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The effects of three hedge management treatments on the wildlife of a Cambridgeshire hedgerow

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Summary

Experimental hedges were established for research purposes at Monks Wood in the 1960s. One of these was divided into 12 hedgerow plots in the winter of 1990/1. One of three extreme management treatments (uncut, laid or coppiced) was applied to each plot. During the summer of 1995, these were monitored for birds and butterflies, and pitfall traps and botanical quadrats were used to provide information on ground invertebrates and the flora of the field layer and of the hedge. The effects of the management, four years after application, on these taxa are presented and discussed.

Key words: Species richness, diversity, conservation, shelter effects

Introduction

During the early period of Monks Wood as a scientific research centre, much emphasis was placed on conservation of the wider countryside in which hedges played a vital role. This work culminated in the publication of the New Naturalist book on hedges (Pollard, Hooper & Moore, 1974). During the 1960s, experimental hedges of mixed planting and of pure hawthorn were established at Monks Wood for scientific purposes.

There has been a resurgence of interest in hedgerows in recent years (e.g. Countryside Commission, 1984; Way & Grieg-Smith, 1987; Spellerberg & Gaywood, 1993; Boatman, 1994; Watt & Buckley, 1994) although much of this work has been based on survey rather than experimental studies. A continuing loss of hedgerows through removal or neglect (Barr & Parr, 1994) and documented declines in many bird (e.g. Marchant, Hudson, Carter & Whittingdon, 1990) and butterfly (e.g. Heath, Pollard & Thomas, 1984) species may have fuelled this interest. One of the experimental hedgerow strips at Monks Wood was managed to provide three contrasting management styles. This paper examines the direct effects of these managements on the flora and fauna of the hedgerow.

Materials and Methods

The hedge

Several experimental hedgerows were established at Monks Wood in the early 1960s and these

run south from the Monks Wood National Nature Reserve to the boundary with neighbouring landowners. These were established on former arable land, which is now managed as a low-input hay system. A strip of pure hawthorn was modified in the winter of 1990/1 to provide 12 plots each of approximately 20m length. To each of the plots one of three treatments was applied: uncut - i.e. no management (mean height in 1995, 3.8m); laid professionally (2.4m); coppiced - cut to ground level (1.2m). The original intention of four replicate plots of each treatment was not achieved when one additional coppice plot was unfortunately created by error. Consequently there were three replicate plots of the uncut treatment, four of the laid and five of the coppice. The experimental design is therefore treated as a completely randomised one with unequal replication, rather than as a randomised block experiment.

Butterfly surveys

Recording of butterflies was carried out along both sides of the hedge using the method adopted in the Butterfly Monitoring Scheme (Hall, 1981). Under this scheme, butterflies are recorded when minimum weather conditions are met (Hall, 1981). 19 visits were made between the beginning of April and the end of September 1995. Butterflies up to 5m from the centre line of the hedge were recorded. Species richness, total butterfly abundance and Simpson's index of diversity were calculated for each plot.

Bird surveys

The hedge was surveyed by mapping the positions of all birds seen during visits made at approximately monthly intervals from late March to mid-August. As well as visual sightings of birds, evidence of breeding was collected by searching the hedges for nests.

Pitfall traps

Three pitfall traps were established in each plot along the central axis of the hedge at the midpoint and at 5m either side of the midpoint. These were of 7.5cm diameter and contained a 20% ethylene glycol solution and a little detergent. Soil surface and litter invertebrates trapped during an eight week period ending in mid-October were identified, where possible, to species, and results bulked over the three pitfalls for each plot. Not-target groups, such as springtails and mites were not counted.

Botanical survey

A survey of the flora of the hedge bottom and of the woody structure of the hedge was carried out in July 1995. Five contiguous $2m^2$ quadrats, aligned along the central axis of the hedge, were placed in the middle 10m of the hedgerow plot and the ground cover of all species and of litter/bare ground recorded within each one. Species present but at very low density were assigned the nominal value of 0.1%. An estimate of ground cover for each species for each plot was made by averaging over all quadrats. Species richness and Simpson's index of diversity were calculated for each plot. The proportion of species forming the canopy was also recorded at the same points.

Analysis

Botanical percentage cover data were angularly transformed prior to analysis. One way ANOVA was carried out on the results for individual species and for the summary variables. Plot number was included as a possible covariate in the analysis to detect any positive or negative influence of Monks Wood National Nature Reserve. Butterfly, bird and pitfall data and their summary

measures were analysed using Kruskal-Wallis nonparametric one-way ANOVA. Ordination of the separate taxa was investigated using Principal Components Analysis (PCA) based on the covariance matrix.

