THE DISTRIBUTION AND FEEDING BEHAVIOUR OF BREEDING SONGBIRDS ON CEREAL FARMLAND AT MANYDOWN FARM, HAMPSHIRE, IN 1984

A REPORT TO THE GAME CONSERVANCY

BY

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INTRODUCTION

In 1984 the British Trust for Ornithology (BTO) conducted studies on the breeding songbird populations of Manydown Farm, Hampshire. The work was carried out between April and July under contract to The Game Conservancy as a part of the Cereals and Gamebirds project. This report describes the objectives, methods and results of the BTO work. Songbirds are defined as all passerines excluding Hirundinidae and Corvidae.

The primary aim was to assess the effects on breeding songbirds of leaving the headlands (the outer 6m strip) of cereal fields unsprayed with agricultural chemicals (herbicides, insecticides and fungicides). Unsprayed headlands should contain larger quantities of weeds and hence might be expected to contain more food for songbirds in the form of weed seeds and insects. Therefore, a series of observations was made to test whether the feeding sites and feeding behaviour of songbirds differed between fields with sprayed and unsprayed headlands. This experimental work was made possible only as a result of The Game Conservancy's research on the ecology of the Grey Partridge[1] at Manydown. Three plots of farmland had been established, each containing one set of experimental fields (with unsprayed headlands) and one set of control fields (with fully sprayed headlands). Further details of the spraying regime are given under 'Study Area'.

With the exception of one study in Huntingdonshire (Davis 1967) there is virtually no published quantitative information on the extent to which hedgerow and woodland-nesting songbirds feed in cereal crops. The present study, therefore, attempted to assess the usage made of cereal crops by different species of songbirds during their breeding season and to define their feeding sites in crops. This aspect of the study should help to indicate which species might potentially benefit from unsprayed headlands. The effects of the following factors on crop-feeding by songbirds were also examined: the nature of the edge habitat, the time of year and the type of crop.

There have been few previous attempts to define systematically the importance of cereal farmland to different songbird species. Therefore, territory mapping was used to assess which species were most closely associated with the farmland rather than with other components of the landscape such as woodland. Results from territory mapping were used to compare densities of birds in hedgerows adjacent to sprayed and unsprayed headlands. The estimates of population densities were also valuable in interpreting some of the feeding observations.

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[1] Scientific names of birds are given in the Appendix

STUDY AREA

BOUNDARIES

The boundaries of the study area are shown in Figure 1. The areas of the crops and other features of the study area are given in Table 1. The boundaries were very similar to those of the Partridge study plots. However, in order to make the songbird study area a manageable size the following fields within the Partridge study plots were excluded: Big Field, Church Field, Innox, Poplar Hill, Wootton Bank and Rooksdown. On the other hand some areas not in the Partridge study area were included: one oilseed rape field (White Borough) and several woods.

CROPS AND CHEMICAL SPRAYS

Large areas of spring barley and winter cereals (Table 1) gave a rare opportunity to assess differences between crops in breeding densities and feeding behaviour of birds. The chemical applications varied according to crop type and in some cases depended on the previous year's crop. The applications are summarized in Table 2. Headlands referred to throughout this report as "unsprayed headlands" received all the appropriate applications in autumn 1983 but these headlands did not receive any spring applications. All other headlands (referred to as "sprayed headlands") received the full appropriate range of sprays in both autumn 1983 and spring 1984. The fields with unsprayed headlands are shown on Figure 1.

A similar experiment involving unsprayed headlands had been carried out in 1983. It was evident, however, that the amount of weed growth in the headlands differed between the two years. The take-up of herbicides applied at Manydown in autumn 1983 was better than for those applied in the previous autumn. This resulted in a less marked difference in weed growth between sprayed and unsprayed headlands in the summer of 1984 than in 1983. Unlike 1984, it had been necessary to apply spring herbicides to the winter cereals in 1983.

Two spring barley fields (Mother's East and Mother's West) were intended to have unsprayed headlands but were subsequently discovered, in June, to have been accidentally fully sprayed. In the analysis these headlands have been treated as sprayed headlands.

The edge of all cereal crops at Manydown in 1984 was marked by a rotovated strip approximately one metre wide (Figure 2). This strip was kept largely free of weeds by rotovating early in the spring and again in June or July. We refer to the half of the headland closest to the rotovated strip as the "near crop", the furthest half of the headland as the

