Responses of farmland birds to set-aside and its management

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The potential of set-aside to re-introduce winter stubble fields and weed-rich fields in summer to arable farmland on a wide geographical scale has led to a substantial area of research into its benefits for farmland birds. Here we present evidence for associations between set-aside and birds in winter and summer, concentrating on two recently completed studies, while also drawing on a considerable literature. In winter, we demonstrate, for several declining farmland species, selection of set-aside stubble over crops and grassland with a notable avoidance of winter cereals and plough. Significant variation in the usage of set-aside both within and between species is apparent depending on its composition as well as the previous crop type. In summer, bird densities were significantly higher on set-aside than on winter cereals for a wide range of species. The vegetation characteristics of set-aside had a significant influence on its usage by birds, with a heterogeneous composition (typically seen in younger set-aside) tending to be preferred. Parallel studies in both winter and summer support these conclusions. In all, the fact that not all set-aside has been suitable for birds is discussed as being a likely factor in it failing to make a major contribution to species population recoveries on farmland, despite set-aside occupying up to 15% of arable land. The conservation successes and limitations of the set-aside scheme are addressed and their consequences for farmland bird populations examined.

Long-term declines in farmland bird populations in Britain (Gibbons *et al*. 1993, Marchant & Gregory 1994, Fuller *et al*. 1995, Shrubb *et al* 1997, Siriwardena *et al.* 1998) and in continental Europe (Flade & Steiof 1990, Saris *et al*. 1994) have led to studies designed to identify the mechanisms that may have reduced the suitability of farmland habitats for birds. Many species, from a broad range of ecological needs, such as Skylark *Alauda arvensis*, Song Thrush *Turdus philomelos,* Linnet *Carduelis cannabina* and Corn Bunting *Miliaria calandra*, have undergone declines of more than 50% since the mid-1970s (e.g. Marchant & Gregory 1994). There is an increasing body of evidence linking many of these declines to aspects of agricultural intensification that have occurred over the same period. Significant changes in farming practice include:

1. A progressive switch from spring-sown to autumn-sown cereals. This has had the combined effects of: (a) removing winter stubbles, which are the preferred feeding sites for several granivorous species, from the countryside (Evans 1997a), (b) increasing crop density and height of cereal fields in spring, so reducing their suitability to field-nesting birds such as Lapwing *Vanellus vanellus* (Shrubb & Lack 1991) and Skylark (Wilson *et al*. 1997) and (c) obviating the need for spring tillage and drilling, both of which may have provided a supplementary food source for birds at a critical time of year.
2. A reduction in mixed farming with rotations and a consequent simplification of farmland at the level of the individual farm and the landscape. Arable land has been increasingly lost from the pastoral west and grassland from the arable east, both resulting in a diminished range of food resources for birds on farmland (Evans 1997b, Fuller 1997).
3. Widespread usage of herbicides and insecticides has reduced food resources for both insectivorous and seed-eating bird species (Potts 1986, 1991, Rands 1985, 1986, Campbell *et al.* 1997).
4. The intensification of grassland management through high inorganic fertiliser inputs, widespread reseeding and associated high stocking rates has resulted in dense grass swards that are less suitable to some ground-nesting birds and poor in diversity and abundance of some species of invertebrates.
5. On grassland, the switch from hay to silage production and consequent earlier and more frequent mowing has resulted in the destruction of nests, young and adults of grassland-nesting birds (O'Connor & Shrubb 1986, Fuller *et al*. 1995, Baillie *et al*. 1997).

In 1992 the Common Agricultural Policy (CAP) was reformed partly with the aim of reducing the level of surplus production. Subsidies were switched from a tonnage to an area basis and, in order to qualify for the new Arable Area Payments, farmers were obliged to remove between 15% and 18% of their arable land from production. For most farmers, Arable Area Payments

constituted such a large percentage of their profit margin that their loss was untenable and set-aside therefore, effectively compulsory. Set-aside land suddenly appeared in the agricultural environment on a vast scale (over 600,000 ha in the UK in 1993).