Results

Butterflies

A total of 646 butterflies of 12 species were recorded along the hedgerow. The most common species were the meadow brown *Maniola jurtina* (64%), hedge brown *Pyronia tithonus* (20%) and the small heath *Coenonympha pamphilus* (9%). Significant differences ($p<0.05$) between hedgerow treatments were detected for the meadow brown, hedge brown, total butterfly count and Simpson's index (Table 1).

Table 1. *A summary of selected butterfly records during 1995*

	mean values			
	uncut	laid	coppiced	Ave. SED
Meadow brown	21.7	47.8	31.4	5.93
Hedge brown	1.0	12.0	16.0	5.17
Small heath	2.0	4.0	7.2	2.44
No. species	3.3	5.0	5.4	1.22
No. butterflies	25.7	67.0	60.2	7.75
Simpson's index	0.274	0.425	0.604	0.077

Surprisingly, in view of earlier studies (Sparks & Parish, 1995), fewer butterflies were detected on the uncut hedges (but see later discussion). For some species, the coppiced hedges were preferred. A PCA ordination of plots suggests that there is some separation of the butterfly communities of the three hedgerow managements (Fig 1).

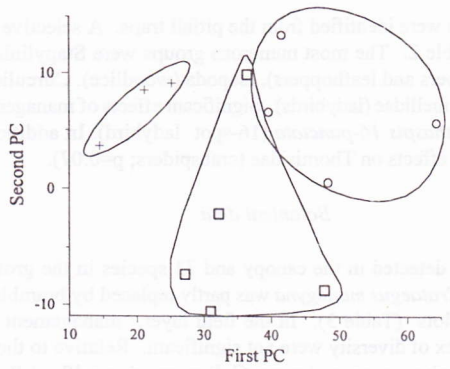

Fig. 1. PCA ordination of butterfly records (+ uncut; o laid; □ coppiced).

Birds

Eleven species of birds were observed in the experimental hedgerow, of which five species were breeding. These were chaffinch *Fringilla coelebs*, wood pigeon *Columba palumbus*, dunnock *Prunella modularis*, blackcap *Sylvia atricapilla* and whitethroat *Sylvia communis*. In addition there was evidence of a previous year's blackbird *Turdus merula* nest. Numbers of individuals were generally low, so it was somewhat surprising that significant management effects were detected for one species - wood pigeon, though it will be no surprise that these were associated with the tall uncut hedges (Inglis, Wright & Lill, 1994). Whitethroats were only associated with the coppiced sections, but numbers were too few for statistical significance. A PCA ordination based on these scant data also suggests separation of the bird communities between the three hedgerow managements (Fig 2).

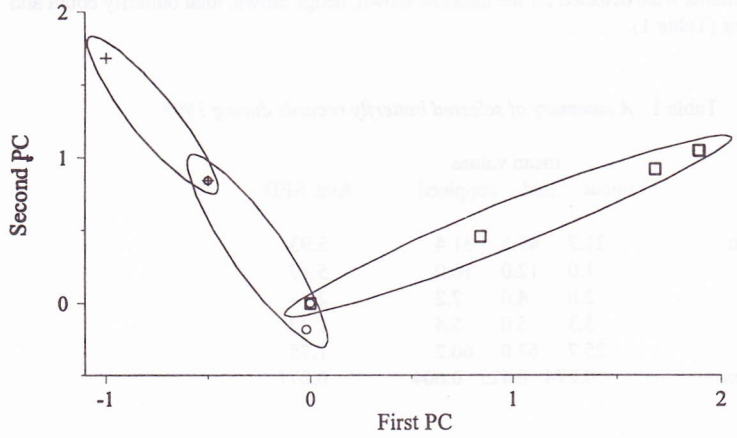

Fig. 2. PCA ordination of breeding bird records (+ uncut; o laid; □ coppiced).

Pitfall traps

A total of 1907 individuals were identified from the pitfall traps. A selective summary of these results are presented in Table 2. The most numerous groups were Stapylinidae (rove beetles), Auchenorhyncha (froghoppers and leafhoppers), Isopoda (woodlice), Curculionoidea (weevils), Formicidae (ants) and Coccinellidae (ladybirds). Significant effects of management were detected for Scirtidae indet. and *Tythaspis 16-punctata* (16-spot ladybird). In addition there was some suggestion of management effects on Thomisidae (crabspiders; p=0.07).

Botanical data

Eight plant species were detected in the canopy and 73 species in the ground flora. Of the canopy species, hawthorn *Crataegus monogyna* was partly replaced by bramble *Rubus fruticosus* in the laid and coppiced plots (Table 3). In the field layer, management effects on species richness and Simpson's index of diversity were not significant. Relative to the uncut hedges, the cover of creeping thistle *Cirsium arvense*, cleavers *Galium aparine*, selfheal *Prunella vulgaris* and creeping buttercup *Ranunculus repens* appeared to increase in the laid and coppiced plots. There was also an increase in litter/bare ground and an increase in forbs at the expense of grasses and bryophytes (Table 3).