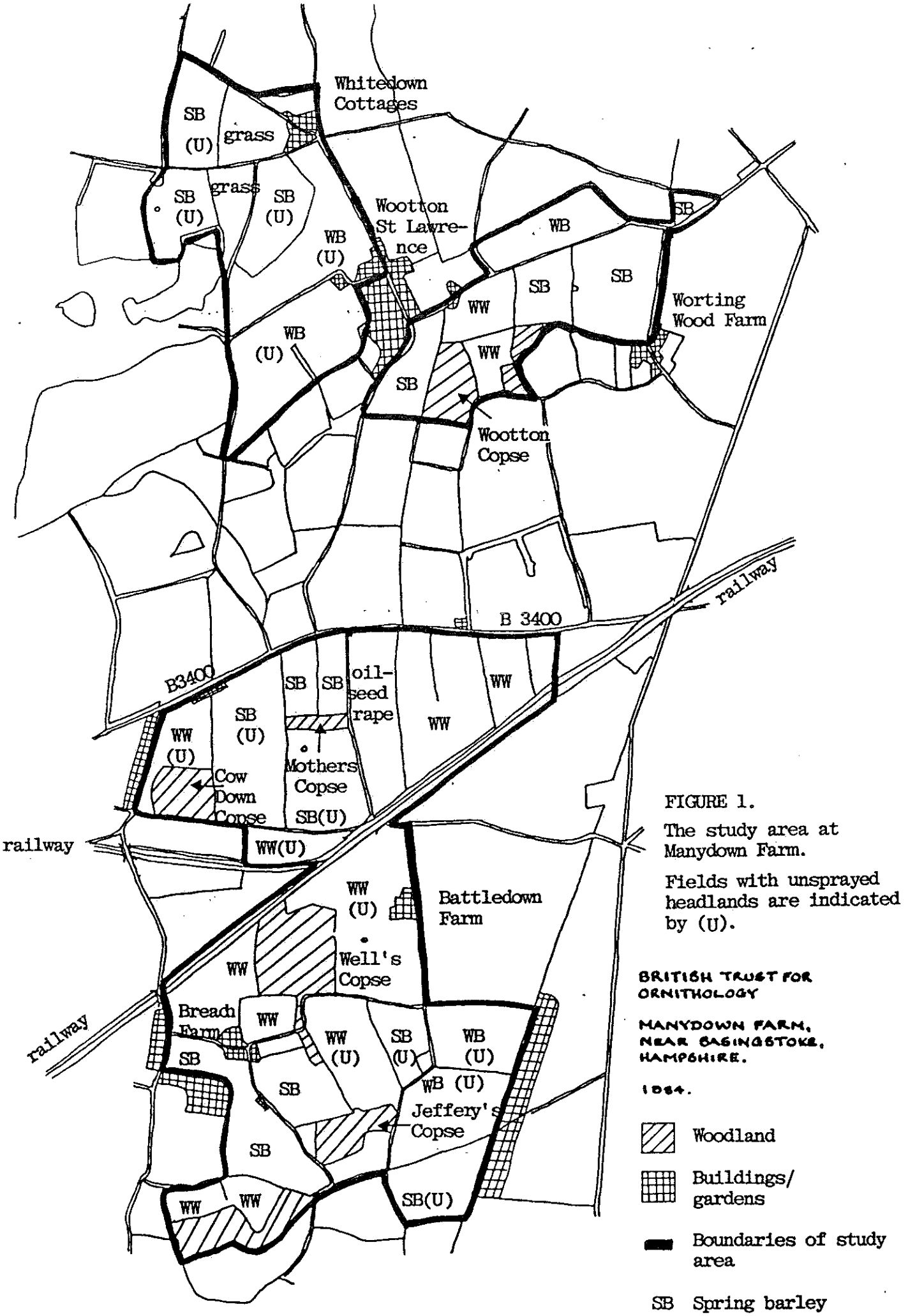

FIGURE 1.

The study area at Manydown Farm.

Fields with unsprayed headlands are indicated by (U).

BRITISH TRUST FOR ORNITHOLOGY

MANYDOWN FARM, NEAR BASINGSTOKE, HAMPSHIRE.

1984.

