years, the repetitive nature of the damage gives rise to serious morphological defects in the tree, which will become a shrub with multiple forks (bushy growth habit) and no real crown, easily mistaken for mere "under-brush" **(Photos 20.2 and 20.3)**.

20.1

20.2

20.3

21.1

21.2

Although spruces may survive for many years in this state, oaks decline rapidly and their branches wither one after another within a few years.

22

Rub wounds on stems and trunks

Aspect of injuries

Male deer rubbing stems and trunks with their antlers cause damage to young trees by tearing off various amounts of bark and sometimes even snapping the main trunk and/or lateral branches. The aspect of these behaviour-related injuries varies with the time of year in which they occur.

Rubs due to velvet scraping

The antlers of male roe deer and red deer (bucks and stags) are branched bony structures which they shed each year. New antlers start to grow immediately and very rapidly. They are covered at first with a soft skin known as "velvet", where there are a great many blood vessels. Once antler growth is complete, this skin is no longer needed and begins to peel off.

To speed up the process, males rub their antlers against thin and relatively flexible young tree trunks. Animals engaging in this behaviour may abrade the bark and the cambium until the sapwood is exposed, thus greatly compromising the future growth of the stems.

In this case, the bark is always damaged on just one side of the trunk **(Photo 21)**. As the deer do not eat the bark, it remains attached to the trunk by both ends in more or less shredded strips. Because certain areas of the velvet are sensitive, the animals are careful and this kind of rubbing is less forceful than rut rubs. Lateral branches or whorls are therefore rarely broken.

Rut rubs

Later in the year, when their antlers are fully developed, male deer may again damage trees and shrubs during the mating season (rut).

Rubbing is then much more forceful than when they are shedding their velvet, as the males engage in mock combats with young trees to release their aggression. During this period, bucks and stags mark their territories with visual and scent signals (glandular secretions) during the entire rutting period to warn others away.

Their state of arousal causes much more dramatic damage to trees than when they are shedding their velvet. Many branches, sometimes even the main trunk itself, may be snapped off **(Photo 22)**.

If sap is still flowing in the tree (during buck rut), the bark is lacerated and may be torn away from the entire circumference of the trunk. Trees that have thus been girdled die very quickly. Rub wounds are often comparable to bark stripping damage.

When sap flow ceases (at the time when the bellows of stags can be heard), the bark is not easily detached and rubbing no longer results in shredding. The bark is rubbed and worn down to the wood, and the edges of the wound are smooth **(Photo 23)**.

23

Deep marks in bark made by antler blows on trunks are sometimes easily visible. This type of injury, also known as "slashing" or "gouging", is often seen on large diameter trees **(Photo 24)**.

Which animal is responsible?

The animal causing the damage can be identified by the size of the tree and the height of the injury.

21 - Roebucks rubbing off their velvet will detach bark in strips, always on just one side of the trunk and only on trees less than 4 cm in diameter.

22 - The presence of broken branches on this locust is characteristic of a buck rub during rutting.

23 - Bark worn down to the wood and smooth wound edges are the result of a stag rub during the period when no sap is flowing (September - October).

24 - These deep marks in the bark of large diameter trees (cherry, 24.1; Douglas fir, 24.2) were made by antler blows from stags during the period when sap was not flowing.

25 - A buck rub on a locust tree: the rubbed area is 10 to 80 cm above the ground but can be as high as 100 cm.

24.1

24.2

25

Bucks shedding their velvet select young, flexible, pole-like trees (Ø < 4 cm, rarely more than 10 cm) **(Photo 21)** that are small enough to fit between the two antlers.

Stags also select trunks suited to the size of their antlers, usually 3 to 5 cm in diameter, but larger trunks may be attacked during the rut: trunks damaged by gouging **(Photo 24)** are generally 10 to 30 cm in diameter and sometimes more (up to 60 cm).

With roe deer, the rubbing zone is usually located between 10 and 80 cm from the ground **(Photo 25)**, but can be as high as 100 cm **(Table 3)**. With red deer, it is around 100 cm high, but can reach 200 cm **(Photo 26)**.

Abrasions due to roe bucks rubbing off their velvet usually less than 60 cm across, while those caused by stags are always more than 40 cm across.

When does the damage occur?

The damage occurs mainly during the velvet shedding or rutting periods, which vary with the species.

Whereas roebucks tolerate one another and form small groups in the winter, they suddenly turn solitary and aggressive towards one another in early spring. They scrape trees and shrubs with their front paws, rubbing in their scent to mark their territory.

