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The Prevention of Mammal Damage to Trees in Woodland

PRACTICE NOTE

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PURPOSE

This note is designed to help woodland managers to diagnose mammal damage, to evaluate its severity, to consider management options and to determine the appropriate action to take. The guide is brief but suggests sources of more detailed information on damage control operations.

ESTABLISHING THE NEED FOR PROTECTION

Types of damage

Woodland managers will be concerned to protect both tree crops and woodland ecosystems from serious damage by mammals. Most damage to trees arises from either browsing (feeding on buds, shoots and foliage) or removal of bark from main stems or branches. The latter may occur by gnawing (bark-stripping) or rubbing. A particularly common type of rubbing injury (fraying) results when male deer rub new antlers to remove 'velvet' or to mark territories.

Close inspection of damaged trees and their surroundings can often reveal the species responsible. The most important features to note are:

- form of damage (i.e. browsing, gnawing or rubbing);
- height of damage;
- time of year when damage occurred;
- presence and size of teeth marks;
- signs of animal presence and abundance - droppings, footprints, runs, scrapes or burrows.

Other impacts

High populations of some woodland mammals can have a significant impact on the wider woodland ecosystem.

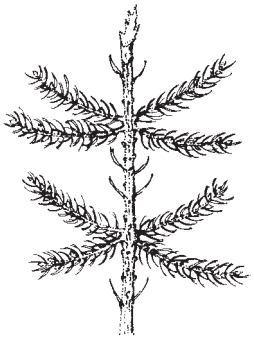
Heavy browsing may:

- prevent natural regeneration from seed[1] or coppice stumps[2];
- prevent the development of a structurally diverse shrub layer;
- reduce the abundance of palatable plants such as bramble, bluebell, dog's mercury and honeysuckle and increase the abundance of grasses and unpalatable species such as bracken, rushes (*Juncus* species) and ragwort;
- reduce the structural diversity of ground vegetation (a particular problem with close grazing by rabbits).

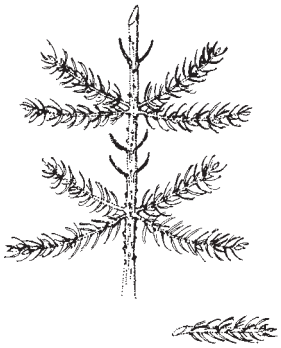
These impacts often occur over time such that their significance may not be immediately obvious and the required action may be difficult to determine in consequence. Complete exclusion of herbivores from woodland can be detrimental in the long term as it results in rank vegetation, reduction of floral diversity and excessive scrub development. In most woodland types, species and structural diversity are higher when some browsing and grazing occurs. Fence specifications may be chosen to allow some species through but not others. Only broad guidance on deer management and woodland conservation is available[3,4,5,33] and much depends on the precise management objectives and the characteristics of the woodland. If in doubt, seek advice from the Forestry Commission, English Nature, Scottish Natural Heritage, or Countryside Council for Wales.

Table 1a Identification of browsing damage to trees

Browsing			
Mammal	**Tree size**	**Time of year**	**Description of damage**
Bank voles	Newly planted	Winter	Will remove buds, particularly of pine, usually on restock sites; often immediately after planting.
Rabbits		Winter, spring, rarely summer	Sharp-angled, knife-like cut on ends of stems or branches, removed portion often eaten. Damage up to 540 mm (higher in snow).
Hares		As rabbits	As rabbits but shoots often not consumed. Damage up to 0.7 m.
Deer		All year	Lack of teeth in front upper jaw produces ragged edge on damaged stems. Roe and muntjac browse up to 1.1 m, fallow, red and sika up to 1.8 m. Fallow pull newly planted trees out of ground.
Sheep & goats		All year	Coarse browsing of foliage to 1.5 m. Newly planted trees pulled out of ground. Sheep and deer browsing damage very similar.
Cattle & horses		All year	Coarse browsing of foliage to 2.5 m with horses, 2.0 m with cattle. Newly planted trees pulled out of ground.



Browsing by deer and sheep leaves ragged ends on stems and branches. The shoots are always eaten.



Rabbits and hares leave clean diagonal cuts on ends of stems and branches. The shoots are often left lying by rabbits, always by hares.

Growing tips of Sitka spruce browsed by deer.

Sharp-angled cut on young stem browsed by rabbits.

Browsing damage to birch by sheep.

Browsing damage to spruce by deer.