Woodland

Buildings/ gardens

Boundaries of study area

SB Spring barley

WB Winter barley

WW Winter Wheat

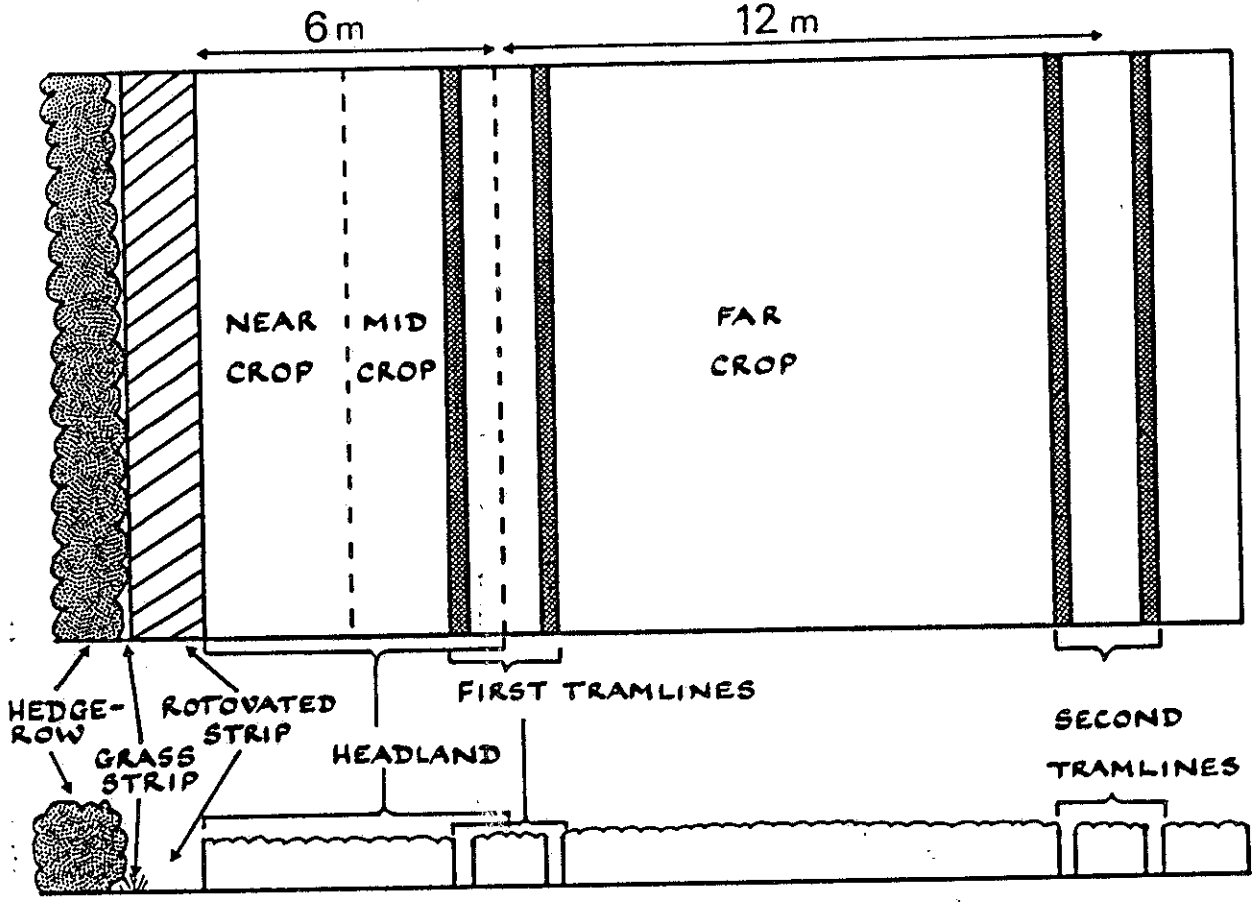

FIGURE 2. Schematic diagram of edge of cereal field at Manydown Farm 1984.

"mid crop" and the crop beyond the headland as the "far" or "field crop" (Figure 2).

FIELD BOUNDARIES

Most hedgerows could be readily defined as "short" or "tall". Short hedges were generally no taller than 1.5m and frequently contained gaps. In contrast, tall hedges were generally taller than 2.0m and rarely contained gaps. Most hedges did not contain mature trees. The small number of double hedges have been classified as tall hedges.

The commonest field boundary was a short hedge, of which there was more than 13km in the study area (Table 1). Hedges were not always present at field edges. Sometimes, fields were separated by a wire fence and, particularly along roads there were often grass banks, sometimes with a line of trees. Some fields were flanked by woodland.

WOODLAND AND SCRUB

The locations and sizes of the woods within the study area are shown in Figure 1 and the total areas of the main types are in Table 1. The larger areas of woodland were mainly oak *Quercus* spp. standards with a hazel *Corylus avellana* coppice understorey. This woodland type contributed over 60% of the total area of woodland / scrub. The main blocks of oak-hazel woodland were Wootton Copse, Mother's Copse, Cow Down Copse, Well's Copse , Jeffery's Copse and Pardown / Small's Copse. The density of standards ranged from scattered trees with a well developed coppice (e.g. parts of Wootton Copse) to almost closed canopy oaks with an indistinct coppice structure beneath (e.g. parts of Well's Copse). Much of the coppice was estimated to be 8-15 years old. In some areas more recent coppicing had produced a range of growth stages, notably in Wootton Copse. All the woods contained ride systems. In some woods (e.g. Wootton, Pardown and Wells) certain rides had been opened out to form linear clearings. All the woods were keepered and some contained release pens.

METHODS

All fieldwork was carried out by four members of staff of the BTO: R.J.Fuller, J.H.Marchant, K.Taylor and P.A.Whittington. All four ornithologists were highly experienced in the use of methods of counting songbirds.

