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# Deer management on National Nature Reserves

## Problems and practices

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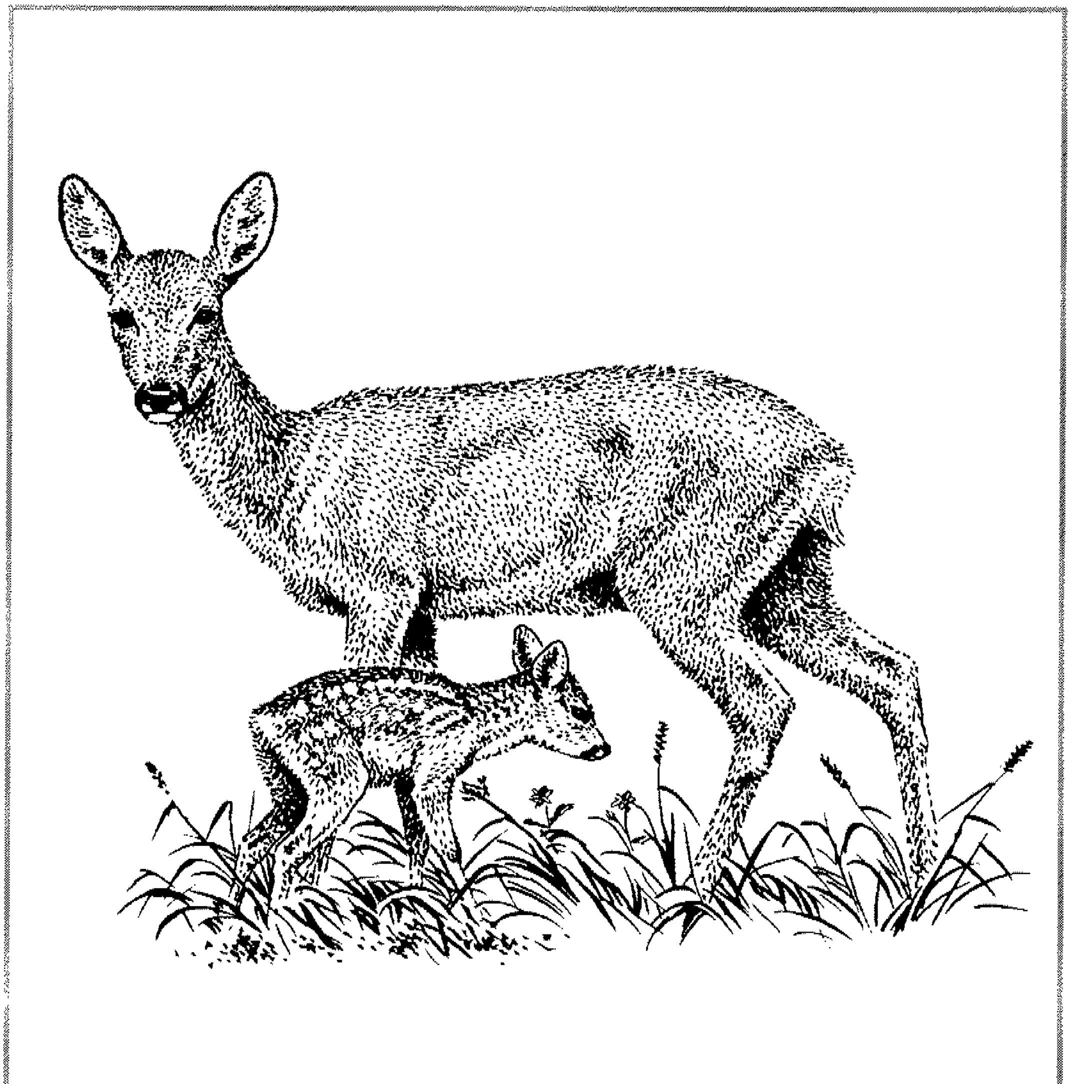

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Number 173

# Deer management on National Nature Reserves: problems and practices

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# Preface

Populations of a number of species of deer are increasing throughout much of England both in numbers and in geographic distribution. In the wake of this expansion, increasing numbers of reports are received of damage to agriculture/ horticulture and forestry, as well as damage to sensitive vegetation in conservation areas. In recognition of the increasing problem posed by deer grazing in conservation management - or at least increased perception of problems with deer, English Nature has determined to develop a policy towards deer and their management, particularly with respect to their statutory remit to manage National Nature Reserves (NNRs). To further this objective the present contract was issued to gain an up to date picture of the current status and distribution of deer on NNRs under English Nature's stewardship, to offer a more objective assessment of the ecological impact of deer when present and to review current management practices employed to manage both deer populations and their impact. This report will evaluate perceived and actual impacts of deer browsing in conservational areas - specifically in relation to National Nature Reserves managed by English Nature - and consider management: both current practices and options for the future.