Complex rules were drawn up governing the management of set-aside land (see Evans *et al*. 1997). The land in question could be taken out of production for a single year and the set-aside quota moved around the farm in successive years (rotational set-aside) or the same parcel of land could be set-aside for more than a year (non-rotational). After harvest, the land was left untilled. To prevent leaching, a green cover had to be established either through natural regeneration (of cereal volunteers and indigenous flora) or through sowing a grass or seed mixture.

Whilst development of set-aside was not driven by environmental concerns, it clearly had potential benefits. Specifically, the recreation of stubbles (a field in rotational set-aside with a naturally regenerated cover begins as an overwinter stubble) might increase the availability of winter food. Meanwhile the reintroduction of areas of grassland into the arable landscape might help increase the availability of invertebrate prey in the breeding season as well as provide nest sites for ground-nesting species (Sears 1992, Wilson & Fuller 1992, Wilson *et al*. 1995, Evans *et al.* 1997).

Here we present evidence for associations between set-aside and birds throughout the year, concentrating on two recently completed studies, whilst also drawing on a considerable literature. Limitations within the set-aside scheme are addressed and their consequences for farmland bird populations examined.

METHODS

Use of set-aside by birds in winter

In a wide-scale study (Buckingham *et al*. 1999) the Royal Society for the Protection of Birds (RSPB) surveyed 40 randomly chosen farm plots, stratified so that there were 20 in each of two regions, Devon and East Anglia. The total area covered was approximately 2,500 ha. Three or four visits were made to each site between October and March 1993/1994 and 1994/95. All species using each farm plot were recorded on each visit by "complete area search" (cf. Wilson *et al.* 1996b). Parallel transects were walked across all fields and margins, the transects being close enough to each other to ensure all birds were flushed. In practice transects were never more than 50 m apart so the observer walked to within 25 m of each point. All birds were counted separately on both fields and boundaries. Habitat details included: crop type, previous crop (where the field was set-aside) and grazing regime used. In the analysis, observed values were compared with expected values generated by statistical resampling methods (Wilson *et al.* 1996b), with each region and winter treated independently.

Use of set-aside by birds in the breeding season

The British Trust for Ornithology (BTO) carried out an extensive survey of birds on set-aside on arable farms in England (Henderson *et al.* 2000a). Volunteers surveyed 92 randomly selected plots in 1996 and a subset of 63 plots in 1997. Average plot size was 40 ha and plots included one pre-selected set-aside field plus 5-10 neighbouring crop, set-aside or grassland fields. Each farm plot was visited four times in each summer and the location of all birds seen or heard mapped using standard Common Birds Census (CBC) techniques (Marchant *et al*. 1990). Recorded habitat features included hedge height and width, the frequency of trees present, crop types, field area and boundary length.

Bird species were assigned to one of six categories, gamebirds, pigeons (*Streptopelia* and *Columba* species), thrushes (*Turdus* species), crows (*Corvus* species), granivores (Fringillidae and Emberizidae) and Skylarks, to make use of all the data available and increase analytical sample sizes. Log-linear Poisson regression was used to identify field-type preferences relative to the commonest crop (winter cereals), and the effects of boundary characteristics were controlled for in the analysis (Henderson *et al*. 2000a).

A botanical survey of each set-aside field was carried out by ADAS staff (Fowbert & Critchley 1998), during which data were recorded from thirty 0.25-m^2 quadrats per field, positioned along five transects extending from the boundary into the field (six quadrats per transect). The area of vegetation cover or bare soil, straw or litter patches was estimated from a single pin-hit lowered on a string in the same corner of each quadrat, and the proportion of pin hits touching bare ground was then calculated for each field. Assessment of the variation in these parameters and its association with bird abundance was by log-linear Poisson regression fitted with and without quadratic terms to allow for non-linear relationships (Henderson *et al.* 2000a). A dispersion factor was included in all models to adjust statistics, including standard errors, by the degree of over or under dispersion in the data (adjusted by: square-root residual deviance/ degrees of freedom). The level of significant over or under dispersion in the data (according to the chi-square Goodness-of-fit tests) is presented in the results below as residual deviance/degrees of freedom (dev./df) for each bird group.

