FIELD MARGINS AS HABITATS FOR GAME

N.J. AEBISCHER & K.A. BLAKE

The Game Conservancy Trust, Fordingbridge, Hants, SP6 1EF

N.D. BOATMAN

Allerton Research and Educational Trust, Loddington House, Loddington, Leics., LE7 9XE

ABSTRACT

Several game species make considerable use of field-margin habitats, in particular grey partridges, red-legged partridges, pheasants and hares. Generally speaking, field margins play a multiple role for these animals: they provide cover for nesting or shelter, they provide brood-rearing areas and they provide food. This paper briefly reviews current knowledge about such use, and presents results from recent work on nest-site selection by grey partridges. It highlights the features that the animals seek out preferentially, and discusses the implications in terms of integrating field-margin management with modern crop husbandry and EU regulations.

INTRODUCTION

Since the 1950s, many of the traditional game species often associated with agricultural land have undergone severe decline. The grey partridge *Perdix perdix* in particular has fallen to 20% of its pre-war abundance on average (Potts, 1986, Marchant *et al.*, 1991), and has disappeared completely from some areas of the British Isles (Gibbons *et al.*, 1993). Bag records suggest that numbers of brown hares *Lepus europaeus* have followed a similar pattern (Tapper, 1992), and numbers of red-legged partridges *Alectoris rufa* and pheasants *Phasianus colchicus* appear stable only because of large-scale releases of reared birds (Hill & Robertson, 1988, Gibbons *et al.*, 1993).

Directly or indirectly, the cause of the decline has been the steady intensification of agriculture: introduction of herbicides in the late 1950s, greater mechanisation leading to hedgerow removal and field enlargement, the abandonment of mixed farming in favour of all-arable agriculture increasingly geared towards winter crops, the rise in the use of fungicides, insecticides and other inputs in the 1980s (Jenkins, 1984, Potts, 1990). For game, the consequences have been a loss of the habitat types that are needed for food, cover or reproduction at one or more times of year. With the sanitisation of the crop itself, game has been squeezed into the intercrop zones of farmland. The relative importance of field margins is thus much greater now than in the past. We describe below the habitat requirements of game during the breeding period (spring-summer) and the non-breeding period (autumn-winter) based on recent work by The Game Conservancy Trust. The emphasis will be on the grey partridge, a bird currently in the UK Red Data Book (Batten *et al.*, 1990), but reference will also be made to the red-legged partridge, the pheasant and the hare. We also discuss the management implications of these habitat requirements.

FIELD-MARGIN REQUIREMENTS OF GAME

Requirements during the breeding season

For adult grey and red-legged partridges, food availability during this period is generally not a problem. The habitat requirements are two-fold: (1) availability of suitable nesting cover and (2) availability of suitable brood-rearing areas for birds that nested successfully. Early work, summarised in Potts (1986), found that partridges nested along hedgerows, fence lines and other linear features of arable landscapes. The physical structure and vegetation characteristics of hedgerows have been identified as a factor affecting the suitability of hedges for nesting (Blank *et al.*, 1967, Hunt, 1974). A more detailed study of nest-site selection by Rands (1986, 1988) showed that grey partridges sought out slightly elevated nesting locations such as ones on hedge banks, which were correspondingly well drained. The presence of dead grass at the bottom of a hedge was also a feature of preferred nesting locations, as it provided cover from predators, cryptic-coloured nesting material and shelter from the weather. Red-legged partridges too selected nest-sites in areas where the amount of dead grass was greater than in the surrounding vegetation and also where the amounts of leaf-litter, bramble *Rubus spp.* and common nettle *Urtica dioica* were higher (Rands, 1986, 1988).

More recent work on radio-tagged partridges at two sites in Wiltshire and Hampshire in 1991 provided an objective assessment of the nesting preferences of grey partridges (Table 1). Although more nests than expected from previous studies were found outside field margins, i.e. within crops or grass fields, two-thirds of nests were situated in marginal habitat such as hedge bottoms, verges and odd corners of uncultivated land, confirming the importance of field margins in the broad sense.