Specific objectives of the contract were defined as:

1. Determine the current status of deer on NNRs in England - to include data on species present, numbers and population history.

2. Determine the perceived impact, or potential impact of deer on NNRs through their effects on habitats of conservation significance.

3. Determine current management practices on NNRs.

4. Make recommendations on ways in which deer management on NNRs might be improved.

Data on the general distribution of deer across NNRs (species present, estimated numbers and patterns of use of the reserve) were derived from responses made to a questionnaire survey, distributed to site managers of all NNRs, (Appendix 1). Managers were also invited to comment on the extent of damage caused by deer presence within a site and whether or not this adversely affected their ability to meet the management objectives of the site. As part of the complete ecological community within any reserve however, deer presence may not necessarily be regarded purely negatively - even despite any potential or actual impact - and managers were also invited to comment on the perceptions of themselves and of visitors to the site as to the importance or value of deer presence within the site to the reserve as a whole or visitor enjoyment. Finally, managers were asked to detail management measures (if any) currently employed in control of deer numbers or impact within the site and to comment on cost and effectiveness of such control effort. Questionnaires were distributed to 162 sites, with a total of 155 returns received.

More detailed evaluation of the impact of deer on specific sites, management measures employed and the effectiveness of different management techniques adopted by different site managers was undertaken during a series of site visits through October and November 1995 to a number of selected reserves. The range of sites selected was chosen on a number of criteria: to offer representation over a wide geographic spread within England and also offer example of sites 'troubled' with different species of deer (red, roe, fallow, muntjac, Chinese Water deer); to offer a range of sites experiencing problems with different types of damage (damage to ground flora, problems of natural regeneration, and problems of coppice damage) Finally the site managers of many of the particular sites chosen have been experimenting with very different forms of management techniques -some of them really very novel - and thus they offer in themselves a most interesting overview of the range of management approaches adopted in different NNRs.

Site visits were made, and discussions about deer, their impact and their management, to:

Bradfield Woods (Suffolk), Castor Hanglands, Chaddesley Wood, Collyweston Great Wood and Easton Hornocks, Cotswolds Commons and Beechwoods, Downton Gorge, Dunkery and Horner Wood (Exmoor), Gait Barrows (Lancashire), Hales Wood and Shadwell Wood (Essex), Highbury Wood (Gloucestershire), Monk's Wood, Park Wood (Cumbria), Woodwalton Fen, the Wyre Forest and Yarner Wood.

On the basis both of an analysis of questionnaire returns and information gained from site visits - within the context of the author's own previous experience of the impact of deer and options for management, this report present a review of i) the distribution and status of deer on NNRs; ii) an overview of the impact of deer grazing and browsing on conservation communities in general as introduction to a specific examination of problems experienced in NNRs under English Nature's management; iii) a summary of all available methods for management of deer or their impact (culling, physical or chemical forms of protection of sensitive areas/species, behavioural manipulation) with an exploration of the advantages, disadvantages and actual effectiveness of each; iv) a review of management practices currently adopted on NNRs; v) recommendations for management for the future.

Findings from the current survey (questionnaire and site visits) are integrated within the context of a more extensive evaluation of the impact of deer and options for management based on wider review.

# 1. Introduction

Largely, it would appear, in response to recent changes in habitat structure (with an increase in agricultural set-aside and a marked expansion in the area now planted to broad-leaved woodland), populations of a number of species of deer in England are increasing both in numbers and in geographic distribution. In the wake of this expansion, increasing numbers of reports are received of damage to agriculture/ horticulture and forestry, as well as damage to sensitive vegetation in conservation areas. This report will evaluate perceived and actual impacts of deer browsing in conservation areas - specifically in relation to National Nature Reserves managed by English Nature - and consider management options.

Six species of deer are currently found in the wild state in Britain; all of these species occur in England. Deer of one species or another occur in most 10km squares of lowland Britain, but within the context of the present review the six species may be considered in four distinct groups: i) species of rather restricted distribution and abundance in the lowlands (sika deer *Cervus nippon* and Chinese water deer *Hydropotes inermis*); ii) those of restricted distribution but of local significance (red deer *Cervus elaphus*); iii) species expanding in abundance within their existing range but not showing significant expansion of geographical distribution (fallow deer *Dama dama*); iv) species expanding both in distribution and abundance (roe *Capreolus capreolus* and muntjac deer *Muntiacus reevesi*).

Current [and recent past] geographic distribution patterns of the different species are relatively well established - at least on a simple presence/absence basis - and such distribution maps are readily accessible (eg Corbet and Harris 1991; Arnold 1993; Trout *et al* 1994). Estimates of actual population densities in the different areas or for the size of particular species populations over the country as a whole are far more difficult to assess but best estimates for actual population sizes for the different species have been presented by Harris *et al* (1995), Trout *et al* (1994) and Putman (1995a); the latter review also offers projections of likely future changes in numbers and distribution of the six species within England over the next few years (Putman 1995a).

