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Impact of roe deer *Capreolus capreolus* browsing on understorey vegetation in small farm woodlands

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The impact of around nine roe deer *Capreolus capreolus*/km^2 on ground and shrub vegetation was assessed in a sample of six small woodlands on a largely arable estate in Dorset, southern England. In January 1996, 30 exclosures of $2 \times 2 \times 1.5$ m and 30 paired controls were set up. Measurements of vegetation density at six height categories using a cover board were taken in late winter and mid-summer in each of the four years 1996-1999. Mean cover values were calculated for each woodland, and they indicated that the density of vegetative cover was reduced by deer browsing in winter and in summer. The effect of the browsing increased significantly within the four-year study period, and plant species composition had changed by the end of the study period. Our results suggest that roe deer may be having a substantial and potentially widespread effect on vegetative structure and composition in small farm woodlands in arable ecosystems in central southern England. The implications of this, for the characteristic wildlife and game species found in this common woodland habitat, are discussed.

Key words: browsing, roe deer, understorey vegetation, woodland

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During the past few decades deer populations in the UK lowlands have expanded both in number and range (Prior 1995, Putman & Moore 1998, Taylor 1981, Ratcliffe 1987). In the next decade, the roe deer *Capreolus capreolus* is expected to continue to increase in range, although not in density, while the fallow deer *Dama dama* is predicted to increase in density but not in range (Putman & Moore 1998).

The main area of range expansion by roe deer in the lowlands coincides with the areas that have seen the largest increase in farm woodland plantings, i.e. parts of central southern and western England (Putman & Moore 1998). In arable areas both roe and fallow deer are able to use small farm woodlands for feeding and cover, using field crops as an additional or primary food source (Putman 1986, Kaluzinski 1982, Cibien, Bideau, Boisaubert, Biran & Angibault 1995, Moore, Hart, Kelly & Langton 2000). As a consequence of this expansion, there is potential for browsing damage to vegetation in these woodlands (Putman & Moore 1998).

However, in their review, Putman & Moore (1998) found very little published work on the extent of damage and consequences of browsing by deer in small farm woodlands (although see Moore, Hart & Langton 1998 and Moore et al. 2000 on fallow deer in young broadleaved plantations). Commercial forestry plantations (Staines & Welch 1984, Gill 1992a, Ratcliffe & Mayle 1992, Tixier & Duncan 1996) and coppice woodlands (Kay 1993, Tabor 1993, Putman 1995) are the areas where the impacts of roe deer have been more comprehensively studied.

A greater understanding of the damage potential by deer in woodlands that occupy a relatively small proportion of the landscape is therefore desirable if the quality of these woodlands as habitats for other wildlife is to be maintained. This project aimed to investigate the impact of, primarily, roe deer on vegetative structure and composition in a sample of small woodlands in a largely arable farmland area in central southern England.

Study area

The study was undertaken on a 400-ha estate in east Dorset (SU 016 196) known to contain roe deer (Fig. 1). In total, 40% of the estate was arable land, 13% grass, 13% set-aside (arable land left uncropped for one or more years) and 10% mature broadleaf woodland. The rest was scrub, edge habitats and some new woodland plantings. Typical woodland understorey vegetation consisted of bluebells *Hyacinthoides non-scripta*, wood anemone *Anemone nemorosa*, ground ivy *Glechoma hederacea*, dogs mercury *Mercurialis perennis*, cleavers *Galium aparine*, and woody species such as hazel *Corylus avellana*, sycamore *Acer pseudoplatanus*, beech *Fagus sylvatica*, and bramble *Rubus fruticosus*.

The land is flat or gently sloping at a mean altitude of 125 m. Rainfall occurs throughout the year and averages around 730 mm a year. The monthly mean daily minimum temperature occurs in February (1.5°C) and the monthly mean daily maximum in July (20.8°C).