TERRITORY MAPPING

The method of territory mapping employed was similar to that recommended by the International Bird Census Committee (1969) and to that used by the BTO in its Common Birds Census (Marchant 1983). For the purposes of territory mapping the study area was divided into six plots approximately conforming to the Partridge study plots. The six study plots were covered on a rotation to ensure that any possible observer-related biases were reduced to a minimum. Different routes were used on each visit to avoid systematic biases in the distribution of registrations arising from diurnal variations in bird activity.

All hedgerows and other field boundaries were walked and the positions and activities of birds were plotted on 1:2500 maps. Birds were mapped in this way over the entire study area on seven visits spread evenly between mid April and mid July. The registrations of each species on the seven sets of visit maps were subseqently transferred to separate sheets (species maps). For each species, these maps were then interpreted in terms of clusters of registrations. These clusters are equated with territories although they do not define exact territory boundaries.

The results obtained from territory mapping should be treated as indices of abundance, rather than as absolute population sizes. An enormous range of potential biases confronts all methods of counting songbirds (O'Connor and Fuller 1984). Nevertheless, results obtained from careful territory mapping give the best chance of making inter-specific comparisons of density (Tomialojc 1981, O'Connor & Fuller 1984).

One of the major problems confronting all methods of estimating songbird numbers is that species differ in conspicuousness making it difficult to directly compare the densities of different species (Dawson 1981). Conspicuousness is influenced by two main factors: the complexity of the habitat and the behaviour of the species (plumage colouration, vocalizations, the extent to which the bird remains in dense cover etc.). The present study covered a range of very different habitats so it is important to consider how this may have influenced the results obtained. The coverage of the farmland was probably sufficient to

detect most of the hedgerow bird territories. It is likely, however, that some Skylark territories were missed in the larger cereal fields. For Skylarks there is the added problem that accurate plotting of singing birds is extremely difficult. Due to the greater complexity of the vegetation, observation is obviously more difficult in woodland than farmland habitats. Furthermore, there is evidence (Walankiewicz 1977, Scott & Ramsey 1981) that observers detect a lower proportion of birds at high densities than at low densities due a saturation effect on the observer. These factors suggest that for most species in woodland a lower proportion of the territories present will have been detected than on farmland. The farmland densities therefore probably approximate absolute densities but the woodland densities should be treated as under-estimates.

TIMED FEEDING OBSERVATIONS

Systematic observations of feeding birds were made along carefully selected field edges. A total of 123 stretches of crop edge, each of 100m, were selected. These stretches were spread throughout the entire study area and they included virtually all suitable crop edges. The stretches were all adjacent to woodland or hedgerows. The field edge had to be straight so that visibility for 100m was unimpaired. There had to be continuity between the hedge or woodland and the crop, so edges with paths, tracks or fences were not chosen. Hedges with large numbers of gaps were not chosen.

As far as possible we attempted to choose similar samples, for sprayed and unsprayed headlands, in terms of crop type and field edge. However, in some cases it was difficult to find large samples of suitable stretches. In particular, there was a paucity of suitable edges next to unsprayed spring barley. Unfortunately, the sample of unsprayed spring barley was further reduced by the accidental spraying of Mother's East and Mother's West (see above).

A total of 72 stretches were adjacent to sprayed headlands and 51 were adjacent to unsprayed headlands. The stretches were of the following types with respect to field boundary: tall hedges (15 sprayed, 12 unsprayed), short hedges (36, 23), woodland (21, 16). Crop types adjacent to the stretches were: spring barley (45 sprayed, 16 unsprayed), winter wheat (19, 23), winter barley (8, 12).

Each stretch was visited on at least six occasions between April and July. On each visit, the observer made three minutes of continuous observation, hereafter referred to as a "timed watch". The positions of all birds seen on the 100m stretch during a timed watch, and judged to be feeding, were recorded in relation to zones of increasing distance from the crop edge. Distances were judged by reference to the position of tramlines.

Two main types of feeding behaviour were observed amongst passerines. The first involved a flight to the ground from the hedge, followed by an almost immediate return to the hedge. This was typical of Robins. Less frequently, Robins captured flying insects by sallying over the crop without landing. Such feeding actions were individually recorded and the numbers of different birds involved were recorded. The second, and commonest feeding method, involved a bird remaining on the ground for a protracted period and making repeated feeding actions during this time. This was typical feeding behaviour of Blackbirds, Dunnocks, Chaffinches and Yellowhammers. For such species an estimate of the time spent at different distances from the hedge was obtained by recording the position of the bird when first seen and subsequently at 15 second intervals. These 15 second records are termed "feeding records" and they were recorded separately for different individuals seen on the same timed watch.

By the end of May the height of the crops made it impossible to record the exact position of birds inside the crop. In some winter cereal fields this stage was reached by early May. Therefore, the procedure was to note the positions at which birds entered and left the crop. Birds were also flushed at the end of the timed watch and their positions recorded. If the bird entered and returned from the same position it was assumed to have remained at the same distance from the edge. If the bird left the crop at a different distance from the edge the appropriate number of feeding records was divided equally between the zones concerned.