In practice, populations of red deer, sika and Chinese water deer in England and Wales remain essentially local - potentially causing problems within those local areas if population levels rise significantly, but unlikely in the near future to pose problems outside their current range. Species for which changes in abundance and distribution are more likely to be of broader significance are roe, fallow and muntjac. All species are generally perceived to be increasing in numbers and range; increased damage may be anticipated within their existing distribution and in addition problems may be encountered in the near future in areas hitherto trouble-free as the range of these species expands.

A recent survey by the British Deer Society of its stalking members concluded that fallow deer have indeed been increasing in numbers within existing range in recent years; reports from local conservation organisations in Essex, Suffolk and elsewhere in East Anglia also point to a substantial increase in numbers in this area. We should note however, that despite this potential increase in population number, *range* expansion seems remarkably slow, with most fallow deer populations still noticeably concentrated around locations of the former deer parks from which the wild populations became established (Harris *et al* 1995). It is difficult to assess to what extent roe deer numbers may be changing within their existing distribution; available habitat appears largely to be saturated to capacity through much of their range with the territorial nature of this species preventing further increase in effective density. Roe are however perceived to be expanding their geographical distribution. While roe are largely absent from Wales and no change in distribution westwards is detected at present, the 'gap' in distribution apparent in the central parts of England is clearly being gradually filled from both directions. Rates of spread are hard to assess but appear to be of the order of 15-20 km per decade.

Likely changes in number and distribution of muntjac are perhaps hardest of all to assess - for these are very secretive and elusive little deer whose presence is often not detected until years after they have colonised an area - and then only after they have built up very substantial populations. Current disjunct distribution patterns seem strongly dependent on deliberate translocation and establishment by human agency (Chapman *et al* 1994); however numbers are clearly increasing and public perception inclines to the view that muntjac may soon become (if they are not already) the most abundant species in southern and eastern England.

Future numbers and geographical expansion of all species is strongly dependent on patterns of land use and future changes in deer management. The projections of increase above are based essentially upon present-day patterns of land use and control. In any particular area, population size and densities depend on habitat type and quality; major changes in land-usage over the next decade could accelerate or reverse the trends identified. In particular, the major land-use developments in agriculture: 'set aside', the planting of farm woodlands, ESAs and new crops are currently changing the mosaic of habitats and foodstuffs available to deer. Farm woodlands in particular, by creating more refuges for deer may serve both to increase densities in local areas within the geographic range and also to provide 'colonisation' corridors to new areas.

Against such a context of expanding numbers and distribution of deer within England therefore it is timely to consider in more detail their potential impact in conservation areas and the potential for management.

# 2. Deer damage in conservation areas

## 2.1 Grazing and browsing as a natural ecological process

Grazing and browsing from wild ungulates have always played a role in determining the structure and dynamics of natural ecological systems both in terms of their immediate, present-day influence on the ecological functioning of those communities and as a powerful selection pressure in the original development of such systems. Indeed the growth form, life-history dynamics, even the very physiological operation of many plant species have developed as they are, in response to the evolutionary selection pressures imposed by large herbivores.

Yet in most natural temperate systems, the actual density of large herbivores is relatively low (even without the historical intervention of man in elimination of many of the larger species or attempted regulation of the population size of others). Density-dependent mechanisms and social factors restrict the density to levels at which, while their impact as selective forces on individual plants may still remain, their impact on the immediate dynamics, species composition, species dominance of whole communities is less obvious. Herbivores in general remove <10% of the above ground primary production from any natural community (more commonly nearer 5%) and large herbivores on their own - as distinct from smaller rodent or invertebrate herbivores - generally consume far less than this. Where populations do reach sufficient density however, they may indeed have a marked impact on their vegetational environment. This increased impact of grazing and browsing may have serious implications for management, which will be considered below. Before embarking on this assessment of negative impact however, it is perhaps worth noting by way of introduction that we should be cautious of over-reaction. Damage caused by grazers or browsers, whether to commercial or conservational interests merely represents the extreme expression of a whole suite of general changes, subtle deflections in the structure and dynamics of natural woodland in response to herbivory. We consider it 'damage' when the consequences are extreme and/or conflict with human interests or management objectives, but in fact from the very outset the presence of herbivores has a number of profound effects on the whole structure and ecological functioning of those woodlands. Grazing and browsing by deer within conservation communities have many positive, facilitative effects, as well as a *potential* for causing damage - and reduction of population levels in response to perceived damage may itself result in even greater disturbance to the system in other ways.