Rubbing frequency varies a great deal during this period. It is most intense in the spring between March and May (velvet shedding), and again in the summer between July and August (rut rubs).

Stags rubs occur three times a year: shortly before they shed their antlers (February to March), and in particular from the velvet shedding stage (end of July to end of August) until they start to bellow (September-October).

Rut rub periods depend on the age of the stags and may vary locally. The oldest stags tend to be the first to go into rut and they mark their territories earlier.

Vulnerability of different tree species

Male deer (stags and bucks) vigorously rub saplings and young trees, sometimes even in the pole stage. They prefer aromatic species that are rich in essential oils and aromatic resins, such as Douglas firs, giant firs, pines, larches and yew, but also cherry, juniper, elderberry, and buckthorn.

Silver firs and spruces are occasionally damaged, but browsing is definitely a greater threat to these species than rubbing.

In young plantations, certain trees may be broken and others rendered unfit for commercial forestry. Animals choose trees with supple trunks and smooth bark, with lower branches set relatively high.

Large, widely-spaced hardwood saplings with few lateral branches and softwoods like poplar and willow are very vulnerable to rubbing. Species that are not site-adapted, locally rare (maple, ash, mountain ash) or present in stands in small numbers are also vulnerable. Beech and other oaks are rarely affected.

Consequences of rub injuries

Bark injuries caused by rubbing can interfere with growth or even cause the death of the tree if they are severe or if the stem or trunk has been girdled.

26

When the sap is rising, forceful rubbing easily tears away the surface tissue (bark and cambium), which soon falls away once it is separated from the sapwood **(Photo 27)**.

If it is not snapped and if the trunk is not girdled, the young tree may survive, but its growth will be severely retarded in subsequent growing seasons.

Some species **(Photo 28)** may react by forming a callus around the wound, but in most cases, the process observed is fairly rapid desiccation of the entire portion of the tree above the exposed sapwood.

This is followed by rapid growth of undamaged lateral branches below the scar and sometimes the development of one or more shoots, compromising the silvicultural future of the tree.

When the trunk snaps as a result of slashing during rut, the tree reacts in a similar way to that observed after browsing of the leader, with the terminals growing upwards or the formation of replacement shoots.

27

ping wounds are sharp. Several strips may be torn off side by side, but rarely from more than 50 % of the circumference of the trunk. A callus forms, but the scar frequently remains until the death of the tree.

Bark stripping when no sap is flowing

In the winter (no sap flow), the bark adheres tightly to the wood and the animal cannot tear it off in strips. It will therefore nibble at the bark with its incisors, removing it little by little. This injury, which is easy to recognise **(Photo 30)**, rarely reaches the same proportions as summer bark stripping.

Teeth marks are easily visible, side by side and separated by the remaining pieces of cambium. Often the marks of only one of the two lower incisors are apparent, as the animal gnaws the bark by turning its head slightly to one side or the other.

26 - A black alder damaged by a stag rubbing off velvet: the rubbed area is around 100 cm above the ground, but can reach 200 cm.

27 - Wildlife pressure on commercial hardwood plantations is increasing. This Norway maple has been rubbed by a roe buck in rut despite the mesh tree guard.

28 - Unlike the gouge on the mature cherry tree (28.2), the wound on the cherry sapling (28.1) is not healing easily.

Stripped stems and trunks

Aspect of injuries and period of occurrence

Bark stripping can be very serious locally and is perhaps the most dramatic of all types of animal damage. The consumption of whole bark pieces by red deer (by tearing or gnawing) causes injuries of two kinds, which vary in aspect according to the physiological condition of the tree when the damage occurred.

Bark stripping during sap flow

In the summer (during sap flow), bark detaches easily from the underlying cambium. The animal is able to grasp the bark by pinching it between its lower incisors and the bony pad of its upper jaw, and then tear off a long, upwardly tapering strip ending in a point **(Photo 29)** or at the insertion of a lateral branch. No teeth marks are visible. The bark is eaten, leaving no hanging strips.

In contrast to the smooth, gradually worn edges of rub wounds, the edges of bark strip-

28.1

28.2

29

30

Which animal is responsible?

Red deer are responsible for this type of damage. Roe deer rarely strip bark from trees, and only during periods of extreme and prolonged food scarcity in poor biotopes with high animal densities.

Damage occurs between 70 and 120 cm above the ground, but can extend from 30 to 200 cm **(Table 3)**. The teeth marks on the cambium are 8 to 9 mm in width.