In several analyses the timed watch data were pooled for the months of April & May and June & July. This seasonal distinction was made because any differences between sprayed and unsprayed headlands in weed growth and insect abundance were likely to become apparent only from June onwards. A total of 947 timed watches was made. In April and May 132 watches were made adjacent to woods and 265 adjacent to hedgerows. In June and July 145 watches were adjacent to woods and 405 adjacent to hedgerows.

As with territory mapping, observers carried out timed watches on a rotation to avoid observer biases. The majority of watches were made between 06.30 and 12.00 hours although some were made in the afternoon and early evening. Two observers always conducted timed watches simultaneously, with one observer working sprayed headlands and the other working unsprayed headlands. This study design aimed to reduce any systematic biases arising from diurnal variations in feeding activity (although in the field there was no obvious evidence of any such pronounced variation).

SUPPLEMENTARY FEEDING OBSERVATIONS

In addition to timed watches, observations were made on any other birds seen feeding in crops or on rotovated strips. For such supplementary observations, the methods of recording the time spent by the bird in different parts of the crop were identical to those of timed watches. This enabled results from timed watches and supplementary observations to be combined for certain analyses. Birds which were located casually were watched for a minimum period of two minutes or until they flew off, whichever period was shortest. Supplementary observations were not recorded where there was a path or track between the field edge and the crop.

The purpose of supplementary feeding observations was primarily to increase the volume of data available for analysis. This was important because the number of birds observed feeding on timed watches was generally small (see below). The supplementary observations also permitted a more complete picture to be established of the range of species that feed in crops.

RESULTS AND DISCUSSION

The results are presented in three main sections. The first describes the main features of songbird distribution and density at Manydown. Densities of songbirds along hedges adjacent to sprayed and unsprayed headlands are compared at the end of the first section. The second section documents the range of species found feeding in crops at Manydown and makes inter-specific comparisons of the usage of crops. The factors influencing crop-feeding by songbirds are considered in the third section which includes a comparative assessment of songbird feeding in sprayed and unsprayed headlands. Much of the detailed discussion related to specific points arising from the results is included in these sections. However, the report is concluded with a more general discussionwhich considers the potential significance of unsprayed headlands for songbirds. The general discussion also considers the implications of the present findings for any future research on songbirds and cereal crops.

PATTERNS OF BIRD DENSITY IN A CEREAL-DOMINATED LANDSCAPE

General distribution of birds

Species densities are given in Table 3 for four broad habitats: woodland & scrub, hedgerows, cereal crops and gardens & farmsteads (referred to hereafter as habitations). The overall songbird densities in these habitats were: woodland 969 territories/km^2 , hedgerows 13 territories/km, crops 21 territories/km^2, habitations 867 territories/km^2.

The percentage of the total number of individuals contributed by the most abundant species provides a simple, but effective,index of community structure (Southwood 1978). Two such dominance indices were calculated for the bird communities at Manydown. The first index was the percentage of the total number of territories contributed by the single most abundant species and the second index was the percentage of the total territories contributed by the two most abundant species combined. The two respective index values for each community were: woodland 17% and 28%, hedgerows 22% and 39%, crops 98% and 100%, habitations 20% and 40%. Hence,woodland held the greatest densities of birds and the dominance values suggest that it also held the most diverse communities.

Woodland supported 53% of the songbirds although it covered only 11% of the entire study area. Habitations were also rich in songbirds, holding a high overall density and

supporting an estimated 18% of the territories in 4% of the area. The cereal farmland and hedgerows contributed only 26% of the songbirds although they covered some 71% of the study area. The bias towards under-estimating the woodland populations (see methods) means that the above figures over-estimate the contribution of the farmland to the overall songbird communities at Manydown.

Comparison of hedgerow and woodland songbird communities

Hedgerows and woodland supported several species in common. An attempt was made to define the broad habitat preferences of songbirds by comparing their woodland and hedgerow densities in a form of two-dimensional ordination. The resulting plot of densities is illustrated in Figure 3. The woodland densities used in this exercise were those from the oak-hazel woods and the hedgerow densities were for tall and short hedges combined.

It is evident from Figure 3 that the majority of species prefer woodland. Only five species were regarded as farmland specialists but 22 woodland specialists were identified. Many species were absent or virtually so from hedges but were chacteristic of the woods. In particular, warblers (with the exception of Whitethroat) and several hole-nesters were absent from hedges. One group of species reached moderate numbers in hedges but appeared to prefer woods (Blue Tit, Great Tit, Wren and Robin). Blackbird and Chaffinch attained high densities in both habitats. Yellowhammer and Dunnock were the only species occurring at high density in hedges but not in woods. Whitethroat was also chacteristic of hedges, but at very low densities. Linnet and Greenfinch were more weakly characteristic of hedges.

