Forestry Commission
231 Corstorphine Road
Edinburgh
EH12 7AT
http://www.forestry.gov.uk

The Impact of Deer on Woodland Biodiversity

INFORMATION NOTE

BY ROBIN GILL OF FOREST RESEARCH

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SUMMARY

Deer can have an adverse impact on woodland vegetation and simplify vertical structure by selectively browsing on herbs, shrubs and young trees. Vegetation changes brought about by deer browsing are also detrimental to some vertebrate and invertebrate woodland fauna. Without appropriate management, deer populations will impose long-term changes on the composition of native woodlands. Available data suggest that densities of deer in upland habitats should be in the region of 4–7 per km^2 to ensure adequate regeneration and to protect sensitive flora and fauna. Further data are needed for lowland habitats. Recommendations for establishing effective deer management and tree protection measures are given.

INTRODUCTION

1. Deer can have a substantial impact on woodland vegetation, and play a significant role in woodland ecosystem function. In the absence of control, deer populations can rise to very high densities due to lack of predators and to the regular provision of ideal habitats through felling and planting in woodlands. Management of deer populations is necessary to limit their impact, particularly in ancient semi-natural woodlands.

2. There have been no field studies to assess the effect of deer on the biodiversity of woodland ecosystems. However, important insights can be obtained by combining information on the impact of deer on vegetation with an understanding of the habitat needs of various woodland taxa.

DEER FEEDING AND IMPACTS ON VEGETATION

3. The effect of deer on woodland vegetation reflects the diet of deer as well as the ability of the plants to withstand damage. In general, deer either eliminate or retard the growth of young trees, shrubs and herbs, allowing grasses and a few unpalatable species such as bracken (*Pteridium aquilinum*) and rushes (*Juncus* spp.) to increase[1,2].

4. Shrubs and herbs constitute much of the species richness of the ground flora, and the loss or reduction of these species may reduce the diversity of woodland vegetation. A number of rare or nationally important flowering plants are also now known to be susceptible to deer. Bluebells (*Hyacynthoides non-scripta*) and dog's mercury (*Mercurialis perennis*) can be depleted by muntjac browsing[3,4] and oxlips (*Primula elatior*) by red deer[5]. Muntjac also feed on early purple orchids (*Orchis mascula*), common spotted orchids (*Dactylorhiza fuchsii*), wood anemones (*Anemone nemorosa*) and ladies smock (*Cardamine pratensis*), and reduce pollination and reproductive success in lords and ladies (*Arum maculatum*)[3,4,6].

IMPACTS ON TREE REGENERATION AND WOODLAND COMPOSITION

5. High grazing pressure by deer suppresses regeneration, both by severely reducing seedling density and by delaying growth of the few remaining survivors[7,1,8]. Repeated browsing, particularly during the first year of re-growth, can also kill unprotected coppice stools[9]. Recent surveys have revealed that the extent of the loss can severely undermine the viability of these systems of woodland management[10].

6. Typically, tree species differ in susceptibility to deer. Provided browsing pressures are not high enough to eliminate all seedlings, deer will bring about a change in the species composition of surviving seedlings and saplings. The composition of woodland canopies may then be affected for several decades, or even centuries and this effect is perhaps the most pervasive impact of deer[2]. In Britain, oak, ash, hazel, rowan and willows are usually found to be the most vulnerable broadleaved

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species and most likely to be reduced or eliminated by browsing. Birch, alder and beech in contrast are usually found to be more resistant. Differences in selection amongst tree species also arise between areas, due to differences in the vegetation or diet between deer species. Aspen, for example, is usually avoided by fallow deer and alder is not normally susceptible to roe deer. Red deer, in contrast browse both of these species. In the uplands, Scots pine and birch are also vulnerable and severely depleted by deer browsing, in marked contrast to the lowlands, where regeneration (particularly of birch) can be achieved even at a relatively high deer population density.