A detailed review of the general effects of large herbivores upon the dynamics of natural ecosystems is presented by Putman (1986, 1995b); a brief summary of the main points, based on these earlier accounts, is offered below.

By feeding in one place and dunging in another large herbivores create discontinuities in nutrient flows through the system - and the fact that many of the system's nutrients are taken out of circulation for a period [retained in the body tissues of the herbivore itself until it dies] imposes further heterogeneity in nutrient availability. Herbivores may affect the productivity of the vegetation browsed: while heavy levels of grazing or browsing may suppress growth rates [by simply leaving the plant insufficient leaf area of photosynthetic tissue to operate at maximum efficiency] lighter levels of offtake commonly result in an actual increase in productivity, stimulating production of side shoots, unfurling of new leaves etc. All these changes in turn will result in pronounced changes in plant species composition and relative abundance at all levels; the importance of grazing in maintaining fine scale heterogeneity of structure and species composition in grassland or heathland communities has been ably demonstrated by Bakker *et al* (1983 a,b).

Grazing may also have a *direct* effect on species composition of a given system. It may lead to actual changes in species composition, with elimination from the community of species particularly sensitive to damage, or others particularly palatable to the grazers which thus incur a particularly high level of 'attack'. At the same time we commonly see an expansion in range and abundance of species which are very tolerant to defoliation, or have specific defences against attack: spines, thorns, or chemical defences rendering them less palatable.

And, as species composition of the community changes in response to the pressure of herbivory, grazing may also affect overall diversity within the system. By reducing the dominance of particularly vigorous or aggressive species, herbivores may reduce the effects of competition on other weaker competitors and thus enhance the overall species richness; through feeding, dunging or trampling they may also create gaps within closed swards for the establishment of ephemerals. By elimination of graze-sensitive species, heavy grazing can also act to reduce diversity: driving the community towards a species-poor assemblage of a few hardy and resistant species. In fact we may see that [actually as a general rule in ecological systems] maximum diversity is associated with intermediate levels of disturbance - neither so high as to cause destruction of the system or elimination of many of its species, yet not so low that its effects are unregistered (eg Connell 1978, Miller 1982, Putman 1994c).

Finally, grazing and browsing by deer populations also have a profound effect on the physical three-dimensional architecture of ecological communities. One of the most striking features of any woodland that has suffered heavy grazing over a protracted period - besides the lack of any significant regeneration- is the notable absence of a middle storey. Under years and years of heavy browsing, shrubby species of the understorey become stunted and 'hedged' - in the limit are completely eliminated, leaving little vegetation between the ground layer and a distinct browseline on the underside of the canopy trees themselves, where any foliage below the canopy within reach of a browsing herbivore will be removed.

Nor do the effects of grazing on the community stop at the level of the vegetation. The reduced field layer resulting from heavy grazing also reduces the abundance and diversity of invertebrates and small mammals dependent on the shrub and ground layers for food and cover (eg Hill 1985, Putman 1986) and thus may in turn reduce diversity of raptors or mammalian predators (eg. Tubbs 1974, 1982; Putman 1986, Putman *et al* 1989, Petty and Avery 1990). Some species however again derive positive advantage from such heavy grazing. Wood warblers *Phylloscopus sibilatrix*, pied flycatchers *Ficedula hypoleuca* and redstarts *Phoenicurus phoenicurus* all depend on the park-like conditions of traditional wood-pastures (Stowe 1987; Mitchell and Kirby 1990).

Responses to grazing of this kind - with changes in species composition and relative abundance of invertebrates, small mammals and birds - illustrate only too clearly that changes in grazing intensity in any ecological system will have implications far beyond the immediate consequences for the vegetation itself or upon direct competitors. These 'knock-on' effects have repercussions throughout the entire community: the effects of grazing may be seen to have consequential effects on the abundance and behaviour of higher order predators, not directly linked to the dominant herbivores, nor themselves directly affected by the changes in the vegetation, but influenced by changes in the abundance of prey or competitors resulting from the more immediate effects of grazing.

In considering the impact of grazing and browsing on the vegetation of conservation areas therefore, it is appropriate to note that such effects are not all entirely negative. It was after all the grazing first of the huge sheep flocks of the medieval graziers, subsequently by rabbits that permitted and maintained the superb diversity and richness of the chalk downlands of southern England. Their effects in reducing the rank growth of vigorous, tall-growing grasses and the resultant reduction in competition for light and space experienced by shorter more prostrate herbs, permitted the coexistence within the grazed sward of a huge diversity of species, prevented scrub encroachment, arrested the natural succession back to woodland. Much of the structure and character of some of the ancient woodlands we treasure today has also developed as a direct consequence of a long history of livestock grazing, which by altering patterns and rates of regeneration has profoundly altered the age-structure of the woodland trees, and has also significantly modified the species composition of the ground flora. And excessive reduction of that grazing pressure can lead to loss of diversity and scrub encroachment. Conservation bodies themselves recognise this and in many instances maintain a regime of controlled grazing specifically to sustain the management system under which the current diversity of many systems has developed and on which its continuance is entirely dependent.