Table 2. *A summary of selected pitfall results*

	mean values			
	uncut	laid	coppiced	Ave. SED
Armadillidium vulgare	5.3	7.0	10.4	6.4
Oniscus asellus	4.0	3.0	4.4	3.0
Philoscia muscorum	3.0	4.0	4.4	2.4
Trachelipus rathkei	15.0	12.0	11.0	5.5
Auchenorhyncha indet.	19.0	20.2	32.4	11.2
Myrmica ruginodis	9.7	4.5	9.4	4.4
Myrmica scabridonis	10.3	5.5	5.8	3.2
Pterostichus cupreus	0.7	2.5	4.8	2.6
Staphylinus olens	39.0	4.2	8.2	21.9
Smaller staphylinids	13.7	5.2	11.8	4.3
Sciritidae indet	3.3	0.0	0.0	1.7
Tythaspis 16-punctata	1.3	2.0	19.2	9.6
Chrysomelidae	1.3	0.8	4.0	3.4
Curculionoidae	9.0	14.2	24.2	12.7
Thomisidae indet.	1.0	0.5	3.2	1.2
Lycosidae indet.	2.0	4.0	7.6	3.3
Total numbers	162.7	116.2	190.8	57.8
No. groups	24.7	24.0	29.6	3.8
Simpson's index	0.854	0.903	0.899	0.034

Table 3. *A summary of selected botanical data*

	mean values			
	uncut	laid	coppiced	Ave. SED
Species Richness	27.3	26.0	33.0	3.8
Simpson's index	0.844	0.821	0.861	0.026
Canopy cover (%ang trans)				
C.monogyna	84.3	72.0	47.7	2.7
R.fruticosus	2.4	13.0	20.8	5.0
Ground cover (%ang trans)				
Cirsium arvense	7.4	11.7	18.7	3.2
Galium aparine	0.6	5.7	3.9	1.6
Poa pratensis	0.5	0	0	0.2
Prunella vulgaris	0.2	0.9	2.6	0.8
Ranunculus repens	0.7	1.3	3.0	0.9
litter/bare ground	39.5	51.4	43.5	3.2
Grass species	38.8	25.2	28.1	3.9
Forb species	12.1	16.9	22.9	3.4
Bryophyte species	11.4	5.4	5.4	1.6
Forb species richness	11.7	11.5	18.4	2.6

Nine species showed some pattern with increasing distance from the wood. Of these, four were more abundant closer to the wood (cleavers *G.aparine* (and in canopy), wood false-brome *Brachypodium sylvaticum,* red fescue *Festuca rubra*, and chickweed *Stellaria media)*, whilst the remaining five were more abundant at the opposite end of the hedge (hawthorn seedlings *Crataegus monogyna* , Yorkshire fog *Holcus lanatus,* Blackthorn seedlings *Prunus spinosa,* dog rose *Rosa canina* and creeping buttercup *R.repens)*. In the case of *B.sylvaticum* this might be considered to reflect movement of a woodland plant species along a hedgerow corridor. Similarly the decrease in *G.aparine*, *F.rubra* and *S.media* may represent movement of weed species from a former position on an arable headland. Many of the other species may be invading from the boundary hedge at the southern end of the experimental hedgerow. Considering the hedge is relatively young, it is surprising to find so many suggestions of a plant corridor effect.

Discussion

That fewer butterfly species were recorded on the uncut hedges is contrary to initial expectations. However, the hedges at Monks Wood are comparatively young and the woody component is dominated by hawthorn. The uncut hedges have a sparse ground flora which has been grazed by rabbits and the base of the hedge itself has been grazed by deer giving little protection against the elements. The managed hedge plots contain more canopy and ground flora species that are likely to be attractive nectar sources, for example *R.fruticosus* is an important nectar source for the hedge brown. In addition there are suggestions that the meadow brown, at least, is making more use of the protection offered by hedges in high wind, particularly the dense laid plots (Table 4). The meadows surrounding the experimental hedges are neither fertilised nor sprayed. As such they are already an attractive resource to many grassland butterflies. In more intensive farming systems, the flora adjacent to the hedge is likely to be more attractive than that of the fields the hedge separates. In addition, butterflies are known to be particularly exacting in their selection of larval foodplants and the grass species in the shade of the tall hedge may not have met these strict criteria, whilst those less shaded in the shorter hedges may well be more suited to these, essentially, grassland species.