TABLE 1. Choice of habitats for nesting by radio-tagged grey partridges at two sites in Hampshire and Wiltshire in 1991.

	Field margins	Winter cereals	Peas/beans	Pasture/hay	Game crops	Total
Wiltshire	12	2	0	4	0	18
Hampshire	8	2	1	0	2	13
Frequency	65%	13%	3%	13%	6%	100%

This work studied the vegetation characteristics of the 31 nest-sites compared to randomly chosen locations at two levels: an "extensive", low-resolution level whereby 40 points were selected randomly within each of three habitats (cropped areas, field margins, other areas), and an "intensive", high-resolution level whereby each nest was paired with a point selected at random within the same patch of habitat containing the nest. The percentage cover of plant species within four 0.25 m^2 quadrats placed around each site was recorded and averaged. Boatman *et al.* (in press) carried out a preliminary regression analysis of these data. They found that nests were associated with dead grass, leaf litter and tall forbs of moderately disturbed ground, but recommended a canonical correspondence analysis of the plant communities; this is presented here using CANOCO (Ter Braak, 1988). The vertical structure of the vegetation was measured as the percentage of a graduated measuring board that was not visible from a fixed observation point at each of 11 height categories (0-5 cm, 5-10 cm, 10-20 cm, ... 90-100 cm), averaged over the four quadrats at each site.

After removing the effects of study area and habitat type, at the extensive level the vertical structure around nest sites was significantly denser at heights above 20 cm than around randomly chosen non-nest sites; the difference was most marked in the range 30-90 cm (Fig. 1). At the intensive level, a similar difference in density was observed at heights from 60 to 90 cm (Fig. 1).

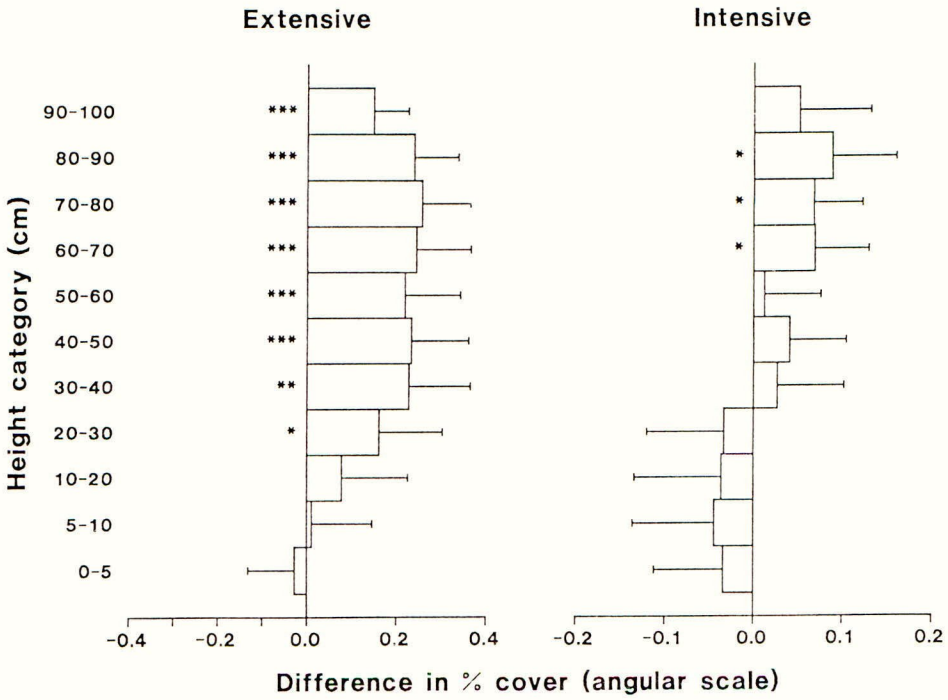

Fig. 1. Differences in vertical structure of vegetation around nests and randomly selected non-nests at two levels: extensive (left) and intensive (right). The percentage cover at each height category was normalised by angular transformation. Positive difference values indicate that cover was greater above nests than above non-nests, and vice versa; error bars represent 95% confidence limits. * $P<0.05$; ** $P<0.01$; *** $P<0.001$.