## 2.2 Deleterious effects of grazing/browsing on conservation habitats

Grazing and browsing by herbivorous mammals have then a direct and important effect on the structure and entire ecological functioning of the woodland community; herbivory is in fact fundamental to determining the whole physical structure of the woodland and species composition of both plants and animals.

In certain situations however there may be a case for controlling the level of grazing: where impact has risen to such a level that it conflicts with other management objectives determined for a particular site.

Grasslands and lowland heaths rely on the maintenance of grazing to maintain their characteristic structure and diversity and it is considered unlikely that these habitats are at risk from increasing deer populations (and see below, page 13) - although there might be specific impact on certain plant species especially favoured for feeding. Woodlands are perhaps the communities most prone to damage from over-grazing (Putman 1994a). Heavy grazing pressure can result in dramatic changes in the composition and relative abundance of species of the woodland floor which may be of serious consequence if that flora itself contains rare or valuable species. Recent declines in oxlip *Primula elatior* populations in many conservation woodlands of East Anglia [as Hayley Wood in Cambridgeshire or Hales Wood, Essex] have been blamed -rightly or wrongly - on the coincidental rapid increases in range and number of fallow deer *Dama dama* throughout that region (Rackham 1975); Cooke *et al* (1995) have reported on declines in bluebell infloresences and dog's mercury in Monk's Wood NNR and other Cambridgeshire woodlands, as a result of heavy grazing pressure from muntjac deer *Muntiacus reevesi*.

Browsing may also, as noted above, have a damaging effect upon field and shrub layers, causing changes to woodland architecture and the microclimate offered to other species. In the extreme (as in the New Forest, or Naddle Wood) it may lead to complete elimination of the shrub layer leading to dramatic changes in three-dimensional structure of the woodland system, to direct loss of affected plant species (hazel, rose, blackthorn, hawthorn, bramble etc) and indirect losses of plant and animal species dependent for habitat or microclimatic conditions on this missing structural layer. Impacts at ground level - in browsing young seedlings of canopy trees, may also have a profound affect on woodland regeneration. Where losses of mature trees through browsing damage or simply old age are complemented by virtual lack of regeneration due to depletion of the seed source or heavy browsing pressure on new seedlings, browsing mammals start to exert a very significant impact. Currently a substantial proportion of Britain's semi-natural or ancient woodlands are suffering from lack of regeneration due to heavy grazing (Taylor 1978, Coed Cymru 1985, Mitchell and Kirby 1990). Recent trials by English Nature investigating the effects of sheep grazing in Naddle Wood in Cumbria, showed a clear decline in survival and growth of oak, birch and ash seedlings once tall enough to protrude above the grass canopy of the woodland floor, under even quite light regimes of summer grazing by sheep (Mitchell and Kirby 1990, Hester, Mitchell and Kirby 1995).

Harris (1981) has established that browsing by fallow deer in Castor Hanglands, while it did not immediately lead to increased mortality of seedlings did suppress growth and subsequent recruitment to the canopy. More recent reports (Ward *et al* 1994) confirms that fallow deer are still causing substantial damage to this reserve with up to 40% of woody plants showing signs of browsing damage. Current work by Langbein and Putman (*in progress*) on Exmoor is investigating the impact of grazing by red deer and sheep in suppression of regeneration of ancient native oakwoods in that region. While the effects of the deer in new plantations seem relatively slight (Langbein and Putman 1992) regeneration within many ancient oak woodlands is practically non-existent (Martin 1994, Langbein *in progress*).

Even here however one must urge caution. There is perhaps a genuine risk in the management of woodland purely for amenity or conservational objectives in being 'infected' by worries transferred from economic forestry, by feeling one should necessarily do something to control the impact. Caught up by genuine concern over checked growth or lack of regeneration managers of conservation areas may forget that objectives of management are clearly distinct from those of economic forestry.

