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Natural Regeneration in Broadleaved Woodlands: Deer Browsing and the Establishment of Advance Regeneration

INFORMATION NOTE

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SUMMARY

The extent of browsing damage to seedling trees depends on a variety of factors including deer numbers and species, the abundance and species of tree seedlings, and the availability of alternative browse. Observations at a variety of sites suggest that although more than 25% of seedlings present are browsed each year, established advance regeneration growing beneath an overstorey canopy may survive several years of severe summer browsing. The presence of advance regeneration is the most reliable indicator that natural regeneration will succeed. Where there are too few seedlings of sufficient size, management to improve their number and growth should be undertaken. Broadleaved tree seedlings of many species are unlikely to establish without protection unless deer numbers are controlled.

INTRODUCTION

1. Natural regeneration is the process by which trees and woodlands are established from seeds produced and germinated *in situ*. It usually relates to the restocking of existing woodland but also includes the natural colonisation of previously unwooded sites. In some circumstances natural regeneration may be more desirable than planting as, for example, it can conserve local genotypes and also create more structural diversity within the site. During the past decade it has become a more acceptable method of establishment and under current guidelines it is the preferred method for restocking semi-natural woodlands.

2. The procedure currently attracts grant aid under the Woodland Grant Scheme (Forestry Commission, 1998) and in the 5-year period 1994–98 about 7500 ha received payment for use of natural regeneration for restocking (Table 1): the majority of this was in Scotland where site conditions are generally more favourable (Harmer and Kerr, 1995). Areas for conifers were less than broadleaves; in Scotland the broadleaved area includes areas of native pinewoods.

3. Historically natural regeneration has been less important in Britain than on mainland Europe where well defined silvicultural systems which use the process have been developed (Matthews, 1990). Although these methods have occasionally been used in Britain (e.g. Everard 1987; Pakenham, 1996) few British foresters have extensive practical experience of natural regeneration. However, interest in continuous cover forestry and the use of uneven-aged silvicultural systems based on natural regeneration is increasing. Whilst these systems are thought to be more natural and have positive environmental benefits they are generally more difficult to manage than clearfelling followed by planting. Current best advice on using natural regeneration is given in Harmer and Kerr (1995).

Table 1

Areas (ha) with approved management plans for restocking by natural regeneration that received payment under the Woodland Grant Scheme in the 5-year period 1994–98.

	Broadleaves	Conifers
England	792	122
Scotland	3639	2617
Wales	368	130

Data from the Forestry Commission Woodland Grant Scheme Database

4. Seedlings which are present before harvesting of the mature trees are known as advance regeneration. Extensive studies in the Allegheny hardwood forests in the USA have shown that the size and amount of advance regeneration are important factors that determine whether restocking will be successful (Kerr and Nowak, 1997). However, in many British woodlands being managed for natural regeneration there may be too few seedlings growing and those that are present too small (Harmer, Kerr and Boswell 1997).

5. Little is known about the development of advance regeneration but its growth is probably restricted by competition from canopy trees and other components of the woodland flora. In addition, seedlings may suffer from fungal or other diseases, invertebrate herbivory, and browsing or other damage from mammals. This Note examines the effect that browsing by deer may have on the growth of advance regeneration in broadleaved woodlands.

AMOUNT OF BROWSING DAMAGE

6. Although it is possible to identify which species of deer are present within an area and to make some estimate of their numbers, it is difficult to predict with any accuracy how much damage will be done by different species of deer within different woodlands.

7. Deer are selective browsers whose diet varies with season and in general most damage to seedlings occurs during spring and early summer when newly flushed shoots of broadleaves are young and most palatable. Red deer will also feed on broadleaved shoots in winter. There are significant differences in diet between deer species which could influence their impact on vegetation. Red, sika and fallow deer are partly grazers, with grasses comprising 30–70% of their diet, whereas roe and muntjac typically eat shrubs, trees and forbs, with less than 20% of their diet composed of grasses. Muntjac feed on coniferous trees to a lesser extent than other deer species resulting in a potentially greater relative pressure on broadleaves.

