

An experimental assessment of the effect of deer on use of young coppiced woodland by Eurasian Woodcocks *Scolopax rusticola* in winter

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There is growing concern among conservationists about the effect of increasing populations of deer across the northern hemisphere, particularly on birds dependent on understorey vegetation. In this study of young deciduous coppice woodland in E England, we detected no effect of deer browsing on the diurnal density of Eurasian Woodcocks within a split-plot deer enclosure experiment, and no fine-scale vegetation characteristics were identified that correlated with locations of encountered birds.

INTRODUCTION

There is considerable uncertainty regarding the population trend and status of the Eurasian Woodcock *Scolopax rusticola* (hereafter Woodcock), though it is widely considered to be in decline as a breeding species, both in the UK (Hoodless *et al.* 2009) and elsewhere in Europe (Burfield & van Bommel 2004). In winter, numbers in the UK increase following influxes of continental migrants (Musgrove *et al.* 2011, Wernham *et al.* 2002), and two general habitat types tend to be used; wooded habitats for roosting by day and agricultural habitats for foraging by night, with some daytime feeding also likely (Duriez *et al.* 2005b, Summers & Buckland 1986). The winter diet consists predominantly of earthworms and fly larvae (Hirons & Bickford-Smith 1983). Diurnal habitats are primarily selected according to shrub cover while earthworm abundance is probably the main factor determining use of agricultural habitats at night (Duriez *et al.* 2005b).

Hunting pressure, disturbance, habitat fragmentation and possible reductions in habitat quality and food availability, may all have impacted negatively on Woodcocks in recent years (Duriez *et al.* 2005b, Hoodless & Hirons 2007). In common with several other bird species, habitat quality for breeding individuals may have been compromised in some British woodlands by loss of shrub cover as a result of browsing from increasing numbers of deer, but this remains a hypothesis (Fuller *et al.* 2005). Due to impacts on habitat structure through alteration of low vegetation, including loss of bramble *Rubus fruticosus* (Gill & Fuller 2007), Woodcock habitat quality could also be compromised in winter by a reduction in both the availability of shelter from predators and of foraging resources. Until now however, a detailed test of whether and how deer browsing affects Woodcocks has been lacking for either season.

METHODS

Study area

This study examined the use of coppiced woodland by Woodcocks in winter at Bradfield Woods (Suffolk, E England). The site is managed using an approximately 25-year cutting cycle, and is characterized by a low density of mature single stem Sessile Oak *Quercus robur*, Ash *Fraxinus excelsior* and birch *Betula* spp. scattered among the coppiced species; primarily Ash, birch, Hazel *Corylus avellana* and Alder *Alnus glutinosa*. The site is used by Roe deer *Capreolus capreolus*, Reeves' Muntjac *Muntiacus reevesi* and Fallow deer *Dama dama*, all of which have increased at the site and in the region in the last twenty years (Fuller 2001, Ward 2005). Within the context of a replicated experiment, we compared eight areas of newly-cut coppice with areas cut at the same time but protected from deer. The study therefore compared complete deer exclusion (treatment) with regular browsing (control), and represents an authentic split-plot design because the treatment and control representing an experimental pair comprised vegetation of the same age. The first two experimental pairs of plots were established in 1999, followed by subsequent pairs in 2000 (2), 2001 (2), 2002 and the last pair in 2003. The mean area of the browsed and unbrowsed plots was 0.42 ha (± 0.13 SD, range 0.22–0.63) and 0.55 ha (± 0.21 SD, range 0.33–0.85), respectively. Further detail on the Bradfield Woods deer exclusion experiment is available in Holt *et al.* (2010, 2011).