Peterken and Tubbs (1965) noted that the woodlands of the New Forest in southern England presented a most peculiar age-structure: composed largely of trees established in the 1750s, others recruited in the mid 1850s and a third cohort established in the 1930s. This somewhat distorted age-structure clearly reflects periods of reduction in browsing pressure, sufficient in most years to suppress natural regeneration of these ancient woodlands, but reduced in 1750 (when new oak plantations were planted, and enclosed, to provide timbers for the Navy's ships), after 1851 (following an Act of Parliament providing for the 'Removal' of all deer from the Royal Forest) and during the Great Depression of the 1930s. This tight relationship between the age distribution of the Forest's mature canopy trees and changes in herbivore number makes it clear what a pronounced effect grazing and browsing may have on the entire woodland structure. Clearly such impact is of crucial significance where restocking of commercial forests is dependent on natural regeneration. However, the studies of Peterken and Tubbs (1965) also offer something of a cautionary tale to those worried about lack of regeneration in amenity or conservation woodlands; despite the centuries of heavy grazing experienced in the New Forest, some regeneration has occurred during sporadic periods of reduced browsing pressure - and the woodlands still survive. I am not advocating complacency: I am fully aware that in certain areas some intervention is necessary. Further, where regeneration coupes are unprotected, even if some regeneration does occur, preferential grazing by deer of some tree species in preference to others may lead to subtle deflections in species composition of trees recruited to the canopy (see below: Section 2.4). I would merely sound a note of warning to suggest that just because we can do something does not necessarily mean that we should. And it is notable that during the consultations undertaken for this current review a number of site managers themselves expressed such need for caution - for remembering that in management of woodland one is working on a time span of 200-300 years. As long as there is some regeneration each year, or circumstances permit the 'escape' of a cohort of regenerating seedlings every 40 years or so, the future of that woodland is assured.

## 2.3 Conservation coppice

Within the context of considering the impact of deer in conservational communities we should perhaps devote especial mention to coppice woodlands. Coppicing in a conservation context is generally undertaken in order to enhance the species diversity supported within a relatively small woodland area. Rotational coppice management establishes within the woodland a mosaic of coupes of different cutting age and thus different structure, each with a particular microclimate and character associated with its particular physiognomic structure (Mitchell 1992). Since a slightly different fauna and flora may also be associated with the different microhabitats created, rotational coppicing maintains a mosaic of patches within a woodland of different composition and character. Thus coppicing is believed to promote diversity in ground flora (Barkham 1992), on species composition and diversity of small mammals (Gurnell *et al* 1992), butterflies (Warren and Thomas 1992) as well as birds (Fuller 1992). Certain species are specifically dependent on a particular stage within the secondary succession of clearance and regrowth of coppice; management of woodlands for species such as the dormouse *Muscardinus avellanarius*, for example is specifically reliant on maintaining a good coppice rotation (Morris and Bright 1990, Whitbread 1996).

Reports from Wildlife Trusts and Woodland Trusts throughout the South and East suggest that regrowth of coppiced areas in conservation woodlands *is* commonly checked or even completely suppressed by deer browsing (Sackur 1984, Tabor 1993, Putman 1994); in the current survey of English NNRs, damage to coppice was identified as the single most significant 'problem' experienced in relation to deer impact in conservation areas.

If all regrowth in any cut-over area is continually browsed back by deer or other woodland mammals such as rabbits and hares, then that coupe and all further areas subsequently coppiced will remain as if freshly cut; rotation of coppicing in such circumstances cannot create the mosaic of different woodland structures sought for diversity in other aspects of the dependent community. Where browsing arrests the normal coppice rotation in this way and holds the cut-over areas open, the whole value of rotational coppice management is lost.

In many cases coppice regrowth will eventually get away even where unprotected, but in such case the effects of early browsing, while they do not wholly arrest development, nonetheless check growth and may hold the cut-over areas as open ground for a longer period than wood be normal. This itself may have deleterious effects. Thus, where coupes are held open longer before canopy closure, it is common to find the ground vegetation becomes more heavily dominated by grasses. In Gait Barrows NNR in Lancashire for example, while hazel coppice does eventually get away even where not protected from roe deer browsing, delay in canopy closure causes increased dominance within coupes of *Brachypodium sylvaticum*. In Monk's Wood NNR, suppression of coppice regrowth by muntjac has again resulted in grassing over of cut areas; in one case, where all coppice growth has been destroyed, the failed coupe has become almost a monoculture of Carex. This increased domination by grasses in checked area causes increased competition for other woodland plant species. In Monk's Wood recorded losses from coppiced areas of bluebell and dog's mercury (Cooke 1994) may be exacerbated by this increased competition from vigorous and aggressive monocotyledons beyond the direct effects of selective grazing of these forbs by muntjac.