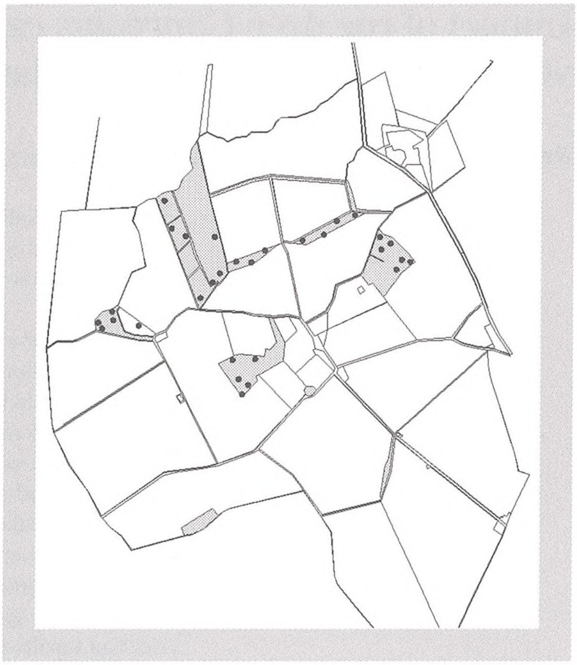

Figure 1. The study site contained 10% broadleaved woodland (▒) in a primarily arable landscape (see text) with fields bordered with managed hedgerows typically < 3 m high. The 30 exclosures are marked (●) within the six woodland blocks.

Methods

A sample of six separate small mature woodlands, between 1 ha and 13 ha, were selected for study. In each, we erected either four, five or six deer exclosures, in total 30 (see Fig. 1). The exclosures were located within a predefined area of wood edge, within 60 m of the actual wood boundary. The precise location was selected using two random numbers to determine pacing distance (accounting for the size of the area) in a random starting direction from a central point. A second plot, used as an unfenced control, was located 5 m to one of four, randomly selected, sides.

Each 2 × 2 m area by 1.5 m high exclosure was constructed using four 7 cm × 2 m steel posts driven into the ground to support a fence of 4 cm chicken wire with a 10 cm space left at the bottom for smaller herbivores.

Surveys of the paired plots were carried out in late winter/early spring (March/April) and in late summer (August) in each of the four years 1996-1999 inclusive. A cover board (Nudds 1977) was used to measure vegetation density at the following height categories 0-10 cm, 10-20 cm, 20-50 cm, 50-100 cm, 100-150 cm and 150-200 cm above ground level. These data were recorded as the proportion of each of a row of five 10-cm wide panels on the board at each height category that was obscured from level viewing. The board was placed at one side of the plot and viewed from the other side in the same direction each time from just outside the fence, at a distance of 2 m across the exclosure.

Plant species within the plots were also recorded in the whole plot area (2 × 2 m). The abundance of each species as an approximate proportion of the plot area was estimated to the nearest 5%.

Deer densities on the estate were estimated by the estate game manager in spring each year. He drove around the estate in late March/early April on each of three mornings using a route that would enable viewing all open areas, wood edges and hedges (both sides). Counts were undertaken during the 2-3 hour period starting 30 minutes after dawn and avoiding wet and/or windy conditions. This count method has been developed by The Game Conservancy Trust to assess population sizes of gamebirds. In these types of habitats, the three-visit count has been shown to include on average 90% of male and 65% of female pheasants *Phasianus colchicus* (Game Conservancy Trust, unpubl. data). While this count is not an established methodology for deer, by repeating visits in this largely open habitat, familiarity with herds and individuals suggested that a good estimate of the deer actually using the open habitats was being made. However, because some individuals may confine themselves to the small woodland patches, the estimate should be considered a minimum count. These counts provided estimates of nine deer/km^2 on the 4-km^2 estate in 1996, 1997 and 1998 and seven deer/km^2 in 1999. All were roe deer except for a total of three fallow deer (less than one/km^2) in 1999.