Previous work at Bradfield Woods has shown there to be greater canopy cover and denser understorey vegetation in the browsed plots than the unbrowsed plots (Holt *et al.* 2011, Stone *et al.* 2004), and associated negative responses to deer browsing by breeding birds dependent on understorey vegetation have been demonstrated (Gill & Fuller 2007, Holt *et al.* 2010, 2011). Based on observations of roding birds,

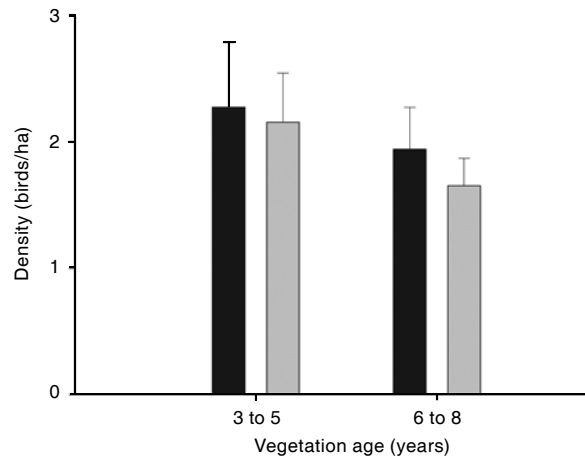


Fig. 1. Woodcock densities (\pm SE) in winter at Bradfield Woods. Black bars = vegetation protected from deer, grey bars = vegetation browsed by deer. The vegetation age categories of 3–5 years and 6–8 years relate to “pre canopy closure” and “post canopy closure” (in summer), respectively.

Woodcocks were considered unlikely to have bred at Bradfield Woods since 2004 (RJF pers. obs.); this study examined the species in winter when it is commonly encountered. We hypothesized that more Woodcocks would be present in unbrowsed vegetation, and that this might be explained by differences in habitat characteristics at locations where individual birds were recorded.

Data collection: Woodcock abundance

During two winters (2006/07 and 2007/08), a total of ten visits (five in both winter periods) were made to each of the eight pairs of experimental plots in order to undertake Woodcock surveys and associated habitat data collection. Over the two winters, the sampled coppice vegetation was in the age range of 3–8 years. Survey visits took place between 08h30 and 15h30 during the period 15 Nov to 10 Mar and consecutive visits were a minimum of 15 days apart. The browsed and unbrowsed plots of an experimental pair were surveyed on the same day, one plot immediately following the other, with the order reversed on the subsequent visit.

Woodcocks were counted using a standardised survey methodology. On each survey, a series of parallel transects, spaced about 4 m apart were walked back and forth through each plot. This provided good coverage of the habitat, considered sufficient to detect the presence of most Woodcocks within the plots. Hence, even if some birds were not detected, the likelihood of detection was probably equal between browsed and unbrowsed plots. All Woodcocks encountered (normally flushed) were recorded, and the total number of birds per plot was subsequently converted to a density per hectare. As far as could be ascertained, all birds that were flushed then flew beyond the boundary of the area of both the plot and its paired experimental counterpart plot. Thus, it is unlikely that the same Woodcock was counted more than once in different plots during the same survey visit; however this cannot be entirely ruled out.

Data collection: fine-scale habitat selection by Woodcocks

Wherever possible, the location was pinpointed where a Woodcock was first seen / flushed during standardised surveys. This was subsequently referred to as a “Woodcock

location”. In some cases, pinpointing was not possible as the flushing point was not precisely located. To assess fine-scale habitat selection by Woodcocks, we examined the following three main variables: (a) canopy cover (% cover using a spherical densiometer; Lemmon 1956), (b) understorey density (measuring proportion of checkerboard obscured by vegetation; Fuller & Henderson 1992, Holt *et al.* 2011), and (c) bare ground cover (visual estimation of % cover). These habitat variables were also measured at ten randomly selected points of 0.5 m radius in each of the 16 sub-plots, which enabled us to compare Woodcock locations with random points and also examine generic habitat differences between the browsed and unbrowsed coppice in winter as a result of deer activity.

Data analysis

Coppice vegetation within the experimental plots was categorised as 3–5 years or 6–8 years re-growth; these age classes represent pre- and post-summer canopy closure respectively. The same definition has been used in previous studies of bird communities in lowland coppice woodland during the breeding season (e.g. Fuller & Henderson 1992, Joys *et al.* 2004).