RESULTS AND DISCUSSION

Use of set-aside by birds in winter

In 1993/1994, 25% of the area studied was under set-aside (a consequence of the study plots being centred on fields in set-aside), falling to just 12% in the following winter as rotational set-aside was often moved outside the study plots. Of the 49,000 bird registrations made, 35% were on set-aside, including more than half of 11,000 Skylark registrations. Results for six declining farmland bird species are presented here; five of these are on the red list of "Birds of Conservation Concern" (Gibbons *et al*. 1997), having declined by more than 50% in 25 years, and the sixth (Yellowhammer *Emberiza citrinella*) would qualify on the basis of a recent severe decline, should the list be revised. Significantly more birds were found in at least one of the two regions in one year on set-aside stubbles than would be expected from a random distribution, for five of the six species, namely Grey Partridge *Perdix perdix*, Skylark, Linnet, Cirl Bunting *Emberiza cirlus* and Yellowhammer (Buckingham *et al.* 1999, Table 1a). In contrast Song Thrushes appeared to avoid winter set-aside, but preferred brassicas. Avoidance of winter cereals and agricultural grassland was consistent across all six species. Species varied in the type of set-aside selected, with the seed-eating passerines preferring naturally regenerated vegetation and Grey Partridge preferring more established grass cover (Table 1b). The previous crop had a significant effect on the usage of first-year fallow fields by birds, with barley stubbles proving the most commonly selected (Table 1c). In none of these analyses did species show contrary results in different regions or years.

Buckingham *et al.* (1999) thus demonstrated, for five declining farmland species, selection of set-aside stubble over crops and grassland with a notable avoidance by all six species of winter cereals and plough. Buckingham *et al.* (1999) also found significant variation in the usage of set-aside both within and between species depending upon

Table 1. Summary results of randomisation tests. '+' = selection shown (more birds counted than expected from random distribution generated by resampling at $P < 0.05$) in at least one region / winter; '-' avoidance shown (less birds counted than expected from random distribution generated by resampling at $P < 0.05$) in at least one region / winter. 'o' = number of birds counted did not differ from that expected from a random distribution generated by re-sampling in any region or winter. Field comparisons related to: (a) winter field types, (b) different types of set-aside, "NR"natural regeneration, (c) fallow land in first year by previous crop (Adapted from Buckingham *et al.* 1999).

Species	(a) Field type				
	Set-aside	Stubble	Winter cereal / plough	Brassicas	Grassland
Grey Partridge[1]	+	+	-	O	O
Skylark	+	+	-	-	-
Song Thrush[2]	-	O	-	+	-
Linnet	+	+	-	+	-
Cirl Bunting[3]	+	+	-	O	-
Yellowhammer	+	+	-	O	-

Species	(b) Set-aside type				(c) Winter fallows: previous crop		
	1st year NR	> 1st year NR	1st year sown grassland	> 1st year sown grassland	Barley	Wheat	Other
Grey Partridge	O	O	O	+	+	O	+
Skylark	+	+	+	+	+	+	+
Song Thrush[4]	-	O	O	O	n/a	n/a	n/a
Linnet	+	+	+	O	+	O	+
Cirl Bunting	+	+	O	+	+	O	O
Yellowhammer	+	+	+	O	+	+	+

1. Grey partridge recorded in East Anglia only; 2. Song Thrush recorded in sufficient numbers in East Anglia for resampling analysis in the second winter of the study; 3. Cirl Bunting recorded in Devon only; 4. Song Thrush not included in the analysis of previous crop type as the species showed avoidance of set-aside.