Damage assessment

Discovery of signs of damage or of damaging mammals does not necessarily mean that protective measures must be taken. The decision should be objectively based on the economic and ecological costs and benefits. This requires an assessment of current damage or damage potential. If trees are already present on or near the site, loss of planted trees can be established by estimating stocking density. The amount of damage to trees can be determined by sampling using the Nearest Neighbour Method[6]. In the absence of trees, prior to planting, damage risk can be inferred from intensity of animal signs and past experience.

Basal bark stripping by rabbits.

Basal bark stripping by field voles.

Summer basal bark stripping by squirrels to a young beech tree (note the bark fragments on the ground). This type of damage is often confused with similar winter bark stripping carried out by rabbits (see above).

Bark stripping by deer showing vertical teeth marks.

Fraying damage by deer.

Bark damage by horses showing typical diagonal teeth marks.

Table 1b Identification of bark damage to trees

Bark damage (stripping, rubbing, fraying)			
Mammal	**Tree size**	**Time of year**	**Description of damage**
Field voles	Young trees to 5 cm diameter	All year but greatest risk in winter	Bark is stripped on roots or lower stem up to height of surrounding vegetation. Very small trees can be girdled and felled. Bark removed in short, irregular strips 5 to 10 mm wide, with incisor marks 1 mm wide in pairs in the bark around the edge of the wound.
Bank voles	To early pole stage	Winter and spring	Bark removed in short, irregular strips 5 to 10 mm wide, with incisor marks 1 mm wide in pairs. Bank voles climb, so damage can occur up to 4 m. Less common than damage by field voles.
Rabbits	All	Winter and spring	Bark stripping can occur to a height of 540 mm (higher in snow). Incisor marks are 3 to 4 mm wide, in pairs, usually running diagonally across the stem. Beech particularly vulnerable.
Squirrel	10–40 yrs	April–July	Incisor marks 1.5 mm wide in pairs, usually running parallel with stem or branch. Sycamore, beech, oak and pine most at risk
Deer	Pole stage	All year March–May	Red, sika and fallow deer strip bark leaving vertical incisor marks. Fraying
Sheep & goats	All	All year	Severe stripping of bark to 1.5 m, often leading to tree death. Incisor marks diagonal
Cattle & horses	All	All year	Severe damage to 2.5 m by horses bark stripping, 2.0 m by cattle rubbing, often leading to tree death. Incisor marks diagonal.

DAMAGE CONTROL

Where an unacceptable risk of damage has been identified, tree protection may be obtained by:

- **barriers** - erection of fencing, tree guards or tree-shelters; use of chemical repellents;
- **control** of animal numbers - shooting, trapping, poisoning or biological control;
- **habitat management** - regrettably, this is a largely theoretical option at present.

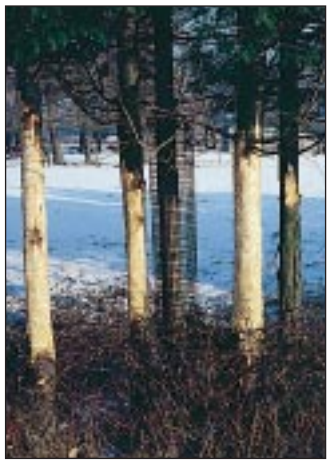
Barriers

Tree guards

Includes treeshelters[7], split plastic tubes, spiral guards[8] and mesh guards[9]. These are available in a range of shapes and sizes, each designed for a specific purpose.

1.2 m high tree shelter for protection against roe deer browsing.

200 mm split plastic tube guard for protection against field vole bark stripping.



Plastic mesh guard providing protection from horses.

Rabbit fence with bottom of netting turned out towards rabbits and turved.

Badgers have dug under this rabbit fence. A badger gate is needed here.

Fencing[11]

Before deciding on a fencing specification, it is important to be aware of what the damaging animals are capable of jumping or climbing over, pushing through or burrowing under. The line of a fence can greatly influence its cost as it affects fence length and the number of strainer posts used. Straight lengths offer lowest costs but can be visually obtrusive, particularly if they cause a distinct vegetation change. Woodland boundaries and design can be planned to ameliorate these impacts[12], for example fences do not necessarily have to follow straight property boundaries. Achieving a balance between cost and visual impact may mean enclosing some land to be left as open ground, or exclosing outlying groups of trees which can be individually protected. Current research will soon offer lower cost fencing specifications with improved potential for reusing materials; for example, new plastic meshes offer good potential as a low cost, light weight, reusable alternative to wire mesh.