Woodcock numbers and habitat selection were modelled using SAS 9.2 (SAS Institute). Woodcock numbers across the experiment were examined using a generalised linear model (GLM) with normal errors. Mean density of birds recorded over the course of the five visits to a plot per winter was used as the dependent variable, and fixed effects were presence/absence of deer enclosure, pre-/post-canopy closure and interactions between these. Experimental plot-pair and the winter of sampling were treated as random factors. Interactions were not retained in the model if $p > 0.1$. Habitat measures at Woodcock locations and random points were compared using a logistic regression model, pooling data across all plots. Habitat measures and vegetation age were treated as fixed effects and plot-pair as a random factor. This was reduced to a minimal model by examination of AICc, based on the principle of parsimony by retaining only the strongest explanatory variables (Burnham & Anderson 2002), thereby enabling identification of any significant habitat predictors of Woodcock presence (which can then be tested using a generalized mixed model to ascertain the significance of a deer effect).

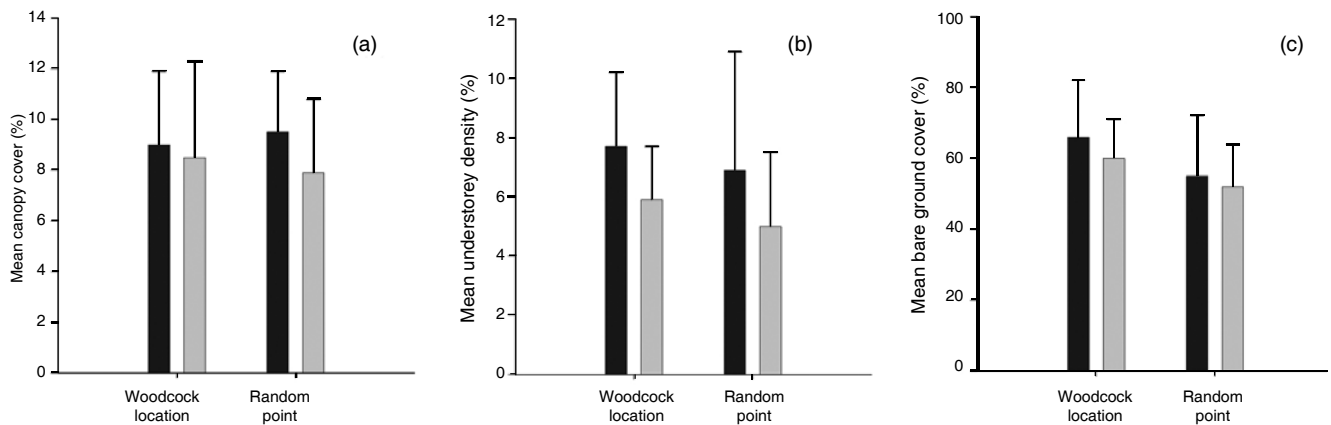


Fig. 2. Mean habitat structure measures (\pm SE) at Woodcock locations and random points in young coppice at Bradfield Woods: **(a)** canopy cover, **(b)** understorey density, **(c)** bare ground. Black bars = vegetation protected from deer, grey bars = vegetation browsed by deer. The vegetation age categories of 3–5 years and 6–8 years relate to “pre canopy closure” and “post canopy closure” (in summer), respectively.

RESULTS

Woodcock distribution

A total of 141 Woodcocks was recorded during the course of the study; 69 in unbrowsed and 72 in browsed plots (Fig. 1). Across all plots, irrespective of coppice age, this equated to mean densities per visit of 2.27 ± 0.28 (range 1.30–4.72) and 1.84 ± 0.20 (range 0.88–3.22) birds per ha, respectively.

Wintering Woodcocks were distributed throughout the coppice age range studied, but there was no significant effect of canopy closure period ($F_{2,29} = 2.54$, $p = 0.127$), with 2.20 ± 0.48 (range 0.88–4.72) birds per ha in 3–5 year and 1.91 ± 0.35 (range 1.30–3.22) birds per ha in 6–8 year old vegetation. Deer exclusion did not have a significant effect on Woodcock densities ($F_{2,29} = 0.47$, $p = 0.501$), which were similar in unbrowsed and browsed plots.