Delays in regrowth of coppice and any consequential changes in the composition of the ground flora in themselves have a tremendous effect on the physical structure of the cut areas and on their dependent fauna. Grassing over of cut panels, combined with a delay to canopy closure in Gait Barrows sufficiently affects the microclimate of these areas to threaten the persistence of dense moss carpets on exposed limestone outcrops in coppiced areas. Yet these moss carpets, temporarily exposed to direct sunlight in recently coppiced areas, are critical to the maintenance on the site of High brown fritillary (Petley-Jones 1995). The larvae depend on exposed carpets of moss in direct sunlight, but the moss itself cannot survive exposure for more than one or two seasons before it itself is lost through desiccation. It is thus critical that coppice rotation is kept at its proper periodicity. In the same way; checked rotation of hazel coppice in Bradfield Woods in Suffolk, with consequent grassing over of cut areas, is believed responsible for a decline in numbers of breeding nightingales (R.Fuller *pers. comm.*)

## 2.4 Susceptibility of different species to damage and differential impact of the different deer species

Both Kay (1992) and Putman (1994) note that different species of coppice suffer different degrees of damage - but that the 'rank order' of susceptibility of tree species differed for different deer species. Certain species of coppice, such as hazel and chestnut proved to be particularly vulnerable to browsing by deer of any species; small-leaved lime, alder and maple seem generally relatively unpalatable. Other species however are perhaps susceptible to damage only by one or two species of deer: ash was particularly badly affected in areas frequented by fallow deer and significantly less browsed by other deer species (a result also reported by Symonds 1985); by contrast roe inflicted higher levels of damage on birch than did other deer (Kay 1992, Putman 1994). In a detailed study of damage caused by muntjac and fallow to coppice regrowth in Hayley Wood, Cambridgeshire, Symonds (1985) noted browsing by muntjac to be particularly concentrated on rose, field maple, hawthorn and hazel.

Similar differences may be recorded in susceptibility to browsing damage of regenerating sapling trees. Several relative ranking schemes have been produced both in the UK and on the Continent. Loudon (1982) for example offers a table for relative vulnerability of different species to browsing by roe deer within the UK and Gill (1992) summarises the findings of 11 different studies for red and roe. There are similar clear differences in susceptibility of different species to barkstripping; indeed differences are even more marked and more consistent than those recorded for browsing (Mitchell *et al* 1977, Holloway 1986, Staines and Welch 1989). Finally differences are also recorded in bole-scoring damage caused by sika (Larner 1977, Carter 1984) with damage particularly concentrated on Yew *Taxus baccata*, ash, Norway and sitka spruce.

These differences between tree species in susceptibility to damage in general - together with differences in the relative preferences shown by the different species of deer themselves - are highly significant and may be of particular importance both in predicting likely situations of risk and of forestalling them with preventative management or in suggesting situations where no protection may be required. It is significant for example that there has been no need to offer any protection from fallow and muntjac browsing to extensive areas of small-leaved lime coppice in Easton Hornocks NNR (Lincs); but coppice regrowth is vigorous and successful.

Such differences in palatability also have other, somewhat more subtle implications that we should consider. For selective grazing/browsing by deer of one species or another on more palatable species may cause subtle but highly significant changes in species structure within a community. It is for example apparent that in any woodland site where deer are present in sufficient density, even though unprotected coppice, or regeneration may appear to be establishing satisfactorily despite browsing pressure, browsing may be causing subtle deflections of species composition (above: Section 2.2).

In site visits discussed below for example (Section 5.2) it is apparent that both as seedlings and as coppice, beech is preferentially very much more heavily browsed by fallow deer in Buckholt Wood (Cotswold Commons and Beechwoods NNR) than is ash, elm or sycamore. Coppiced stools of hazel, ash and elm show vigorous regrowth on these productive site even where unprotected; beech coppice suffers heavy browsing and gets away only if protected. Similarly while there is clear sign of extensive natural regeneration within mature woodland blocks of the same woodland, most of the regeneration is of ash and sycamore and there is little sign of any recent establishment of beech. Continued browsing in this site therefore, while it will not destroy or even check coppice growth, will not suppress regeneration, will indubitably result over time in significant changes in species composition and species dominance within the woody plants.

# 3. The current survey

In recognition of the increasing problem posed by deer grazing in conservation management - or at least increased perception of problems with deer, English Nature has funded the current programme of work to gain an up to date picture of the current status and distribution of deer on NNRs under English Nature's stewardship, to offer a more objective assessment of the ecological impact of deer when present and to review current management practices employed to manage both deer populations and their impact.

Specific objectives of the contract were defined as:

1. *Determine the current status of deer on NNRs in England - to include data on species present, numbers and population history.*

2. *Determine the perceived impact, or potential impact of deer on NNRs through their effects on habitats of conservation significance.*

3 *Determine current management practices on NNRs.*

4. *Make recommendations on ways in which deer management on NNRs might be improved.*

Data on the general distribution of deer across NNRs (species present, estimated numbers and patterns of use of the reserve) were derived from responses made to a questionnaire survey (see Appendix One), distributed to site managers of all NNRs. Managers were also invited to comment on the extent of damage caused by deer presence within a site and whether or not this adversely affected their ability to meet the management objectives of the site. As part of the complete ecological community within any reserve however, deer presence may not necessarily be regarded purely negatively - even despite any potential or actual impact - and managers were also invited to comment on the perceptions of themselves and of visitors to the site as to the importance or value of deer presence within the site to the reserve as a whole or visitor enjoyment. A summary of responses to this part of the questionnaire is presented here. In addition, managers were asked to detail management measures (if any) currently employed in control of deer numbers or impact within the site and to comment on cost and effectiveness of such control effort; responses to such review are considered in Section 5 of this report. Questionnaires were distributed to 162 sites, with a total of 155 returns received.