7. Browsing on trees and shrubs also has an effect on the vegetation structure. Deer reduce the height of low growing shrubs, such as heather (*Calluna vulgaris*) and bilberry (*Vaccinium myrtillus*) as well as preventing taller species such as hazel (*Corylus avellana*), holly (*Ilex aquifolium*), dogwood (*Cornus* spp.), ivy (*Hedera helix*) and honeysuckle (*Lonicera periclymenum*) from reaching full stature. This effect tends to result in a woodland with a simplified vegetation structure, that possesses a ground layer and canopy but a poorly developed or absent middle layer.

IMPACT ON FAUNA

8. The majority of herbivorous insects feed almost entirely on one or a very limited number of plant species. As a result, their diversity is likely to be directly related to the richness of the plant community. In contrast, predators do not need to be so specific, but instead rely on strategies such as camouflage or stealth to obtain prey. The diversity of predators may therefore depend as much on vegetation structure as plant species composition.

9. Since deer browsing typically reduces both plant species richness as well as simplifying vegetation structure, invertebrate diversity is likely to be reduced by deer, if present at high density. A study comparing an area exposed to deer for 22 years with an adjacent deer-free enclosure in the New Forest revealed many more families of Coleoptera and Diptera in the area free of deer[1]. These are taxa which typically constitute a substantial proportion of insect species richness. Groups which were more abundant in the browsed area included staphylinids, some carabid beetles, ants and true spiders (Araneae). In Scotland, invertebrate populations have also been found to be higher in areas protected from browsing by red deer[12].
By reducing the height of key food plant species, deer appear to reduce the number of feeding and egg-laying sites for lepidoptera, thereby having a disproportionate effect on their populations. Many butterfly species that inhabit woodland have food plants that are known to be depleted by deer browsing, and therefore are potentially at risk[13,14]. Deer are also known to affect invertebrates indirectly, by changing habitat structure rather than simply depleting food plants. The creation of a browse line on yew trees, for example, has been found to reduce the area of key habitats for rare snails (*Vertigo angustior*) and fungi in Gait Burrows NNR.

10. Apart from changes in vegetation structure, changes in tree species composition are also likely to have a long-term effect on invertebrate fauna. Tree species differ considerably in the number of phytophagous insects known to be associated with each of them[15]. Oak and willows for example support a wider range of invertebrates than most other tree species but are amongst the most vulnerable to deer. The loss of these tree species as seedlings could therefore have long-term and far-reaching consequences for insect diversity.

11. Invertebrate groups that clearly *benefit* from deer include dung beetles, both external and internal parasites and species dependent on carrion. Three species of dung beetle (*Aphodius* spp.) with a limited range are known to occur in woodlands and use deer faecal pellets[16]. There are also 13 rare species of carrion feeding beetles (mostly sexton and rove beetles, *Nicriphorus* spp., *Silpha* spp. *Sphaerites* spp. *Aleochora* spp., *Omalium* spp.), that are known to occur in woodlands. Five of these species have red data book status[16,17]. With the decline in extensive grazing, especially in woodland habitats, both dung and carrion feeders are now likely to be very dependent on deer.

12. The majority of bird species using woodland are insectivorous or granivorous. Typically, there are species occupying a range of niches such as tits (*Parus* spp.; *Aegithalus caudatus*) and goldcrests (*Regulus* spp.) which forage in the canopy for invertebrates, finches and crossbills (Fringillidae) which depend heavily on seeds, treecreepers (*Certhia* spp.) and woodpeckers (*Dendrocopus* spp.) which forage for insects on tree trunks and various other species including warblers (*Sylvia* spp.), nightingale (*Luscinia megarynchos*), wren (*Troglodytes troglodytes*), robins (*Erithacus rubecula*) and blackbird (*Turdus merula*) which feed in the understorey or in thickets. The density and number of woodland bird species increases

with the number of tree species in the canopy as well as with stand maturity and structural diversity[18]. By reducing the tree species richness and the height of the shrub understorey, deer would be expected to reduce the suitability of the woodland for many bird species[19].