Habitat measurements and fine-scale selection by Woodcocks

There were no significant differences in habitat characteristics between Woodcock locations and random points (Fig. 2).

Comparison of the habitat data collected at random points in the browsed and unbrowsed plots showed that although canopy cover did not differ in presence of deer (probably attributable to no or minimal leaf cover during the sampled winter periods) ($F_{1,30} = 2.11$, $p = 0.225$), understorey density was greater ($F_{1,30} = 6.01$, $p = 0.024$) and there was also significantly more bare ground ($F_{1,30} = 4.54$, $p = 0.048$) inside plots from which deer were excluded.

DISCUSSION

This study adds to the body of evidence detailing impacts of deer on woodland habitat, and indicates that understorey density and ground characteristics can be affected in winter (as well as the more typically studied spring/summer period). However, our results indicate that deer and any associated habitat modification do not affect winter densities of Woodcock at Bradfield Woods in the years that we undertook the study.

The number of Woodcocks present in Britain tends to vary between winters, probably linked to reproductive success overseas. The two winters sampled in this study (2006/07 and 2007/08) featured relatively high densities of Woodcocks in

the UK (GWCT 2009), and it is possible therefore that preferences for particular habitat types may not have been as evident as expected due to density-dependent habitat selection. We also acknowledge that radio-tracking, or alternatively the use of dogs to flush birds, would be the most effective sampling methods for Woodcocks (O. Duriez, pers. comm.), but all else being equal, similar diurnal densities of Woodcocks at Bradfield Woods in the browsed and unbrowsed coppice imply that deer did not have a sufficiently profound impact on habitat structure to affect either shelter from predators or potential foraging resources. The transects we used would have passed within a maximum of *c.* 2 m of all individual birds, and we consider that any variation in habitat structure between plots would have been insufficient to affect detectability in the browsed and unbrowsed coppice.

It is unclear where the Woodcocks that we recorded preferentially foraged, or whether foraging behaviour may have affected our diurnal records. Although previous studies of Woodcocks have demonstrated nocturnal foraging in agricultural fields (Duriez *et al.* 2005b), all the fields surrounding Bradfield Woods are intensively managed arable land where earthworm densities may be low relative to grassland (Curry *et al.* 2002, Tucker 1992). Consequently, it is possible that the woodland itself was used for foraging more than might be expected, or that permanent grassland within the woodland glades and rides may have represented important feeding habitat at night. In winter, a trade-off between starvation and predation risk leads individual Woodcocks to adopt one of three broad behavioural strategies in terms of space use and time budget management (Duriez *et al.* 2005a); some birds being faithful to one site, while others visit several sites either alternatively or successively. Without radio-tracking, it is not possible to say whether the Woodcocks we recorded at Bradfield Woods varied in terms of foraging strategy, and therefore we are unable to judge whether there were differences in, for example, site fidelity between individuals recorded in the browsed and unbrowsed coppice. Previous studies have shown that habitats used diurnally by Woodcocks are selected according to shrub cover and richness in earthworms, both in winter (Duriez *et al.* 2005b) and summer (Hoodless & Hiron 2007). In this study, we did not estimate earthworm abundance or availability, but this could potentially have been a factor in the fine-scale diurnal distribution of Woodcocks at Bradfield Woods. However, it should be borne in mind that during initial design of the experimental layout, it was

ensured that there were no obvious differences in soil texture between paired browsed and unbrowsed plots; soil texture being recognized as a variable that can affect earthworm abundance (Curry *et al.* 2002, Hendrix *et al.* 1992).

Effects of deer browsing on habitat quality for woodland passerines during the breeding period have been demonstrated by Holt *et al.* (2010, 2013). We suggest that research is also needed to elucidate how deer in woodland systems may influence habitat use by Woodcocks throughout the year (as well as how they affect woodland birds generally during non-breeding periods). Although this small-scale study has not identified increasing deer populations to be a pressure facing Woodcocks in a British coppiced woodland in winter, breeding individuals may well be more sensitive to the negative effects of browsing by deer (Hoodless *et al.* 2009).

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