Analyses

The study design allows a replicated study of the effect of grazing between woodlands in an area exposed to deer grazing pressure. For each wood and each visit, we calculated the mean cover values across exclosure plots and across control plots of each cover height category. A similar measure of mean plant species abundance was also calculated. The number of plots in each wood im-

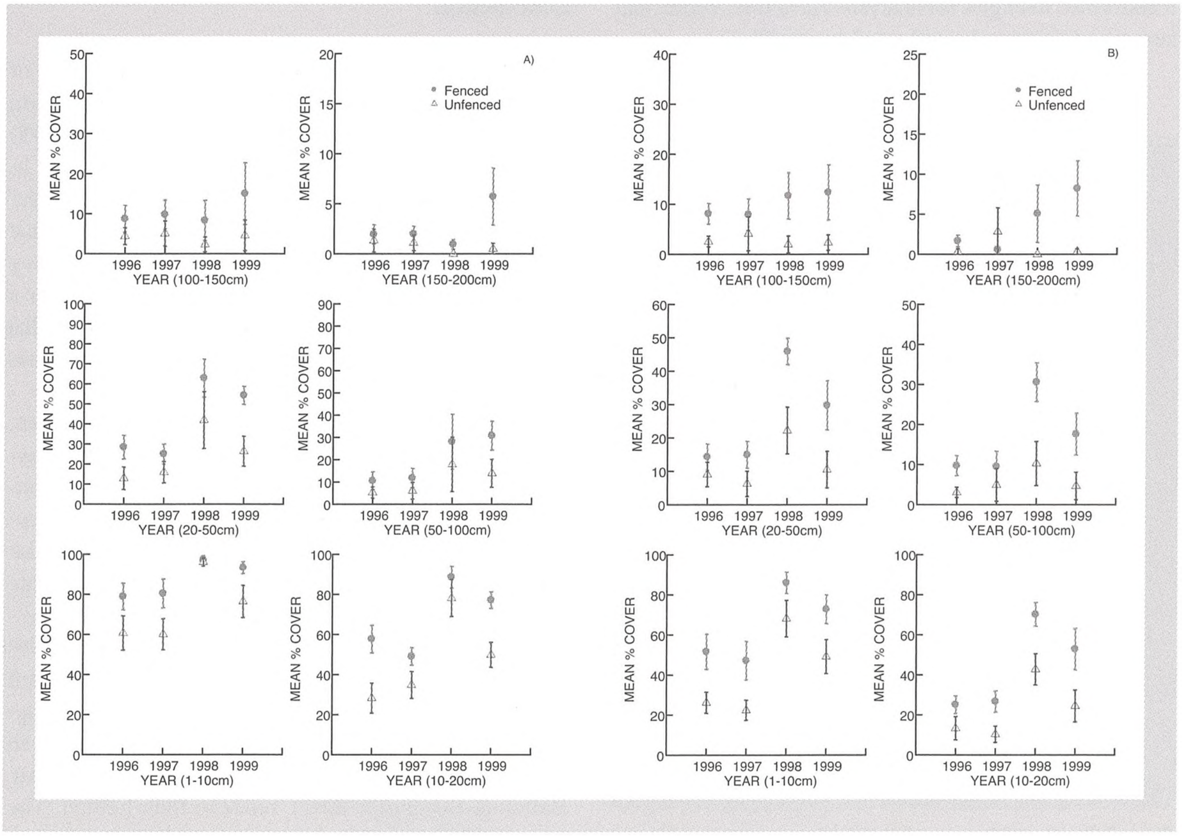

Figure 2. Percentage cover (± 1 SE) of vegetation in fenced and unfenced plots for A) summer and B) winter. The values are means across all six woods for the height categories indicated. The overall difference in these mean values between fenced and unfenced plots increased over time in both seasons (see text for multivariate test results).

proved the accuracy of each woodland mean but did not contribute to the basic sample size for analysis, which was six woods.

As proportions, all cover board data were transformed to angles (arcsine(p)$^{1/2}$). The difference in cover between exclosure and control for each wood/visit was calculated and used in subsequent analyses.

For the analysis of the difference in vegetative cover, a multivariate ANOVA was used including all six height categories as dependant variables simultaneously. 'Wood' was included as a categorical independent variable and 'Year' as a continuous one together with the interaction term 'Wood*Year'. These were tested for overall significance using the multivariate test statistic Wilks' Lambda. Data collected during the summer and winter were tested in separate models.