The CANOCO ordinations revealed that, at the intensive level, there were no detectable differences between the vegetation communities around nests and around non-nests. There was, however, a significant difference ($P<0.05$) in plant communities at the extensive level. In the ordination diagram (Fig. 2), the first axis represents the separation between nests and non-nests. The vegetation surrounding nests had features typical of mesotrophic rough grasslands, with species such as common nettle, cock's-foot *Dactylis glomerata* and upright hedge-parsley *Torilis japonica*. The non-nest plant community represented mainly vegetation of disturbed chalk, either low-lying species such as clovers *Trifolium* spp. and plantains *Plantago* spp. or taller clump-forming species colonising bare ground (e.g. mugwort, *Artemisia vulgaris*). Between the two extremes lay a group of species belonging to coarse chalk grassland.

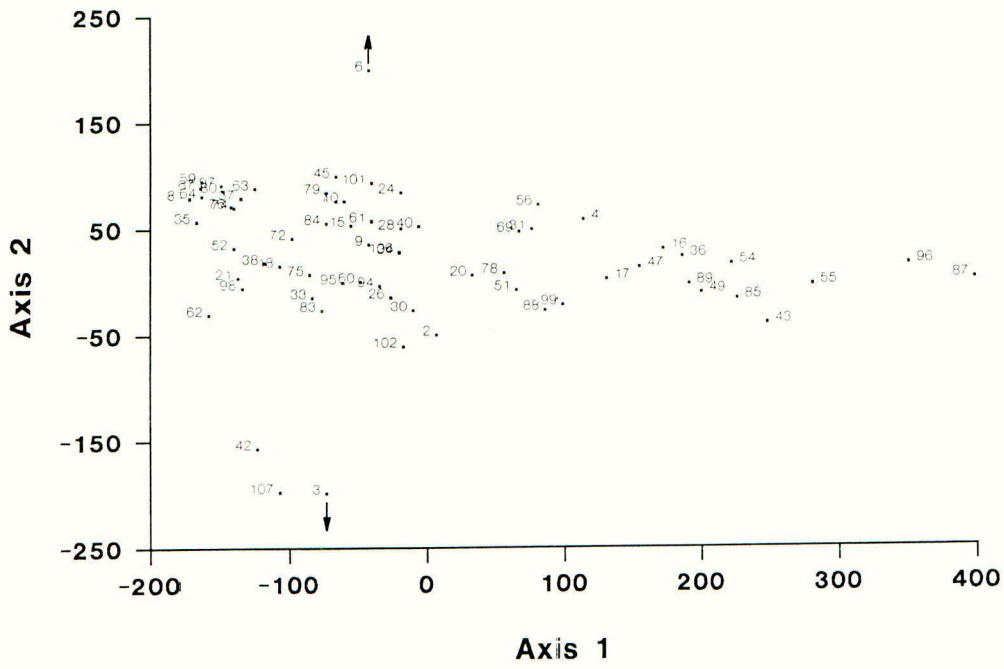

Fig. 2. CANOCO ordination diagram of plant species associated with nests and randomly selected non-nests at the extensive level. Axis 1 represents the separation between nests (positive values) and non-nests (negative ones). The arrows indicate values outside the scale of Axis 2. The species codes are explained in the Appendix.