8. Results from a survey of 78 natural regeneration sites in the south of England showed that over all species at all sites, 30% of all tree seedlings showed some evidence of browsing damage (Harmer, Kerr and Boswell, 1997). There was large variation between species and sites: willow and rowan were browsed the most with about 50% of seedlings damaged, whereas only 20–30% of seedlings of ash, beech, birch, oak and sycamore were browsed. Although palatability of tree species to deer varies, for example alder and birch are generally thought to be less palatable than oak and ash, the basis for the differences are not well understood and it is not possible to rank tree species precisely in order of susceptibility to browsing damage.

9. For broadleaves the most damaging effects of browsing occur during the growing season. Observations of seedlings more than one-year-old, that were carried out during summer at six sites over three consecutive years, suggest that in general more than 25% of seedlings of the most common species were browsed during each growing season (Table 2). However, the percentage of seedlings browsed varied between years.

10. The amount of browsing at any one site will depend on deer species and numbers, the local abundance of seedlings, their palatability, and the availability of alternative food sources. Consequently the density below which deer populations need to be maintained to allow successful regeneration will vary substantially between sites. In the uplands, a number of studies indicate that deer population densities of <4–7 km^{-2} allow successful regeneration of birch and Scots pine. There are fewer data from lowland habitats, but regeneration can occasionally be achieved at densities as high as 15–25 km^{-2}. However, in the absence of control, deer populations in southern England can easily rise to between 30 and 100 km^{-2}, and effective deer control is essential for successful regeneration of sensitive species.

11. The potential for damage to seedlings will vary both between and within woodlands. Small woods (<5 ha) which are isolated from other woodland by farm or urban land, or which experience regular disturbance from visitors or traffic, are less likely to have resident deer and therefore often suffer less damage than sites in or close to larger woods. Where deer make use of fields for feeding then damage within the woodland is potentially lower for any given population size.

Table 2

Percentage of seedlings more than one-year-old with some evidence of spring or summer browsing damage

Site	Predominant species of seedlings	Year 1996	1997	1998
Herriard	Ash, elder, field maple	*	25	37
Norton Wood	Ash	33	37	37
Stansted 1†	Oak, birch	22	16	36
Stansted 2	Ash, oak, birch	37	34	32
Vernditch	Ash, beech, sycamore	33	4	23
Wyre Forest	Oak, birch	26	24	40

* No seedlings more than one-year-old on site

† Two areas at this location

Edges between thicket or mature stands and more open areas, such as felling coupes, rides or fields are particularly attractive to deer because they provide a combination of food and concealment. Roe and muntjac deer usually remain closer to such edges than fallow or red, which move further out when grazing in fields. Small felling coupes, as recommended in current management guidelines (Forestry Commission, 1994), will increase the edge:area ratio and damage will increase unless appropriate control or protection measures are taken.