13. The reduction in vegetation cover brought about by grazing can be detrimental to small mammal populations. An area protected from grazing by fallow deer (*Dama dama*) supported good populations of woodmice (*Apodemus sylvaticus*) and bankvoles (*Clethrionomys glareolus*) as well as small numbers of shrews (*Sorex* spp.). and yellow-necked mice (*Apodemus flavicollis*) in contrast to a heavily grazed area which supported only a reduced number of woodmice[1]. Coppice woodland is a key habitat for dormice (*Muscardinus avellanarius*) and if efforts to maintain and protect coppice from deer are not kept up then their numbers may decline further.

THE RELATIONSHIP BETWEEN IMPACTS AND DEER POPULATION DENSITIES

14. Several studies in the uplands suggest that regeneration of Scots pine can occur where densities of red deer (*Cervus elaphus*) are in the region of 4–7/km^2 [23,24], but that regeneration is adversely affected by higher densities. Invertebrate populations appear to be adversely affected at similar densities[12]. On Exmoor, red deer densities need to be in the region of 5/km^2 to permit regeneration of oak in upland oakwoods[20].

15. In most lowland wooded environments, deer are smaller and the vegetation more productive, so that it is likely that unwanted impacts will generally occur at higher densities[22]. Regeneration of birch for example appears to be little affected by deer in the lowlands; and in France, oak regeneration was found to be little affected by roe deer at a density of as much as 25/km^2 [25].

16. In mixed broadleaved woodlands in the USA successful regeneration of black cherry (*Prunus serotina*), a relatively unpalatable species, can be achieved at densities of up to 15 deer/km^2 where alternative food is abundant, but at only between 2.5–7/km^2 where it is sparse[21]. Further, tree seedling diversity was found to be highest at intermediate density (3–7 deer/km^2) than at either zero or high deer density (10–17/km^2). The diversity of songbirds in these forests was found to be highest at deer densities of around 8/km^2 [28].

17. In the absence of control, deer populations in British woodlands typically achieve substantially higher densities than those at which unwanted impacts occur. Densities of between 25 and 40/km^2 are commonly encountered even where some culling is exercised, and densities of over 50 are known to occur [26,34].

CHARACTERISTICS OF THE IMPACT OF DEER IN DIFFERENT WOODLAND TYPES

Lowland broadleaved and mixed woodlands

18. Recent surveys have revealed poor and rather variable levels of regeneration in broadleaved woods with many seedlings failing to reach above 2m due to browsing and competition from weeds[10]. Regeneration is limited in part by the scarcity of mature mast-producing trees, however the pressure from deer makes the problems of poor seed supply and competition more acute.

19. Regeneration of coppice is also a widespread problem. The practice of cutting small coupes can create sites that are attractive to deer if they are not fenced. Coppice stools are particularly vulnerable to deer browsing in the first one or two years after cutting, and the cost of fencing may make management of the coppice uneconomic. Damage to ground flora has been reported in many ancient woodland sites, in some cases reducing the availability of food plant species for scarce lepidoptera.

Upland ash, oak, willow and juniper woodlands

20. These woodland types occur in fragmented patches and are typically exposed to heavy grazing by sheep as well as deer. Many upland ash and oak woodlands have been used for sheltering livestock and are also subjected to heavy (although sometimes ephemeral) use by deer in winter. Montane juniper and willow occurs at higher elevations and are more likely to be exposed to grazing in summer than winter. Upland oakwoods are important habitats for some bryophytes and insectivorous birds (notably spotted flycatchers *Muscicapa striata* and redstarts *Phoenicurus phoenicurus*) that depend on an open understorey. To maintain woodlands suitable for these species may pose a dilemma, because a reduction in grazing and browsing may involve detrimental habitat changes for these species.

21. The scarcity of all these woodland types is in part due to high grazing pressure by sheep and deer in the past 200 years. Habitat action plans are to increase the area of upland oak and ash woods by about 10% by 2005. All these woodlands include both tree and understorey species that are vulnerable to deer browsing (willow, oak, ash, birch, rowan, holly, hazel, ferns and bluebells). The diversity of ash woodland flora in particular has been found to be sensitive to grazing and browsing.

22. To achieve effective regeneration will require reduction of both deer and sheep to low densities. The only investigation relating deer densities to regeneration has been on Exmoor[20], which indicated red deer densities need to be approximately 5/km^2.