These results are consistent with the idea that that hedgerows are a sub-optimal habitat for many species (Krebs 1971, Murton & Westwood 1974). Nevertheless, farmland covers such a large part of lowland England that hedgerows must carry enormous populations of songbirds. Hedgerows must be seen as an important habitat for Yellowhammers, Dunnocks and Whitethroats.

Hedgerow densities

Table 3 illustrates the importance of hedgerows to the avifauna of the farmland (defined here as the cereal crops and hedgerows). Although 23 species held territory on the farmland only two - Skylark and Corn Bunting were associated with the crops. It was assumed that songbirds foraging in crops next to hedges were primarily associated with the hedges where they were undoubtedly nesting. The commonest hedgerow species was the Chaffinch; such high farmland densities of this species are unusual in our

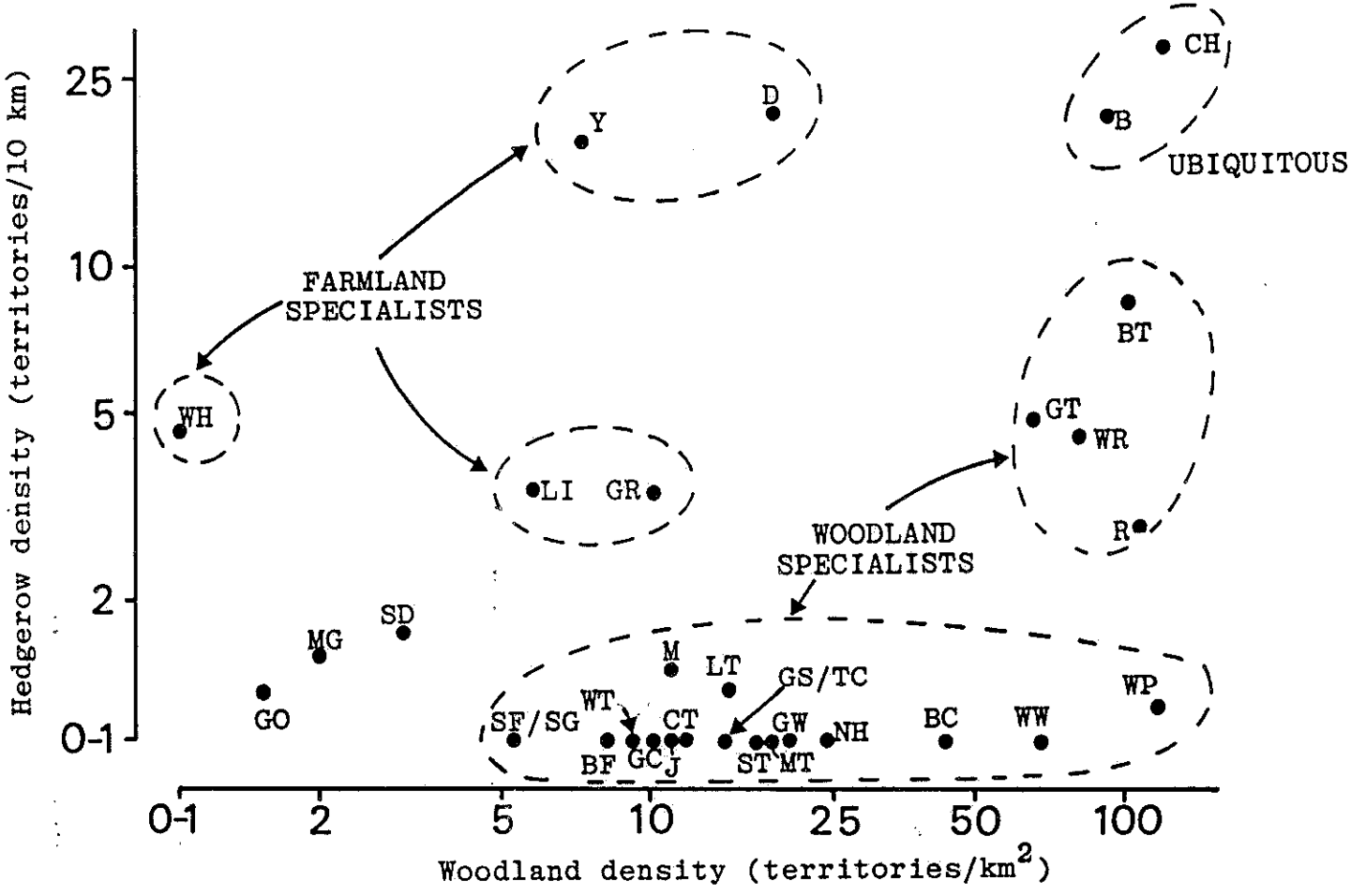

FIGURE 3. Comparison of hedgerow and woodland bird communities, Manydown Farm 1984. Species symbols are defined in Appendix 1.

experience. The three next most abundant hedgerow species were Dunnock, Blackbird and Yellowhammer. These four species contributed 69% of the hedgerow territories.