For the analysis of species composition in 1999 a paired t-test was used to compare the abundance of common plants for each wood between fenced and unfenced plots. Mean values were calculated for each wood across exclosure plots and across control plots and transformed to angles for analysis. As before, winter and summer data were investigated separately.

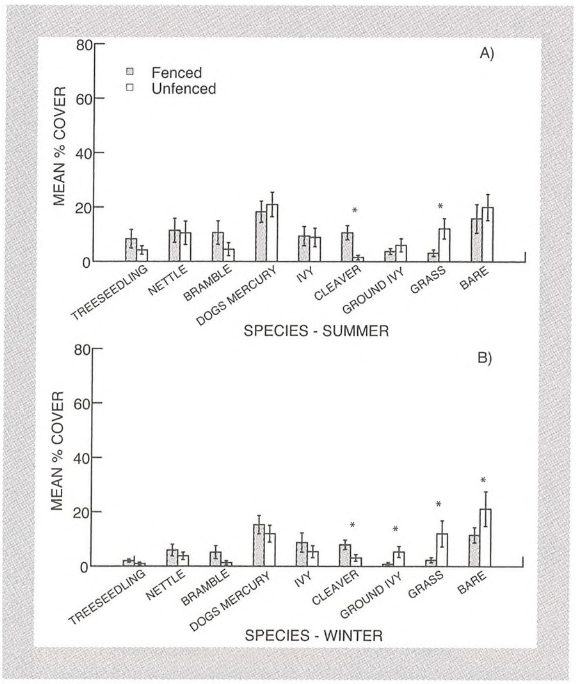

Figure 3. Percentage cover (± 1 SE) of dominant vegetation in fenced and unfenced trial plots in A) summer and B) winter 1999, the last year of data collection. * indicates the difference between plot types based on wood means (N = 6) significant at P < 0.05.

Results

In the overall multivariate test of the cover board data, presented as the difference in cover between fenced and unfenced plots, the interaction term 'Wood*Year' was significant in both summer (Wilks' $\lambda = 0.002$, $F_{30,30} = 3.73$, $P < 0.001$) and winter (Wilks' $\lambda = 0.012$, $F_{30,30} = 2.00$, $P = 0.03$). This indicates a relationship over the four-year study period that was not consistent across all woods. Closer inspection of the mean relationships between cover and year for all woods shows that the mean difference in cover was almost always positive (i.e. more cover in fenced plots) and tended to increase over time, particularly for the height categories above 10 cm (Fig. 2).

In the last year of the study, the unfenced plots contained more grass, more bare ground and less cleaver than the fenced plots (Fig. 3). The species abundance data had high variance, and there were no other significant differences in cover between plot types at P < 0.05.

Discussion

Ratcliffe & Mayle (1992) suggest that five deer/km^2 of woodland may lead to some changes in vegetation structure in continuous woodland, whereas Prior (1995) suggests a sustainable maximum of 14 deer/km^2 in immature broadleaf and 21 deer/km^2 for mature broadleaf woodland. Cibien, Boutin & Maizeret (1988), found that a density of 20 roe deer/km^2 led to a decrease in ivy *Hedera helix* and an increase in moss and Butcher's broom *Ruscus aculeatus*. More generally, Gill (1992b) describes a decrease in shrub and herbaceous biomass and an increase in grasses, ferns and mosses.

Using deer densities to predict ecological change can, however, mask some of the subtle aspects of the roe deer-forest relationships because they depend on environmental conditions. To account for this, indicators of ecological change that reflect deer population size in relation to their habitat have been developed. Some relate to the deer themselves, where juvenile body mass (Gaillard, Delorme, Boutin, Van Laere & Boisaubert 1996) or mandible size (Hewison, Vincent, Bideau, Angibault & Putman 1996) can be used to provide an index of population size or ecological change, whereas others, such as the browsing index (Morellet, Champely, Gaillard, Ballon & Boscardin 2001), relate to their habitat. The browsing index enables land managers to track changes in deer population size by measuring the frequency of browse damage to woody plants alone.