The plant community characterising nest sites was therefore on average taller, and had a more continuous canopy, than that associated with non-nest sites. In the latter case, the vegetation cover was patchy, and the canopy tended to be lower and much more open. The vegetation classification agreed well with the results on vertical structure (Fig. 1). Taken together, the results implied that partridges preferred to nest in the type of plant community that provided them with the best cover around and over the nest; moreover within such a community they sought out those patches that best fitted those criteria.

For pheasants in most of Britain, field margins are important only if adjacent to woodland edges and shrubby cover (Woodburn & Robertson, 1990), and are used early in spring by males setting up their territories. Territory density was three times higher when such woodland edges were adjacent to cereal crops than to grass because the crop edges offered better feeding opportunities for the hens in each male's harem (Robertson, 1992, Robertson *et al.*, 1993). For nesting purposes, radio-tracking studies have shown that unlike the situation for partridges, grassy banks and hedgerows are not preferred habitats (Hill & Robertson, 1988). Work in the USA suggests however that grass strips are attractive as nesting cover provided that the vegetation height is sufficient to afford concealment from avian predators (Mankin & Warner, 1992).

Radio-tracking of hares (Tapper & Barnes, 1986) has shown that on intensive arable areas, hares suffer a food bottleneck during the summer. Frylestam (1980a) has shown that during this period grass strips are very attractive to hares as feeding areas, and that there is a link between nutrition and reproduction (Frylestam, 1980b). Field margins also offer shelter and resting places for hares in the form of hedgerows and grass banks (Tapper & Barnes, 1986).

Grey partridge and pheasant chicks both require an insect-rich diet in the first weeks of life (Hill, 1985, Potts, 1986), but a high-protein diet seems less critical for young red-legged partridges (Green, 1984, Rands, 1988). The structure of the vegetation in which the chicks forage is also important, as it must be tall enough for concealment from predators, yet sufficiently open to allow easy passage. In wet weather, the chicks must be able to avoid becoming soaked through contact with vegetation and, if wet, must be able to dry out. The structure of cereal crops are ideal from these points of view, and radio-tracking has demonstrated that hens lead their broods from the nesting site into adjacent cereal crops, where they spend most of their time (Green, 1984, Hill, 1985). Cereals can provide the insects that the chicks require as long as enough broad-leaved weeds are present as insect hosts; too often, however, this weedy understory is eliminated by the use of herbicides (Southwood & Cross, 1969, Potts, 1986). In Poland, where up to 70% of crop area was not sprayed, the mean brood size of grey partridges was 9.3 (Panek, 1992) compared to 4.8 on intensively farmed English land (Sotherton & Robertson, 1990); the latter increased to 7.4 in insect-rich, selectively-sprayed, weedy cereal headlands.

Pheasant brood sizes increased from 2.8 in fully-sprayed fields to 4.9 in ones with selectively-sprayed headlands (Sotherton & Robertson, 1990). In Austria, differential brood sizes of pheasants on conventionally farmed land and in untreated cereal mix on set-aside land were 4.9 ($n = 153$) and 6.8 ($n = 53$) respectively (P.A. Robertson, pers. comm.). Direct insect mortality through summer aphicide use may also negatively affect chick survival rates; Potts (1990) found that the chick survival rate of grey partridges and of pheasants was 50% lower in cereals sprayed with a broad-spectrum insecticide in June than in cereals that had not received the aphicide treatment.

Requirements during the non-breeding season

Field margins in winter are mostly useful to partridges as a source of cover in the form of hedgerows and rough grass. To a limited extent, they may supply some food items as well, such as green vegetable matter and weed seeds. Hedgerows and most grass strips play a more important role in late winter, as the birds start to form pairs and space themselves out. Potts (1980) found that the emigration rate of grey partridges was negatively related to the density of linear features (km/km^2) in the landscape. The importance of these features on a local scale was confirmed by Rands (1986), who observed that the length of potential nesting habitat (field boundaries including hedgerows) explained up to 81% of the variation in grey partridge pair density within farms, and up to 98% of that for red-legged partridges.