EFFECTS OF BROWSING ON GROWTH

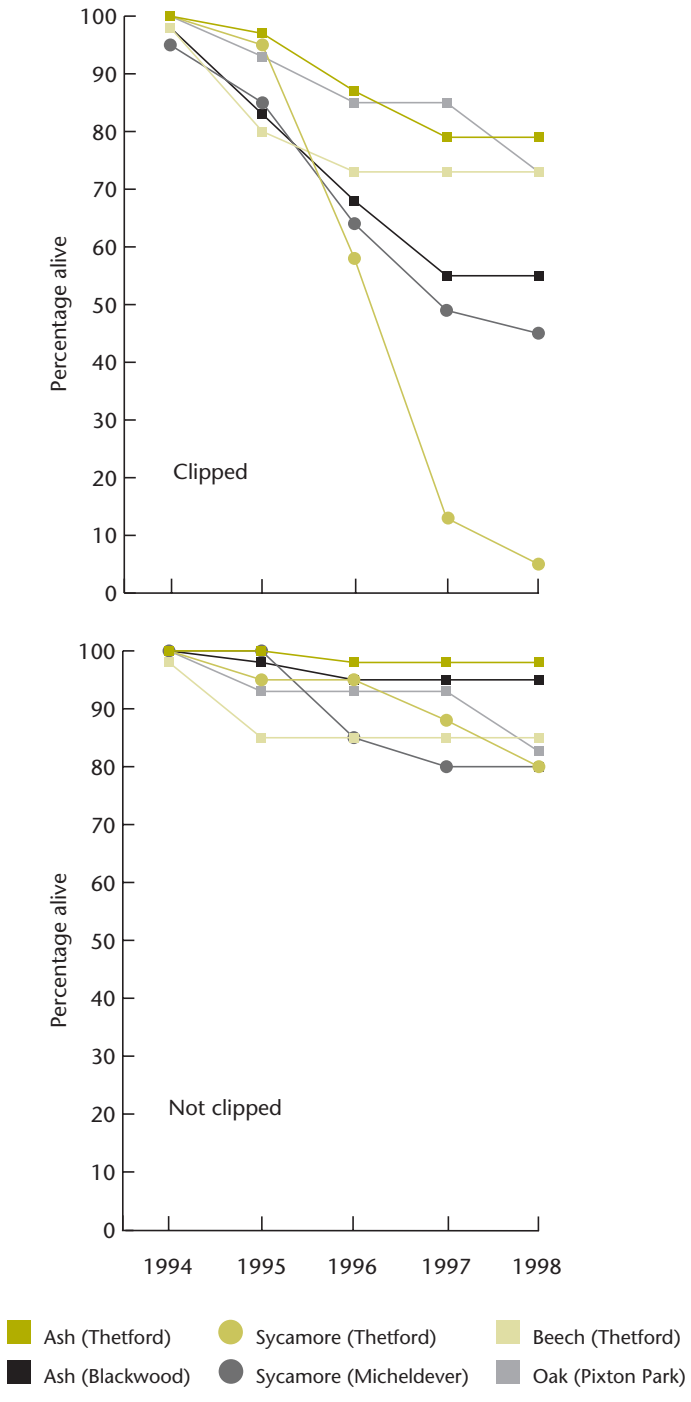
12. The amount and type of damage inflicted on any seedling is very variable and its effects are difficult to quantify. The vulnerability of a seedling to damage depends on the deer species and vegetation structure. Muntjac deer browse very close to ground level, whereas red and roe deer focus most feeding on vegetation between 30–60 cm in height. Although the woodland groundflora will provide some protection to seedlings, their leading shoots become vulnerable when they emerge above the height of the surrounding vegetation. Brash has a similar protective effect. Browsing of small advance regeneration is unlikely to have long term effects on tree form if the trees are subsequently protected and allowed to grow.

13. Plants can often survive browsing for many years when they grow in full sunlight, but the effect of browsing on seedlings in shaded environments beneath a tree canopy where there is competition for moisture is little understood. For the past five years experiments at four woodland sites have investigated the influence of simulated browsing on the growth and survival of advance regeneration of several broadleaved species. The sites had canopy covers which varied between 50–100% and although the type and amount of vegetation in the ground flora varied, bramble was not abundant anywhere. In January 1994 naturally occurring seedlings of ash, beech, oak and sycamore about 30 cm tall were protected from browsing animals, and in June and August of each subsequent growing season all new growth longer than 1 cm was clipped from half of the plants. There were 80 seedlings of each species at each site, but not all species were present at each site.

14. Height and stem diameter growth varied with site and species. The shoots of clipped plants often died back and they had stem diameter increments that were negligible. During the 5 years of the experiment only 5–20% of the unclipped controls died (Figure 1). Simulated browsing increased mortality, most notably for sycamore. These results suggest that, with the possible exception of sycamore, established advance regeneration more than 30 cm tall may survive 5 years of severe browsing on sites where bramble growth is sparse.

Figure 1

Percentage survival of seedlings of each species that were either clipped or unclipped during the 5-year experimental period.



PROTECTION

15. Unless deer populations can be maintained at sufficiently low levels to allow the development of advance regeneration, then some form of protection will be needed. However, the growth and population dynamics of young seedling trees are poorly defined and it is unclear how many growing seasons are necessary to establish sufficient advance regeneration on any site. Observations in fenced exclosures suggest about 4 years but this will depend on tree species, site and management; for example ash seedlings on a favourable site will establish more quickly than beech on a poor site.