Deer fences can be a significant source of mortality to low flying ground nesting birds, particularly capercaillie and black grouse. Fences should not be used in areas of highest vulnerability, elsewhere plastic netting and high visibility fence tags may be beneficial[13]. Where possible, fences should not cross established badger runs. If necessary, set badger gates into rabbit fence-lines where they cross main runs[14]. Fences should be removed as soon as they have served their purpose.

Electric fencing

Has little potential for long term woodland protection against wild mammals, but may offer temporary protection for small areas. Electric fencing is most suited to farm fencing; it is most effective against domestic stock, offers some protection against rabbits and will add to the barrier effect of line wire fences. However, mesh fences provide a superior barrier to rabbits and deer.

Chemical repellents

These are currently the subject of much research effort. The only currently recommended repellent is Aaprotect, an irritant to herbivores which offers over-winter protection of young trees[15] and potential for protection against bark-stripping by rabbits, squirrels and voles. Longer acting repellents are being developed using microencapsulated capsasin (a substance derived from chilli peppers). There is currently little progress on the development of systemic repellents which protect new growth after application.

The chemical repellent Aaprotect used to protect newly planted pine from rabbits.

Deer control

Populations and ranges of most deer species are increasing[16], and most protection efforts alone are unreliable in the face of very high deer densities. In the long term, deer control becomes an essential element of a successful damage management strategy. The strategy must be based on an estimates of current population density, population trends, future availability of food (in effect, a function of the amount of open space and restock) and the target deer density. This technique is being successfully used by the Forestry Commission for red[17] and roe[18] deer. It is best implemented in collaboration with neighbours through local Deer Management Groups[16]. Designing deer glades and ride systems with shooting in mind can greatly increase cull efficiency. As well as controlling the impact of deer, carefully planned culling regimes can generate income from stalking and venison, as well as reducing mortality from road traffic accidents, disease and starvation.

Shooting

Shooting is the only permissible method of killing deer. It must be done humanely and within the terms of the relevant Acts[19]. Generally only rifles of specified calibre and muzzle energy can be used, and then during tightly defined open seasons[19].

Grey squirrel[20] control

Shooting

Squirrel shooting, with or without drey poking, will rarely reduce grey squirrel numbers during the damage season sufficiently to prevent bark-stripping damage.

Poisoning

Warfarin is regulated by the Control of Pesticides Regulations 1986 which permits the use of 0.02% warfarin on wheat to control grey squirrels in specified areas of England, Wales and Scotland where red squirrels are locally absent (consult the Forestry Commission for details). The technique is designed to achieve short-term targeted removal of squirrels in and around damage vulnerable tree crops during the damage season. Woodlands will be recolonised by grey squirrels within three months. An index is being tested to help forest managers judge the risk of squirrel damage each year to guide control decisions. A grey squirrel immunocontraceptive is being developed but this new technology, if successful, will take at least five years to come to fruition.

Multi-capture trap in use in a young beech plantation.

Live trapping

Multi-capture cage traps are the preferred type for woodland protection as they hold more than one squirrel. Trapping operations should be targeted in the same way as poisoning operations. It is a legal requirement of all live-capture traps that, once set, they must be visited daily.

Kill trapping

Spring traps cannot be made completely specific to grey squirrels and should not be used where there is a risk of trapping other animals, including red squirrels. The Protection of Animals Act 1911 requires that spring traps be set in tunnels and visited at least daily. This method is inhumane and unselective; it is not recommended for grey squirrel control.

Rabbit control

Gassing[34, 35]

The fumigation of burrow systems with either sodium cyanide or aluminium phosphide is the most effective method of rabbit control. However it requires trained personnel and stringent safety precautions.

Trapping/snaring[34]

Cage traps baited with carrots and box traps set in fence lines can be useful in rabbit control. It is a legal requirement of all live-capture traps that, once set, they must be visited daily.

Snaring is not recommended unless other methods have been unsuccessful. The Wildlife and Countryside Act 1981 prohibits the use of self-locking snares and requires snares to be visited at least daily.

Owners or occupiers of land may be legally obliged to carry out rabbit control at any time of the year under the Pests Act 1954, the Agricultural Act 1947 and the Agricultural (Scotland) Act 1948[21].