the way in which the green cover had been established and on the type of previous crop grown. Nevertheless, the selection of stubbles as a foraging habitat by seed-eating birds on arable land is consistent with Wilson *et al*. (1996b). Note that this review is concentrating on six declining species that eat predominantly seeds in winter. For a broader view of how the farmland bird community uses the farmland landscape in winter see Buckingham *et al*. (1999) and Wilson *et al*. (1996b). Further studies of two bunting species, both of high conservation concern, emphasized the selection of weed-rich stubble fields as winter foraging habitat. Loss of stubble fields in the agricultural environment is widely accepted as having contributed to the dramatic decline of the Cirl Bunting in southern England (Evans & Smith 1994). Provision of stubble fields, initially by the RSPB, then through set-aside and latterly through Countryside Stewardship agreements, has coincided with a dramatic recovery in the population (Aebischer *et al.* 2000). The BTO's national winter survey of Corn Buntings in 1992/93 found that stubbles were particularly preferred as foraging grounds over all other crops and that weedy stubbles held approximately twice the number of birds as "clean" stubbles (Donald & Evans 1994).

Use of set-aside by birds in the breeding season

Bird densities were significantly higher on rotational set-aside than on winter cereals for all bird categories (Fig. 1). Bird densities on rotational set-aside consistently exceeded those recorded on neighbouring fields from April to July (except for *Corvus* species - preferring grassland). This was true also during April and May when there was no difference in vegetation height between set-aside and crops (Henderson *et al*. 2000a). Insectivorous thrushes also utilized rotational set-aside in preference to crops, although possibly their preference for set-aside depends on the amount of cover provided, since this result contrasts with their general indifference towards set-aside as a short winter cover or stubble (see above and Table 1). On 10 farms where both rotational and non-rotational set-aside were present, relative bird densities were highest on rotational set-aside ($P < 0.001$) for all bird categories except *Corvus* species (preference for non-rotational set-aside) and lowest on winter cereals (Henderson *et al*. 1998).

With respect to vegetation cover on set-aside and its influence on bird abundance, log-linear models fitted to granivore data (likelihood ratio (LR): $F_{1,63} = 3.9$, $P < 0.05$, dev./df = 0.8), and gamebird data (LR: $F_{1,68} = 6.2$, $P < 0.05$, $n = 65$, dev./df = 1.7), yielded significant quadratic terms indicating optima for a mean percentage of bare ground/straw or litter equivalent to 17% and 39% respectively. Possibly this reflected the foraging styles of the two groups, with the larger gamebirds requiring a larger proportional area of unvegetated ground from which to obtain adequate food and also to allow adequate access into the field to begin with. For Skylarks too, Henderson *et al.* (in press) identified optima of 30% bare ground/straw or litter as preferred habitat (possibly reflecting a more active walking style of foraging than that adopted by finches and buntings, cf. Overview below). Finally, pigeons were positively associated with bare ground but the association was not statistically significant (LR: $F_{1,66} = 3.3$, $P < 0.06$, dev./df = 11.6). Overall, mosaics that incorporate bare ground/straw/litter and vegetation cover were most frequently associated with younger set-aside, e.g. natural regeneration rotational set-aside or the earliest years of non-rotational set-aside (Fowbert & Critchley 1998, Critchley & Fowbert 1998).

Preferences by birds for set-aside in summer have also been demonstrated by other European studies. In England, Sears (1992) reported higher densities of Skylarks on set-aside than on crops, while in Sweden, Skylarks, Whinchats *Saxicola rubetra*, Whitethroats *Sylvia communis* and Linnets were found in significantly higher numbers on set-aside margins than on cereal margins around forests (Berg & Part 1994). In north-east Scotland, breeding densities of Curlew *Numenius arquata*, Grey Partridge and Skylarks on first-year set-aside exceeded those on older set-aside as well as on neighbouring crops (Watson & Rae 1997). In an additional intensive study of set-aside by the BTO, of 11 independent pairs of set-aside and adjacent crop fields, higher densities were also recorded for 87% of 32 species on set-aside than on crops (*Corvus* species and Red-legged Partridge *Alectoris rufa* being the most consistent exceptions, Henderson *et al.* 2000b). Many of these species do not nest on fields, and so their preferences are likely to indicate good foraging conditions.