Our estimated deer population of around nine roe deer/km^2 had a cumulative effect on the amount of vegetative cover in our sample of six small farm woodlands in winter and in summer. Figure 2 suggests the effect extended above the normal browse range of deer, typically up to 1.15 m (Prior 1983), as potentially taller annual plants were curtailed earlier in their growth period. An effect on species composition by the end of the four-year study period had also occurred. Together these changes represent substantial ecological change. While the number of deer using our study site woodlands was unlikely to be excessive in the context of the density figures given above, the environmental conditions were of a particular kind. The land-use mix on our study site, dominated by farmland, meant that there was effectively a much greater density of deer/km^2 of available woodland on the estate. The overall deer density we observed translates to a much higher one if only woodland is considered.

The changes in woodland vegetative structure and species composition that we observed could be beneficial to the types of woodlands depending on management objectives. Browsing is a natural ecological process that can maintain or enhance the conservation interest of habitats (Putman & Moore 1998). For other wildlife, however, shrubby woodlands tend to provide habitat for more species for a greater part of the year than woodlands that have a sparse understorey. For example many woodland songbird species, particularly migrant species occur in greater densities in shrubby woodland (Fuller & Henderson 1992, Moss 1978). Woodland small mammal communities and many butterfly and moth species also benefit from woodlands with shrubs and a ground flora (Gurnell 1985, Ferris & Carter 2000). Woodlands with plenty of cover will hold many more pheasants during the shooting season and provide better breeding habitats for the species during spring and summer (Robertson, Woodburn, Neutel & Bealey 1993, Robertson, Woodburn, & Hill 1993). Woodlands with greater hiding cover are also preferred by the deer themselves (Mysterud & Østbye 1999). Therefore, our study indicates that browsing of small farm woodlands by roe deer could be negatively impacting the conservation value and aspects of a woodland's commercial value by reducing the amount of shrubby cover.

After four years of study, we noted that one or two fenced exclosures in one woodland were starting to provide a support structure for some rambling shrub species, particularly bramble, thus biasing this vegetative growth towards increased growth in these plots. While this was accounted for during data collection, this effectively terminated the study. We recommend that proposals for longer studies using replicated plots in similar habitats, should account for this by using a larger plot size with a central assessment area. Some of our exclosures may also have been excluding hare *Lepus europaeus* although they were designed to include them. We suggest that the minimum gap size at the base of deer exclosures used in similar work should be increased by perhaps 50 mm.

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References

Cibien, C., Bideau, E., Boisaubert, B., Biran, H. & Angibault, J.M. 1995: Seasonal diet and habitat use in field roe deer (Capreolus capreolus) in the Picardie region. - Gibier Faune Sauvage, Game and Wildlife 12: 37-49.

Cibien, C., Boutin, J.M. & Maizeret, C. 1988: Impact of roe deer (Capreolus capreolus) on vegetation in relation to population density and type of woodland. - Zeitschrift für Jagdwissenschaft 34: 232-241.

Ferris, R. & Carter, C. 2000: Managing Rides, Roadsides and Edge Habitats in Lowland Forests. - HMSO, Forestry Commission Bulletin 123, 78 pp

Fuller, R.J. & Henderson, A.C.B. 1992: Distribution of breeding songbirds in Bradfield Woods, Suffolk, in relation to vegetation and coppice management. - Bird Study 39: 73-88.

Gaillard, J-M., Delorme, D., Boutin, J.M., Van Laere, G. & Boisaubert, B. 1996: Body mass of roe deer fawns during winter in 2 contrasting populations. - Journal of Wildlife Management 60: 29-36.

Gill, R.M.A. 1992a: A review of damage by mammals in north temperate forests. 1. Deer. - Forestry 65: 145-169.

Gill, R.M.A. 1992b: A review of damage by mammals in north temperate forests: 3. Impact on trees and forests. - Forestry 65: 363-388.