16. If small established seedlings are present then they can be given suitable individual protection such as mesh guards or shelters but it may be necessary to fence larger areas if seedlings are few in number. Recommendations for suitable types of fencing for protecting small regeneration coupes can be found in Pepper (1999).

17. Protection alone does not necessarily create the conditions necessary for the establishment of advance regeneration as prevention of browsing will often release a competitive ground flora which can prevent establishment and smother any existing seedlings. Weed control may be necessary on sites where growth of competitive weeds such as bramble is vigorous.

PROMOTING THE GROWTH OF ADVANCE REGENERATION

18. As the presence of advance regeneration is the most reliable indicator that natural regeneration will succeed, fellings should only occur if advance regeneration is present. It should aim to release existing seedlings rather than provide a canopy gap in which it is hoped that new seedlings will develop.

19. Species with shade tolerant seedlings such as ash, sycamore and beech will establish more readily beneath a canopy than light demanders such as oak and birch which will only grow well if the canopy density is low. Sites with trees which fruit frequently such as ash and sycamore have the potential to form advance regeneration more regularly than those with masting species such as oak and beech.

20. Where advance regeneration is absent or too small it may be necessary to stimulate the growth of seedlings by carrying out preliminary work such as thinning to provide more light, and weed control to reduce competition from the ground flora. Although scarification can be appropriate it should not be used indiscriminately, especially on those sites where competitive weeds could flourish (Harmer and Kerr, 1995).

21. As many woodlands suffer from excessive browsing, tree seedlings are unlikely to establish without protection unless deer numbers are controlled.

22. Much of the advance regeneration present in woodlands is browsed, and although the effects of damage are likely to be species specific, evidence suggests that established advance regeneration more than 30 cm tall can survive severe browsing for several years on sites with little bramble.

23. The size requirements necessary to maximise the probability of seedling survival following regeneration felling will vary with species and site. Evidence from current experiments and other sources (see Kerr and Nowak, 1997) suggests that newly germinated seedlings and others less than 5 cm tall are unlikely to survive: success is most probable from established seedlings 15 cm or more in height.

24. Although advance regeneration provides the best route to successful natural regeneration, the number of seedlings required is currently unknown. It will vary with site depending on features such as rate of seedling growth, weed competition and deer densities. Slow growing species, on sites with uncontrolled growth of competitive weeds and high levels of deer browsing, will need more than fast growing species on a site with few weeds and little browsing pressure. The number of established seedlings necessary for success will probably be in the range of 10 000–100 000 ha^{-1}.

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REFERENCES

EVERARD, J. (1987).
Natural regeneration of oak. In, *National Hardwoods Programme, Report of 7th Meeting*, P.S. Savill (ed.)
Oxford Forestry Institute Occasional Paper 34, 23–28.

FORESTRY COMMISSION (1994).
The management of ancient semi-natural woodlands.
Forestry Practice Guides 1-8.
Forestry Commission, Edinburgh.

FORESTRY COMMISSION (1998).
Woodland grant scheme.
Forestry Commission, Edinburgh.

HARMER, R. AND KERR, G. (1995).
Natural regeneration of broadleaved trees.
Research Information Note 275.
Forestry Commission, Edinburgh.

HARMER, R., KERR, G. AND BOSWELL, R. (1997).
Characteristics of lowland broadleaved woodland being restocked by natural regeneration.
Forestry **70**, 199–210.

KERR, G. AND NOWAK, C. (1997).
Regeneration of Allegheny hardwoods: Lessons for silviculture in Britain.
Quarterly Journal of Forestry **91**, 125–134.

MATTHEWS, J. D. (1990).
Silvicultural systems.
Oxford University Press, Oxford. 284 pp.

PAKENHAM, R. (1996).
Natural regeneration of beech in the Chilterns.
Quarterly Journal of Forestry **90**, 143–149.

PEPPER, H. W. (1999).
Recommendations for fallow, roe and muntjac deer fencing: new proposals for temporary and reusable fencing.
Forestry Commission Practice Note 9.
Forestry Commission, Edinburgh.

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