Table 2 Summary of options for tree protection

	Barriers				Control		
	Tree guards	Fencing	Electric fencing	Chemical repellents	Shooting	Gassing/ poisoning	Trapping/ snaring
Field vole	✓	✗	✗	?	✗	✗	✗
Bank vole	✗	✗	✗	✗	✗	✗	✗
Grey squirrel	✗	✗	✗	?	✗	✓	✓
Rabbit	✓	✓	✗	?	?	✓	?
Hare	✓	✓	✗	?	?	✗	✗
Deer	✓	✓	?	?	✓	✗	✗
Sheep & goats	?	✓	✓	✗	✗	✗	✗
Cattle & horses	✗	✓	✓	✗	✗	✗	✗

✓ primary option
? not to be relied upon; may offer temporary or partial protection
✗ either not viable or illegal

Table 3 Assessment of Protection Methods

Method	Advantages	Disadvantages
Tree guards	Cost effective for small areas; can protect trees from herbicide damage; can make trees easier to locate; do not present a barrier to public access; do not prevent positive herbivore impacts on ground vegetation. In addition, treeshelters can provide an early boost to growth.	Do not protect other elements of the woodland ecosystem; are costly for large areas; require regular inspection, maintenance and often eventual removal; are generally not reusable; taller guards can be unstable and cause damage to trees in windy situations; can be unsightly and attract vandalism[10].
Fencing	Cost effective for large areas and high stocking densities; often less visually intrusive than individual tree protection; offers protection for natural regeneration and other woodland vegetation.	Expensive for small areas; reduces accessibility to woodland users; a breach can put whole planted area at risk; may prevent beneficial herbivore impacts. Some reduction of animal numbers may also be necessary when populations are high.
Electric fencing	Low capital cost; reusable.	Generally reliable for domestic stock only; dependent on intensive checking and maintenance; requires reliable power source and earthing; breach or loss of power renders the whole fence-line ineffective.
Chemical repellents	Useful emergency measure for immediate and over-winter protection of small areas.	Expensive for large areas and where repeat applications are necessary, current repellents offer limited duration of protection and do not protect growth occurring after treatment.
Deer - shooting	Limits deer damage whilst maintaining positive impacts; recognises deer as a part of forest biodiversity, as a recreational resource, as a tool for habitat management, and as a potential source of income.	Requires time, experience and long-term commitment to plan and implement; requires cooperation with neighbours if used in small woodlands; public safety considerations may limit potential to cull.
Grey squirrels - poisoning	The most effective method currently available, particularly in terms of labour requirement.	Use of a hazardous mammalian toxin in the environment.
Grey squirrels - multi-capture traps	Easy to site and set; may be used even where red squirrels are resident.	High capital cost and labour requirement.
Rabbits - gassing	The most effective method of rabbit control.	Extremely hazardous to operators if prescribed methods not fully observed; requires properly trained and equipped personnel[34, 35].
Rabbits - cage traps	Non-target species can be released unharmed; does not require access to burrow systems. Useful for removal of rabbits from within fenced areas	Unsuitable for removing substantial numbers of rabbits.
Rabbits - box traps	Can catch substantial numbers of rabbits; useful for removal of rabbits from within fenced areas and for maintaining good relations with neighbours.	High capital cost.

Table 4 Operational Notes

Mammal	Individual tree protection
Field voles[22] (populations fluctuate and so first signs of extensive damage should trigger protection)	**Tree guards** 200 mm tall split plastic tubes, buried at least 5 mm into the soil. As trees grow, tubes open out and are easily collected. Treeshelters will not protect against voles unless staked firmly and buried 5 mm into soil. Plastic guards with aeration holes are ineffective. **Chemical repellents** Paint or spray Aaprotect on stem to 300 mm.
Grey squirrels	**Chemical repellents** Paint or spray Aaprotect on stems to be protected.
Rabbits[34]	**Tree guards** 0.6 m treeshelters, split plastic tubes or plastic mesh guards (lateral growth may still be browsed); spiral guards. **Chemical repellents** Aaprotect applied to dormant trees from mid November[15].
Hares	**Tree guards** 0.75 m treeshelters or plastic mesh guards. **Chemical repellents** As above.
Deer	**Tree guards** 1.2 m for roe and muntjac. 1.8 m for red, sika and fallow. Piling brash on coppice stools as a browsing deterrent is largely ineffective and provides ideal cover for rabbits and muntjac. **Chemical repellents** As above.
Sheep and goats	**Tree guards** 1.8 m (with regular access, two tall stout stakes needed for most breeds). Not reliable for goats.
Cattle and horses	Individual tree protection not viable other than for specimen trees.