Gurnell, J. 1985: Woodland rodent communities. - In: Flowerdew, J.R., Gurnell, J. & Gipps, J.H.W. (Eds.); Symposia of the Zoological Society of London No.55. Oxford University Press, Oxford, pp. 377-411.

Hewison, A.J.M., Vincent, J.P., Bideau, E., Angibault, J.M. & Putman, R.J. 1996: Variation in cohort mandible size as an index of roe deer (Capreolus capreolus) densities and population trends. - Journal of Zoology 239: 573-581.

Kaluzinski, J. 1982: Composition of the food of roe deer living in fields and the effects of their feeding on plant production. - Acta theriologica 27: 457-470.

Kay, S. 1993: Factors affecting severity of deer browsing damage within coppiced woodlands in the south of England. - Biological Conservation 63: 217-222.

Moore, N.P., Hart, J.D., Kelly, P.F. & Langton, S.D. 2000: Browsing by fallow deer (Dama dama) in young broadleaved plantations: seasonality, and the effects of previous browsing and bud eruption. - Forestry 73: 437-445.

Moore, N.P., Hart, J.D & Langton, S.D. 1998: Factors influencing browsing by fallow deer (Dama dama) in young broadleaved plantations. - Biological Conservation 87: 255-260.

Morellet, N., Champely, S., Gaillard. J-M., Ballon, P. & Boscardin, Y. 2001: The browsing index: new tool uses browsing pressure to monitor deer populations. - Wildlife Society Bulletin 29: 1243-1252.

Moss, D. 1978: Diversity of woodland songbird populations. - Journal of Animal Ecology 47: 521-527.

Mysterud, A. & Østbye, E. 1999: Cover as a habitat element for temperate ungulates: effects on habitat selection and demography. - Wildlife Society Bulletin 27: 385-394.

Nudds, T.D. 1977: Quantifying the vegetative structure of wildlife cover. - Wildlife Society Bulletin 5: 113-117.

Prior, R. 1983: Trees and Deer, how to cope with deer in forest field and garden. - B.T. Batsford, London, 208 pp.

Prior, R. 1995: The roe deer: conservation of a native species. - Swan Hill Press, Shrewsbury, 230 pp.

Putman, R. 1986: Foraging by roe deer in agricultural areas and their impact on arable crops. - Journal of Applied Ecology 23: 91-99.

Putman, R. 1995: Deer damage in coppice woodlands: An analysis of factors affecting the severity of damage and options for management. - Quarterly Journal of Forestry 89: 45-54.

Putman, R.J. & Moore, N.P. 1998: Impact of deer in lowland Britain on agriculture, forestry and conservation habitats. - Mammal Review 28: 141-164.

Ratcliffe, P.R. 1987: Distribution and current status of sika deer in Great Britain. - Mammal Review 17: 39-58.

Ratcliffe, P.R. & Mayle, B.A. 1992: Roe deer biology and management. - HMSO, Forestry Commission Bulletin 105, 28 pp.

Robertson, P.A., Woodburn, M.I.A. & Hill, D.A. 1993: Factors affecting winter pheasant density in British woodlands. - Journal of Applied Ecology 30: 459-464.

Robertson, P.A., Woodburn, M.I.A., Neutel, W. & Bealey, C.E. 1993: Effects of land use on breeding pheasant density. - Journal of Applied Ecology 30: 465-477.

Staines, B.W. & Welch, D. 1984: Habitat selection and impact of red deer Cervus elaphus and roe deer Capreolus capreolus in a sitka spruce plantation. - Proceedings of the Royal Society of Edinburgh 82: 303-319.

Tabor, R.C.C. 1993: Control of deer in a managed coppice. - Quarterly Journal of Forestry 87: 308-313.

Taylor, K. 1981: The northerly spread of muntjac in the Midlands. - Deer 5: 185-186.

Tixier, H. & Duncan, P. 1996: Are European roe deer browsers? A review of variations in the composition of their diets. - Revue D'Ecologie (La Terre et la Vie) 51: 3-17.