Thus, in summary, there are clear demonstrations in summer of preferences for set-aside over neighbouring crops or grassland for a wide number of species in farmland across Europe. However, not all set-aside is equally suitable since vegetation composition significantly influences the level at which fields are utilized by birds. Set-aside fields with a heterogeneous mix of vegetation types and ground cover were most preferred by birds.

OVERVIEW

Year-round effects of set-aside composition and management

Although set-aside has rarely been intentionally managed for wildlife, there now exists a wealth of information showing positive, short-term responses of a broad range of bird species to set-aside. Such responses, in terms of both numbers and productivity, occur in both summer

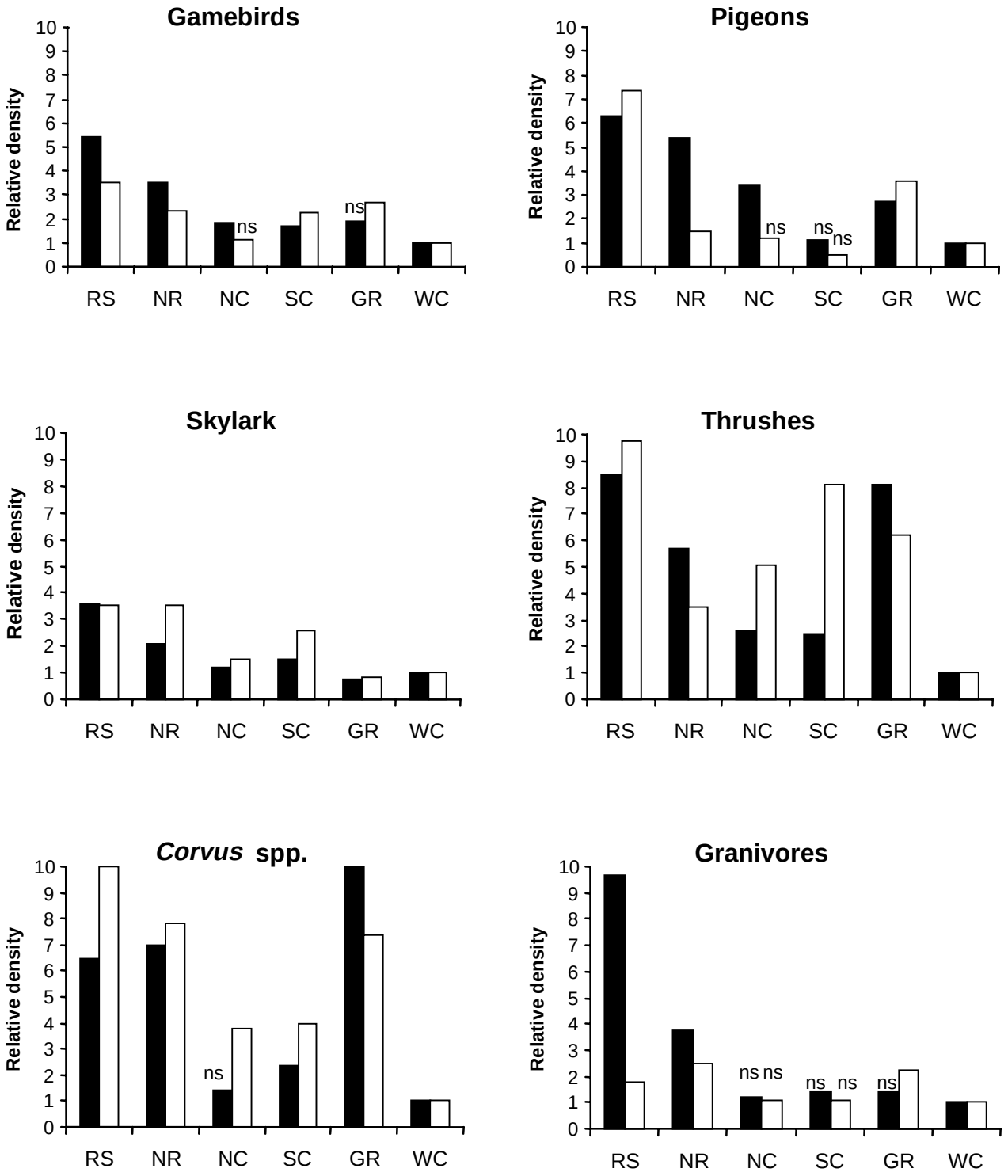

Figure 1. Log-linear Poisson regression exponential parameter estimates summarising the densities of birds (within 6 species categories) on field types relative to their densities on winter cereals (WC, for which the relative density index = 1, and a value of 2 is twice the density). The differences between field types and winter cereals are significant ($P < 0.05$), except where indicated by "ns", for the years 1996 (■) and (□) 1997. Abbreviations: RS = rotational set-aside, NR = non-rotational set-aside, NC = non-cereal, SC = spring cereal, GR = grassland. (Data from Henderson *et al.* 2000a).

(Moreby & Aebischer 1992, Sears 1992, Mañosa 1994, Watson & Rae 1997, Wilson *et al.* 1997) and winter (Donald & Evans 1994, Donald & Forrest 1995, Wilson *et al.* 1996b, Chaney *et al.* 1997, Evans *et al.* 1997, Buckingham *et al.* 1999). Preferences for set-aside or its equivalent are also reported from Sweden (Berg & Part 1994), Denmark (Poulsen 1996), Switzerland (Weibel 1998) and the USA (Millenbah *et al.* 1996). It seems highly likely that these preferences were attributable to increased foraging opportunities since set-aside is known to support higher densities of indigenous weed seeds (Wilson *et al.* 1996a, Draycott *et al.* 1997), plants (Clarke & Cooper 1992, Wilson & Aebischer 1995, Hansson & Fogelfors 1998) and invertebrates than cropped land (Kennedy 1992, Moreby