For hares in winter, field margins are less important as a food source as they are able to feed on winter crops. However, hedgerows and strips of long grass are still intensively used as shelter, as in the summer, particularly by day (Tapper & Barnes, 1986).

Pheasants in winter concentrate in areas of shrubby cover that provide shelter adjoining suitable feeding areas. As in the summer, densities are higher where cereal fields rather than grass abut the cover, by a factor of two (Robertson, 1992).

DISCUSSION AND IMPLICATIONS FOR MANAGEMENT

The relevance of different forms of field margins to farmland game is summarised in Table 2. The grey partridge, red-legged partridge, pheasant and hare all rely on field margins at some point in their life-cycle, be it for food, shelter or nesting.

TABLE 2. Summary of field margin types and their importance to game in spring/summer and autumn/winter.

Species	Hedgerow	Grass strip	Crop edge	Rough ground
Spring/summer				
Grey partridge	nesting	nesting	brood-rearing	nesting/brood-rearing
Red-legged partridge	nesting	nesting	brood-rearing	nesting/brood-rearing
Pheasant	-	nesting	brood-rearing	nesting/brood-rearing
Hare	shelter	feeding	-	shelter/feeding
Autumn/winter				
Grey partridge	shelter/feeding	pairing	feeding	shelter/feeding
Red-legged partridge	shelter/feeding	pairing	feeding	shelter/feeding
Pheasant	-	feeding	feeding	feeding
Hare	shelter	feeding	-	shelter/feeding

A number of management options have been developed and proposed as a means of integrating game conservation and modern farm management. Below, we review these for each of the different types of field margin that are relevant to the requirements of game.

Hedgerows

Between 1989 and 1990, 52000 km of hedgerows in Great Britain were removed while only 25400 km of new hedges were planted (Brown, 1992). This represents a continuation of the process of hedgerow removal described by Barr *et al.* (1986). The planting of new hedgerows is encouraged by government grants, now supplemented by a new Countryside Commission "Hedgerow Incentive Scheme" to encourage improved hedgerow management. Other schemes such as Countryside Stewardship or Environmentally Sensitive Areas also seek to favour a more sympathetic management of linear habitat features. Such management includes maintenance of the woody structure of the hedge at a height of approximately 2 m (Pollard *et al.*, 1974), rotational cutting of the hedge, bank and grass margin every two to three years to allow cover to develop (Rands, 1987), no spraying or selective spraying of the hedge bottom to control agricultural weed pests such as cleavers *Galium aparine* or brome *Bromus spp.* (Boatman, 1992), and establishment of a buffer strip between the crop and the hedge to protect the hedge from fertilizer and pesticide drift (Jepson *et al.*, in press) and the crop from weed encroachment (Boatman & Wilson, 1988).

Grass strips

Grass strips are valuable for game only if part of them at least is allowed to grow up and provide cover. Ideally, strips should be cut every two to three years, on a rotational basis around the farm (Rands, 1987). They can be planted alongside hedgerows, tracks or roads, or around crops. The Game Conservancy Trust, in conjunction with Southampton University, has developed "Beetle Banks", raised strips across fields that are planted with a mixture of tussocky grasses such

as cock's-foot or Yorkshire fog (Thomas *et al.*, 1991, 1992). Besides harbouring high densities of natural aphid predators over winter, these banks may also provide alternative shelter and nesting cover for hares and partridges. Work in the USA has shown that wide strips are better for nesting gamebirds than narrow ones, as predation rates were much higher in narrow strips than in ones 10 m or more wide (Olsen, 1977).