Densities of hedgerow birds varied considerably according to the type of hedge. The overall density of songbirds along tall hedges was 23.4 territories/km compared with 10.1 territories/km along short hedgerows. As one would expect, the density along banks and fences was negligible (2.5 territories/km). The densities of individual species along tall and short hedges are compared in Figure 4. The density of most species was greater along tall hedges, but this was particularly so for Chaffinch which was more than three times as abundant along tall hedges as short hedges. Dunnock and Blackbird were more than 1.5 times as common along tall hedges, but Yellowhammer occurred at approximately equal density in both types of hedge. Further analysis of relationships between hedgerow type and songbird populations will be undertaken on the data collected at Manydown.

Densities in relation to crop type

Crop type appeared to have little influence on densities of the main field-nesting passerine, the Skylark. The overall densities (territories/km^2) were spring barley 20.0, winter barley 21.6, winter wheat 20.8.

Although not a songbird, the overall densities of Lapwings were interesting because they suggested a preference for spring barley. The Lapwing densities (territories / km^2) were: spring barley 4.5, winter barley 0.4, winter wheat 2.7. Lapwing populations have declined over the past two decades in central and southern England and it has been suggested that this decline is associated with loss of grasslands and with a major change in the pattern of cultivation away from spring to autumn sowing (O'Connor & Shrubb in press). Extensive areas of spring barley such as are found at Manydown are now unusual in much of south, central and southern England. Klomp (1953) showed that Lapwings prefer to nest on brown substrates which are indicative of fields where vegetation is likely to remain short later in the breeding season. It is possible, therefore, that the early growth of the crop deters Lapwings from nesting on some winter cereals. In contrast, spring barley fields are largely bare ground when Lapwings establish their territories.

Hedgerow densities in relation to spraying in headlands

Densities of Blackbirds, Dunnocks, Robins, Whitethroats, Chaffinches and Yellowhammers were compared along hedgerows adjacent to sprayed and unsprayed headlands. The samples used in this comparison were similar in terms of hedgerow type and included all suitable hedges in the study area.

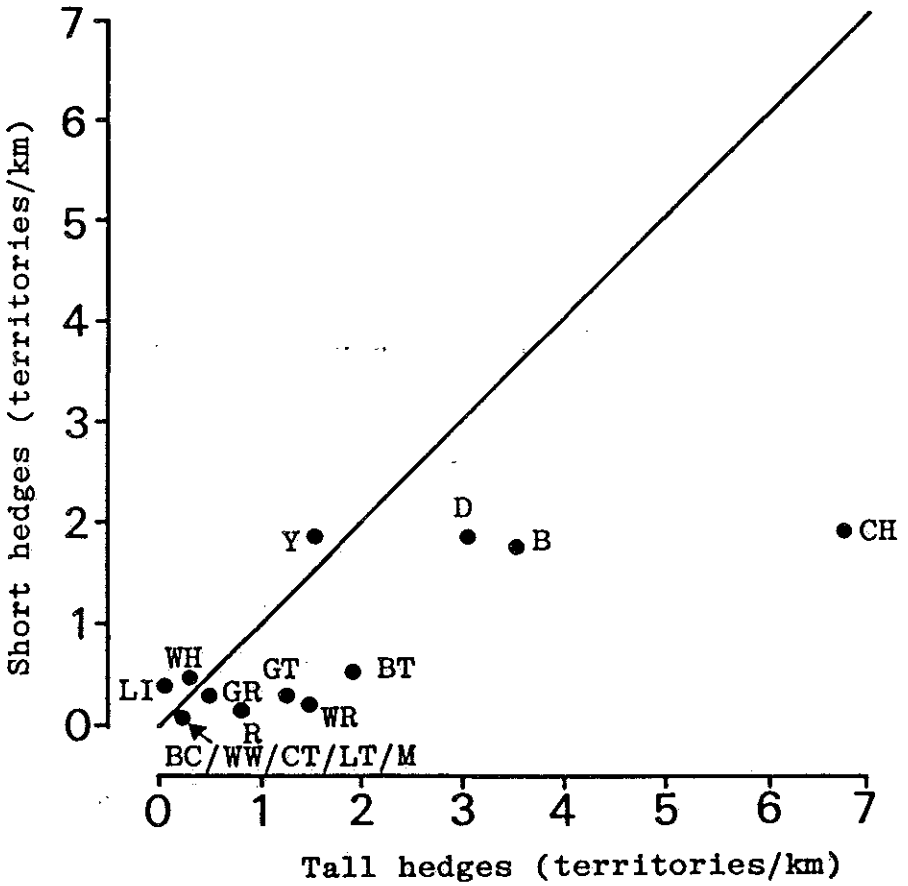

FIGURE 4. Density of songbirds along tall and short hedges, Manydown Farm 1984. The line marks equal density in the two types of hedgerow.