Vulnerability of different tree species

The differences in vulnerability among tree species are fairly distinct, but can vary in different stands, with bark stripping occurring on the most prevalent species. Their vulnerability is proportional to the fragility of their bark and the time required for suberisation.

Red deer only feed on thin bark. Spruce, ash, chestnut **(Photo 31)** and mountain ash are frequently stripped. Other species commonly affected include Douglas fir, Scots pine, beech and poplar. Some species such as fir, oak, alder and birch are rarely affected.

Trees may be stripped as soon as their trunks become accessible when the lowest lateral branches die back (natural pruning). The damage often increases in intensity soon after artificial pruning prior to the first thinning.

Bark stripping begins when trees reach a diameter at breast height (DBH) of 1 to 2 cm, but damage is most frequent in saplings of 10 to 15 cm, especially spruce, Douglas fir and beech. Trees are no longer vulnerable to bark stripping when the bark becomes too thick and difficult to remove.

Species that take a long time to develop thick bark, such as beech (10 to 30 years) and spruce (10 to 45 years), remain vulnerable for longer than species in which the bark quickly becomes hard and rough through early suberisation, such as Douglas fir (6 to 20 years) and especially pines (4 to 10 years).

Consequences of bark stripping

Bark stripping rarely occurs around the entire circumference and almost never leads directly to the death of the tree. It may survive (especially in the case of winter bark stripping) and continue to grow slowly while gradually recovering from the injury.

Its healing capacity will depend on many factors, including the size of the wound (large wounds heal more slowly), the age of the tree (healing takes more time in old trees), the season in which the injury occurred, the species (some species heal faster than others), and the spectrum of microorganisms and rot fungi colonizing the wound.

Even if a callus forms, the scar generally remains visible until the death of the tree and remains exposed to fungal rot that deteriorates the timber of the butt log, making it totally unfit for commercial use. Trees with low resistance to mechanical stress in the vicinity of the damaged zone may then snap under wind or snow pressure **(Photo 32)**.

Healing slows in proportion to the size of the wound and the age of the injured trunk. Economic losses will depend on the species and volume of the rotted zone that needs to be cut out. As a general rule, economic losses are not too great for rapidly healing species such as Douglas fir, but are significant in spruces or Scots pine, which do not heal well.

Gnawed bark

Aspect of injuries

Due to the nature of their teeth, rabbits and hares, unlike ruminants, cannot tear off strips of bark, even during the growing season (sap flow). They have extremely sharp incisors on both jaws, requiring them to nibble at the bark in order to feed **(Photo 33)**.

As a general rule, hares and rabbits damage trees less than 5 to 6 cm in diameter, sometimes feeding on low-growing

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lateral branches. The injury is generally at a very oblique angle to the axis of the shoot, and the exposed portion of the wood is surrounded by an area of characteristically bevelled bark. The marks of both incisors are often visible on each bite. The trunk may be completely girdled.

32

Which animal is responsible?

The species (rabbit or hare) responsible can be identified by the width of the teeth marks on the wood and the height of the damage above the ground.

The total width of both incisors is about 5 cm in rabbits and 6 mm in hares. For the record, it varies from 1.5 to 2.5 mm in small rodents (mainly voles) **(Photo 34)**.

Rabbits gnaw from the collar to a height of 45-50 cm **(Table 3, p.12)**. Hares rarely gnaw higher than 70 cm. Small rodent wounds are found at the collar of the tree, no higher than 15 cm above the ground.

The presence of droppings (which are larger and more scattered in hares than in rabbits) also helps to identify the animal responsible.

When does the damage occur?

Bark gnawing is feeding-related damage and closely correlated with food scarcity and with the animal's need to wear down its incisors.

As with browsing, it mainly occurs during the winter, when food is scarce and the main food source, herbaceous plants, is insufficient in quantity and quality.

Vulnerability of different tree species

Hares and rabbits prefer hardwoods. The most vulnerable species are beech and oak, but damage is often found on cherry, ash, poplar, aspen and willow.

Conifers are less affected: those most frequently damaged are Douglas fir and pines (Corsican and Scots).

29 - Summer bark stripping on a Douglas fir: bark torn off in tapering strips, wound edges sharp and not worn smooth by rubbing.

30 - Bark stripping damage on ash during the period when no sap is flowing.

31 - The teeth marks of red deer are clearly visible on the exposed cambium of this chestnut tree.

32 - Snapped stem of a spruce subsequent to rotting induced by bark stripping during sap flow.

33 - Maple bark gnawedby a rabbit.

34 - Underground bark gnawing is the work of small rodents.

33

34