& Aebischer 1992, Sears 1992, Wilson & Fuller 1992, Wilson *et al.* 1995, Poulsen, *et al.* 1998). However, compromises between the presence of a potential food resource (e.g. invertebrates) and access to the resource (via bare ground) may limit the full exploitation of some fields. In winter too, stubbles created under set-aside may provide a key foraging habitat for seed-eating passerines (Donald & Evans 1994, Evans & Smith 1994, Buckingham *et al.* 1999). In addition, increased breeding success associated with set-aside is known for at least two bird species. Mañosa (1994) demonstrated higher chick survival rates in Ring-necked Pheasant *Phasianus colchicus* associated with grassy set-aside. Wilson *et al.* (1997) and Poulsen *et al.* (1998) reported higher fledging success for Skylarks utilizing set-aside than was found for pairs foraging or breeding on neighbouring winter cereals.

Despite these broad-scale geographical and seasonal preferences for set-aside by a wide range of species, as well as evidence of improved breeding success in at least two species, the evidence that set-aside has helped reverse downward population trends in farmland birds is equivocal. In Skylarks, for example, despite their close association with fields and field type, population trends on farmland in the UK show no clear response to the introduction of set-aside (Siriwardena *et al.* 1998). The rate of decline was certainly less between 1988 and 1998 than over the previous decade but this amelioration began before set-aside was widespread and is possibly symptomatic of a general reduction in the rate of farmland intensification over this period (Chamberlain *et al.* 1999). In Skylarks, higher breeding densities (Donald & Vickery 2000) and an extended breeding season on set-aside (Poulsen *et al.* 1998), may allow this species to fledge up to twice the number of chicks per given area of set-aside compared to cereals, despite higher predation rates in set-aside (Donald & Vickery 2000). Clearly, the ultimate contribution of set-aside to Skylark population abundance will therefore depend on the scale of its integration within the landscape at both local and national levels.