Crop edges

Modern crops provide the right structure for gamebird chicks, but are deficient in the insect food that the chicks require (Southwood & Cross, 1969, Potts, 1986). Conservation Headlands are a tried and tested way of restoring the understory of weeds and their invertebrate fauna, with beneficial effects upon gamebird chick survival (Sotherton and Robertson, 1990, Sotherton, 1991, Chiverton, 1994). The idea is that the outer 6-m band of cereal crop receives reduced and selective pesticide inputs that control grass weeds and cleavers, while enabling most broad-leaved weed species and beneficial insects to survive. The guidelines are constantly being updated so as to maximise the benefit to game while minimising the agricultural disadvantages (Boatman & Sotherton, 1988, The Game Conservancy Trust, 1993).

Set-aside

The latest MAFF guidelines and EU regulations concerning management of set-aside land are much more favourable towards game than in previous years (MAFF, 1993). The option of mixing rotational and non-rotational set-aside on the same farm is particularly promising (The Game Conservancy Trust, 1994). Strips or blocks of non-rotational set-aside can be strategically placed to provide shelter, nesting or brood-rearing cover for all species of game. Strips across large fields can constitute islands of game habitat and make large cultivated areas more diverse. Rotational set-aside following cereals can be used to make up the required area; it provides food over winter and, if a strong growth of volunteer cereals develops, becomes ideal brood-rearing habitat if left undisturbed until mid-July.

Conclusion

As regards the fortunes of farmland game in Britain, set-aside holds the greatest potential because it affects the greatest surface area and is already being implemented. This and the other options mentioned above show that there is now more scope for sympathetic management and financial support for such management than there has been for several decades. Time will tell whether the opportunity will be grasped, and whether we are at a turning point in the declining fortunes of our wild lowland game.

ACKNOWLEDGEMENTS

We thank Hugh Oliver-Bellasis and the Ministry of Defence for granting access to their land.

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APPENDIX

Plant species recorded in four 0.25 m^2 quadrats around each of 31 grey partridge nests and 120 randomly-selected non-nests. Numbers represent codes allocated by CANOCO in Figure 1.

1	Bare ground	59	*Linum catharticum*
2	Dead grass	60	*Lolium perenne*
3	Spring barley	61	*Lotus corniculatus*
4	Winter wheat	62	*Chamomilla suaveolens*
6	Peas	63	*Medicago lupulina*
9	Winter rape	64	*Melilotis officinalis*
15	*Achillea millefolium*	67	*Odontites verna*
16	*Agrimonia eupatoria*	69	*Papaver rhoeas*
17	*Elymus repens*	70	*Pastinaca sativa*
18	*Agrostis stolonifera*	72	*Phleum pratensis*
20	*Arrhenatherum elatius*	74	*Plantago lanceolata*
21	*Artemisia vulgaris*	75	*Plantago major*
24	*Bromus erectus*	76	*Plantago media*
26	*Bromus sterilis*	78	*Poa trivialis*
28	*Centaurea scabiosa*	79	*Potentilla anserina*
30	*Cirsium arvense*	80	*Potentilla reptans*
31	*Cirsium vulgare*	81	*Prunus vulgaris*
33	*Convulvulus arvensis*	83	*Ranunculus repens*
34	*Crataegus monogyna*	84	*Reseda lutea*
35	*Crepis capillaris*	85	*Rubus fruticosa*
36	*Dactylis glomerata*	87	*Rumex crispus*
37	*Daucus carota*	88	*Rumex obtusifolius*
38	*Epilobium hirsutum*	89	*Senecio jacobea*
40	*Festuca rubra*	94	*Stachys sylvatica*
42	*Fumaria officinalis*	95	*Stellaria media*
43	*Galium aparine*	96	*Torilis japonica*
45	*Galium verum*	97	*Trifolium pratense*
47	*Geranium dissectum*	98	*Trifolium repens*
49	*Glechoma hederacea*	99	*Urtica dioica*
51	*Heracleum sphondylium*	100	*Veronica persica*
52	*Holcus lanatus*	101	*Vicia cracca*
54	*Knautia arvensis*	102	*Viola arvensis*
55	*Lamium album*	106	*Taraxacum sp.*
56	*Lathyrus pratensis*	107	*Helianthemum sp.*