Native Scots pine

23. Regeneration in Caledonian pinewoods is notoriously sporadic, with failures in some sites proving hard to explain. However, deer have been identified as one of the key factors limiting regeneration at most sites. Results from a number of studies have indicated that densities should be between 4–7 deer/km^2 to permit regeneration[23,24].

24. Pine seedlings do not grow well under shade, but where sufficient light enters the canopy regeneration can then be limited by competition with heather. Where protection from deer can be achieved, regeneration of rowan is often more prolific than Scots pine, particularly under partial shade. Successful pine regeneration is only likely to be achieved if deer control is applied in conjunction with other measures, including a reduction in sheep grazing. The use of fire or cattle grazing may prove helpful in reducing competition from heather.

Wet woodland habitats

25. The majority of wet woodland types occur in small patches or intermingled with woodland on drier soil. There do not appear to be any studies of the effect of deer browsing in wet woodland habitats in Britain. However deer will readily take to water and feed on vegetation in pond and river margins. On the basis of known preferences, willow woodlands would be more vulnerable than alder if roe deer are the main species present. Where mixtures of tree species occur, deer would be expected to deflect succession towards alder or birch woodland at the expense of willow or ash.

Plantation forests

26. Deer have an impact on the rides, ride edges and other permanent openings in a woodland, and these sites form the focus of important conservation efforts in plantations. Ride and stand edges are used heavily by deer (particularly by roe and muntjac) and broadleaved trees and shrubs that have been planted along edges with the intention of diversifying forests are particularly vulnerable. Since fencing edges is impracticable, protection will be more effective by deer control or by using tree guards.

MANAGEMENT RECOMMENDATIONS

- A sustained reduction in population density can only be achieved by establishing a regime of deer control. Methods of assessing deer population size and performance are described elsewhere[26,27,35]. In view of the fact that deer can extend their ranges over several thousand hectares, control is best achieved through the co-ordinated efforts of a local deer management group. Support and advice for deer management groups is provided by the Deer Initiative in England and Wales, and through the Deer Commission in Scotland[29].

- A sufficient number and type of openings need to be created in woodlands to facilitate deer control[30]. This is particularly important where large areas of woodland provide thicket for cover.

- Fencing is recommended to protect small areas, particularly where protection is needed only for a temporary period (for example to regenerate coppice or to establish advance seedling regeneration), or where deer control is unlikely to be effective enough for the area[31,36].

- Treeshelters can provide effective protection for trees planted in small groups or where fencing is impracticable, such as along woodland edges or roadsides[32,36].

- In areas where it remains a priority to maintain open sub-canopy conditions then grazing with livestock is likely to be more effective than a high deer population. Provided appropriate stock fencing and livestock in nearby farms are available, then it may be possible to provide a grazing regime that can be targeted to the area in question [33].

CONCLUSIONS

27. The damage inflicted by deer on young trees and coppice regrowth clearly undermines efforts to establish and regenerate woodlands, some of which are key habitats for wildlife. However, the effects of deer go further than this. At the moderate to high densities, deer are likely to alter the structure and species composition of woodland vegetation as well as reduce the abundance of some rare flowering plants. These changes are also likely to be detrimental to many groups of both vertebrate and invertebrate fauna. In the absence of deer management, such densities are typical in woodlands.

28. Current evidence indicates that deer populations need to be in the range of 4–7/km^2 in the uplands to ensure adequate regeneration and maintain plant diversity. Diversity of young trees and shrubs is likely to be greatest with a low density of deer present than either none at all or too many. Resort to fencing will not achieve this and should not be seen as the sole solution to deer impact management. Reducing deer populations through co-ordinated deer management provides a means of keeping densities within the range that will enable woodlands to achieve their potential as wildlife habitats. Further work is required to tailor the density estimates to specific habitat types.

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Enquiries relating to this publication should be addressed to:

Dr Robin Gill
Forest Research
Alice Holt Lodge
Wrecclesham
Farnham
Surrey
GU10 4LH

Tel: 01420 22255
Fax: 01420 23653

E-mail: robin.gill@forestry.gsi.gov.uk

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