When tied to the receipt of Arable Area Payments in 1992 to 1993, set-aside nominally occupied around 15% of arable farmland (over 600,000 ha). In this first year, farmers were unsure of the best way to manage set-aside. Thus, in the 1992/1993 winter, almost all set-aside was rotational with a green cover, established by natural regeneration. This sudden reintroduction of fallow probably represented one of the largest single instantaneous changes in farming practice witnessed in the UK (Evans 1997b). By 1995/1996 the non-rotational option had grown in popularity, comprising over 40% of all land in set-aside. Thereafter the two options were combined as "flexible set-aside". Thus, as with its historical application, most studies emphasize wide variation in the type and subsequent usage and year-round attractiveness of set-aside to birds (e.g. Watson & Rae 1997, Henderson *et al.* 2000a, Buckingham *et al.* 1999). The attractiveness of winter stubble created under rotational set-aside depends upon the amount and quality of regeneration of broad-leaved weeds. This in turn depends on soil type and past husbandry (especially herbicide regimes) of the field. Weed-rich set-aside in an early successional stage, and with a heterogeneous sward structure, tends to support a higher abundance and species richness of birds than thick, grass-dominated swards (Millenbah *et al.* 1994, Watson & Rae 1997, Hansson & Fogelfors 1998, Wiebel 1998). Weed-rich cover is especially associated with higher invertebrate densities (Kennedy 1992), while mosaics including bare ground may aid foraging access to the soil/litter layer (e.g. Jenny 1990, Wiebel 1998), a factor that could significantly reduce the suitability of superficially rich foraging habitats for ground-feeding species. In the UK, in summer, uniform grass-dominated set-aside may have occupied up to a half of the set-aside allocation in any single year. On top of this, for Skylarks at least, early management requirements to cut or cultivate rotational set-aside during May and June (which destroyed nests during the peak Skylark nesting period) may have further reduced breeding recruitment into future years. Overall, the lack of any clear "population effect" of set-aside on birds is most likely a consequence of there not having been sufficient set-aside of optimal quality, over a long enough period of time, for a change to be registered by the CBC (Marchant *et al.* 1990).

Set-aside is an agronomic mechanism designed to reduce arable surpluses. It is not an agri-environment scheme, and was not intended to be managed sympathetically for wildlife on a broad scale. Nevertheless, land in set-aside clearly can benefit declining farmland bird species if managed correctly. Thought should be given to the siting of set-aside at the farm scale. For instance, when using set-aside land to produce winter bird food (either through natural regeneration or by sowing a wildbird cover), it may be beneficial to site it near existing cover such as a hedgerow. If set-aside is used to produce nesting sites for Skylarks, grassy strips in the open, away from any cover, are probably the best option. It is likely that in the medium term Arable Area Payments will be decoupled from any requirement for set-aside. Whilst the mechanism will probably be retained for voluntary uptake the amount of land in set-aside is likely to fall dramatically. This means that it will be essential to extract the maximum environmental benefit, through careful planning and management, from that which remains. Even so, without an agri-environment scheme available on the same scale as set-aside (10-15% of the farmed landscape) it is unlikely that the government will be able to meet its targets under the Biodiversity Action Plan process. We believe that, if real progress is to be made towards the conservation of farmland birds, it is essential that the pilot Arable

Stewardship Scheme (introduced by the Ministry of Agriculture, Fisheries and Food in two restricted areas in 1998) is made available to all arable farmers in the UK. In addition, advice should be made available to farmers to enable them to optimise the potential of non-cropped land to support wild bird populations so that the maximum possible area available contributes to their welfare.

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