Fencing	Direct control
Vole guards may be required in fenced areas.	**No viable options. Use of poisons is illegal.** Good weed control will reduce the risk of damage.
	Poisoning Use 0.02% warfarin/wheat bait presented in hoppers of specified dimension[23] for tree protection between 15 March to 15 August in permitted areas[20,24]. **Live Trapping** Multi-capture traps are the preferred trap for woodland tree protection. A four day pre-bait period is required before traps are set. Set traps must be visited daily[25]. **Control more effective when coordinated by a local Squirrel Management Group.**
Fencing 0.9 m; 18 gauge X 31 mm hexagonal mesh[11, 27] with bottom of netting turned out 150 mm towards the rabbits and turved.	**Shooting** Labour intensive and rarely effective. **Gassing** Hydrogen cyanide (Cymag) or phosphine gas[28] (Phostoxin or Talunex) is used from November to March to fumigate burrow systems; extremely hazardous to operators; requires properly trained and equipped personnel[34, 35]. **Live Trapping** Box traps along fence-lines for large numbers, cage traps for small numbers. Traps must be visited daily[25].
Fencing 1.0 m. Use rabbit netting with a line wire 100 mm above netting.	**Shooting** Can be effective where damage is due to few individuals.
Fencing[11, 36] 1.8 m red, sika, fallow; 1.5 m roe, muntjac. Evidence suggests that well made dead hedges can protect coppice regrowth from fallow for up to 18 months if deer are at low densities and have alternative browse. However, highly labour intensive and ineffective against roe and muntjac. **Electric fencing[29, 30]** Roe are not deterred by shocks given by currently available energisers. In recent (unpublished) trials, electric fences have provided an effective barrier against fallow but not against muntjac.	**Shooting** Set cull levels according to current population estimates, estimate of population growth and target density to ameliorate negative impacts. Optimal strategy may involve shooting and selective use of other deterrents for particularly vulnerable trees. **Control most effective when coordinated by a local Deer Management Group.**
Fencing[31, 36] 1.5 m (goats) or 1.0 m (sheep) agricultural stock fence. **Electric fencing** To recognised specification[32].	
A buffer zone is needed between fence and trees. **Fencing** Agricultural stock fence (without barbed wire for horses). **Electric fencing** To recognised specification[32].	

COST-EFFICIENCY OF PROTECTION

Tree protection is often the most expensive operation of the establishment phase. The cost of a deer culling strategy has to be considered in relation to the whole land holding, and over a long time period. In the absence of such a strategy the choice of protection method must generally be made between fencing and individual tree protection, the decision depending on:

- the cost of individual protection (/tree) and the cost of fencing (/m);
- the size of the area to be planted;
- the shape of the area to be planted;
- planting density.

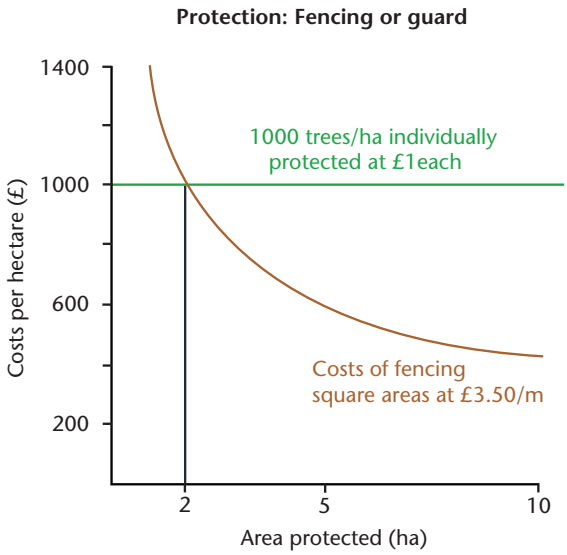


Figure 1 Comparative costs of protection with individual guards and fencing (roe deer only).

Table 5 Example calculation for cost-effective tree protection

Animal pests	Site 1 - roe deer and rabbits	Site 2 - rabbits
The planting site		
Shape	Rectangular	Triangular
Dimension	100 x 60 m	200 x 400 x 450 m
Area	0.6 ha	4 ha
Number of plants	1200 (2000/ha)	12000 (3000/ha)
Fencing		
Fence length	320 m	1050 m
Fence cost (/m)	£4.10 (for deer fencing)	£3.30 (for rabbit fencing)
Total fencing cost	**£1312**	**£3465**
Individual tree protection		
Cost of treeshelter	£1.00 (for 1.2 m shelters)	£0.70 (for 0.6 m shelters)
Total treeshelter cost	**£1200**	**£8400**
Most economical protection	**Treeshelters**	**Fencing**

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