Table 4. *The mean numbers(%) of meadow brown butterflies observed during visits at Beaufort scales two (n=3), three(n=3) and four(n=4)*

Wind speed (Beaufort scale)	uncut	laid	coppiced	Ave. SED
2	2.0(18)	4.5(40)	4.6(42)	1.2
3	11.3(26)	19.2(44)	12.8(30)	2.7
4	8.3(18)	24.0(52)	14.0(30)	4.6

Bird numbers were lower than desirable to draw firm conclusions in a study of hedgerow management, reflecting the shortness of the hedgerow plots (20m). However, the association of whitethroats with the coppiced sections was probably due to the presence of dense, low cover (favoured by this species for both nest sites and foraging) in these sections. In practice, an examination of the effects of hedgerow management on bird populations is likely to require plots in excess of 100m. At this length, it becomes much harder to maintain homogeneity of the hedge (other than its management) and of the surrounding environment. The effect of management on

berry production, as a food source for birds outside the breeding season, is not examined in this paper. The experimental hedgerow, because of its youth, was dominated by hawthorn, although bramble and rose also provided fruit in certain plots. Hedges that produce large quantities of hawthorn berries may be of immense value to wintering bird populations, particularly migrating thrushes. There was insufficient time to quantitatively assess berry production in the hedgerow plots. However visual inspection suggested very low production in the coppiced hedge, whilst the uncut hedge sections appeared to provide not only greater production for a given unit surface area, but overall greater production once larger surface area was taken into account. This feature deserves fuller investigation in subsequent years. At the time of writing, autumn observations of bird populations were continuing, and initial analysis suggested reduced numbers of birds in the coppice section relative to the uncut and the laid ($p=0.08$).

The experimental hedges have been established for 30 years, and the three management regimes were applied four years before botanical assessment in 1995. Of the 75 botanical variables examined, ten showed a significant management effect, whilst a further six demonstrated a pattern in relation to distance from Monks Wood NNR. Many of the observed trends were entirely predictable, especially with respect to hawthorn. However, patterns in species cover in the ground flora and undergrowth present more useful information. For most variables, the treatments may be arranged along a gradient of increasing disturbance from uncut, through laid to coppiced.

The uncut hedges have a ground flora characterised by high grass cover, especially of coarse species, with moss patches largely confined to the hedge centre where light levels are lowest and grass-cover thins out. The main grass dominant (*Arrhenatherum elatius*) is also intolerant of frequent cutting, preferring undisturbed conditions (Grime, Hodgson & Hunt, 1988). The relatively forb-poor community reflects a lack of colonisation/regeneration niches in a sward which is coarse and unbroken, precisely where light-conditions might be suitable for the establishment of a wide variety of such forbs. In contrast, the most extreme cutting regime (coppicing) not only removes much of the hawthorn growth, but is also associated with soil disturbance - stimulating the spread of invasive plants (e.g. *C. arvense* and *R. fruticosus*) and of light-demanding creeping forbs (e.g. *P. vulgaris* and *R. repens*). The resultant community is thus forb-dominated, except where dense bramble restricts all herbaceous growth, and has a restricted grass cover.

Examination of the primary ecological strategies (Grime, 1977) of those species showing significant patterns in relation to management, provides some tentative evidence that competitors and stress-tolerators are more common in the uncut hedges, whilst species with a ruderal strategy (at least in part) are particularly common in the coppiced lengths. However, use of the light indicator values (L) for the same species shows no established pattern in relation to relative light intensity (Ellenberg, 1988). The Monks Wood hedges have not been established long enough to have acquired a distinctive shade flora, and the main patterns in species abundance reflect the passage of time since disturbance rather than variation in the light-regime.

There were few significant management effects on the invertebrates captured by pitfall trapping. Like birds, the 20m plots may not be of sufficient length to demonstrate effects. Alternatively greater replication or an extended sampling period may be necessary to establish statistically significant effects of management. Many ground species may not be particularly fussy about the structure of the hedge above them, whereas the vegetation structure of the hedge base may be more important. More information about the effects of contrasting management may be forthcoming by sweeping, beating or vacuum sampling of the hedge itself rather than pitfall trapping at the hedge base.

The first year of recording of this hedge experiment has produced much useful information. In some circumstances there are suggestions that plot length may be inadequate or that additional replication and sampling effort is necessary to estimate management effects with sufficient precision. Certainly single experiments should not be considered adequate to examine the effects on all taxa. Hedge management does have a substantial effect on the conservation value of the

hedge itself, and hedges within intensive farming systems are very important refugia for species. However, hedge management is not the only influencing factor of the wildlife value of a hedge; management of adjacent land (e.g. spray and fertiliser applications) and grazing by farm stock and by rabbits are all influential. Consideration of all these factors is necessary when plans to enhance the conservation value of single hedgerows and hedgerow networks are raised.

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