**Deer distribution across NNRs**

Managers reported deer present on 112 of the sites for which questionnaire returns were received. In most cases deer were observed regularly (at least weekly) on the reserve and were believed to be resident or at least regular users of the reserve area. 66 sites had only one species of deer present. (Red deer were present as the only deer species on 3 of the reserves, fallow occurred as the only species on 10 reserves and muntjac on a further 9. 44 sites reported roe deer as their only species). A further 46 sites had more than one species of deer resident or regularly visiting (all summarised in Appendix 1). Distribution of deer species corresponded with known geographical distribution patterns (as in Arnold 1993); within geographical regions there appeared no particular associations between presence of particular deer species and major habitat type of the reserve.

**Reported damage**

Some level of damage (often emphasised as slight) was reported by site managers of 50 out of 112 sites with deer present, but only 20 of those reporting damage claimed that it conflicted with management aims (20/112 (17.9%) of sites with deer present; or 20/155 (12.9%) of all sites surveyed). Such figures should, however, be interpreted with some caution, since those reporting lack of conflict with management aims in the face of damage may in effect fall into either of two distinct classes. Lack of conflict may be reported by managers of (non-intervention) sites where damage is in any case slight and does not require preventative management; but equally, lack of current conflict may be reported by managers of sites where that lack of conflict is the direct consequence of past and present management undertaken to keep damage levels within tolerable bounds. Management history thus confounds the response to this particular question and the proportion of managers reporting lack of conflict should not be simply equated to those who would find no conflict in the absence of any management.

What was, however highly significant was that those sites which reported damage from deer at any level were without exception woodland reserves - managers of 'open sites' (grasslands, meadows, heathland or fenland sites), generally regarded the presence of deer as neutral or positively advantageous in suppressing encroachment by scrub.

Detailed vegetational data were unfortunately not available for a number of the sites; over that subsample of sites for which vegetational data were available (n = 79 of 112 sites with deer present), degree of concern about deer damage increased significantly with mean proportional area of any site covered by woodland (deciduous, coniferous or mixed). Thus the wooded proportion of sites reporting no damage was 23.95%; proportional area of woodland in those sites reporting damage but not at a level to conflict with management aims was 43.43%; sites which reported damage from deer at a level inconsistent with management objectives were heavily wooded, with proportional area of the site as woodland 72.8% on average.

Within woodlands, while problems were reported in a small number of cases in relation to impact on sensitive ground flora, or suppression of natural regeneration, the vast majority of complaints concerned browsing damage to coppice regrowth on those sites where coppice management has been reintroduced. Of all sites where damage from deer was reported (n = 50), 9 (18%) reported damage to ground flora; 4 (8%) reported physical damage to fences, banks or ditches; 15 (30%) reported damage to regeneration if unprotected and 18 (36%) reported damage to coppice regrowth (Totals add to >50, since many sites reported more than one form of damage). If analysis is restricted to those 20 sites where damage was seen to conflict with management aims, equivalent figures are (n = 20): damage to ground flora, 8 sites (40%); physical damage, 3 sites (15%); damage to regeneration, 14 sites (70%); damage to coppice regrowth 13 sites (65%).

No significant relationships could be determined between deer species present on a site, and incidence, severity or type of damage (as: *incidence*: number of sites with species x showing damage as a proportion of all sites reporting presence of species x; *severity*: damage as conflicting with management aims as a proportion of all sites reporting damage from a given species; *damage type*: damage to ground flora, coppice regrowth, regeneration etc.)

Managers perceived a trend of increasing numbers of deer resident on or visiting the reserve in only 25/112 cases where deer were reported; for the most part numbers were generally seen to be holding more or less constant. Where damage from deer was reported (n = 50) damage levels were seen to be decreasing on 5 sites, remaining more or less constant on 5, but actively increasing on 15 (30% of those sites reporting damage); a further 5 sites didn't know or did not answer this particular question.

As already noted, managers of 'open sites' (grasslands, meadows, heathland or fenland sites) generally regarded the presence of deer as neutral or positively advantageous in suppressing encroachment by scrub. Even on woodland reserves, the majority of managers noted that they liked to see deer on the site; responses for those reserves open to public access further indicated that visitors universally enjoyed seeing deer on the reserve. Only 30 site managers (<27%) however considered deer an important feature of the reserve as such.