Results and details of the samples are given in Table 4. No significant differences were detected in mean density for any of the six species in relation to headland spraying. These results were to be expected because most species of songbirds established territories early in the spring. Any marked differences in food availability arising from headland management would have become apparent much later in the breeding season (M.Rands and N.Sotherton pers comm.).

SONGBIRDS FEEDING IN CROPS

Which species feed in crops?

A summary of all the species recorded feeding in crops and / or on the rotovated strip during the study is given in Table 5. Two general points, which are treated in more detail below, emerge from this table. First, despite a very large amount of fieldwork, many of the species holding territory in the woods and hedges were not recorded feeding in fields. This was especially true for woodland species (see below). Second, there was a strong edge effect in the distribution of feeding records within the fields. With the exception of Skylark, few songbirds were recorded more than 50m from the edge and virtually none were seen more than 100m into the field. Davis (1967) also recorded a strong edge effect.

The frequency with which different species fed in crops

The timed watches gave a means of comparing the frequency with which the species fed in crops. Observations of birds feeding during timed watches are summarised in Table 6 for woodland watches and in Table 7 for hedgerow watches. No songbirds at all were observed on 806 (85%) of the timed watches and even the commonest songbirds were recorded on very few watches.

The species most frequently seen feeding in rotovated strips and crops next to woods were Blackbird, and to a lesser extent Robin. The species most commonly feeding next to hedges were Dunnock, Blackbird, Chaffinch and Yellowhammer. The percentages of watches (all watches combined) on which these species were recorded on rotovation / crops were: Blackbird 6%, Dunnock 3%, Chaffinch 2%, Robin 1% and Yellowhammer 1%.

Few woodland species were seen feeding in fields adjacent to the woods. Of the 20 woodland songbird specialists (Figure 3A) only Robin, Song Thrush and Mistle Thrush were recorded, albeit rarely, next to woods (Table 6). No warblers, tits or Wrens were seen in fields next to woods despite the fact that these species attained high densities in woods. In contrast to woodland, all the commonest hedgerow species fed in crops next to hedges. This is illustrated in Figure 5

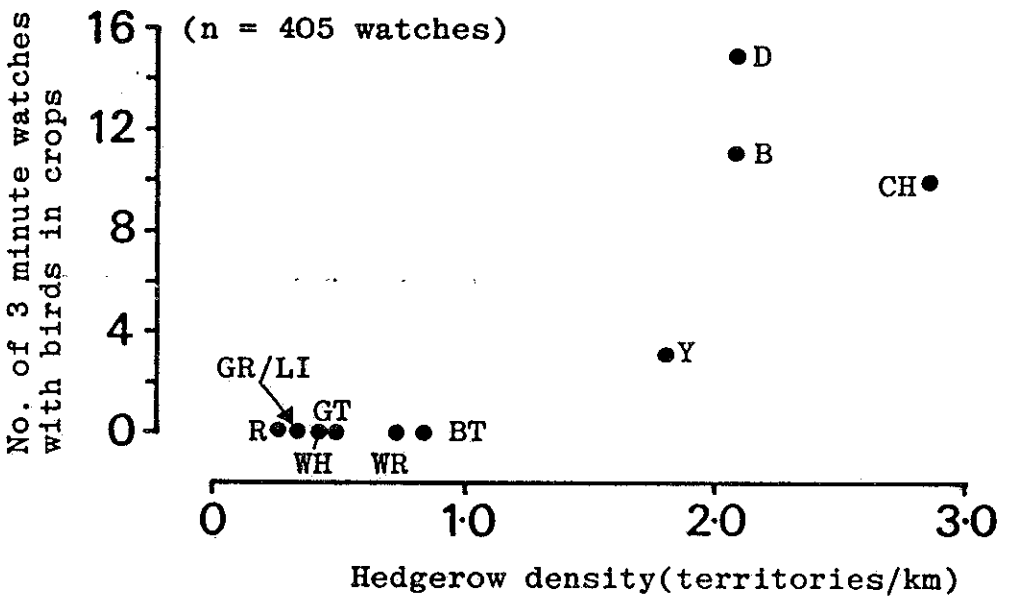

FIGURE 5. Frequency with which songbirds fed in crops by hedges in June and July at Manydown Farm, 1984.

which shows a positive relationship (r_s = 0.83, P<0.01) between the hedgerow density of a species and the frequency with which the species fed in the crop.

How far from the edge of the field do songbirds forage?

The timed watches showed that the great majority of feeding observations of all songbird species came from the rotovated strip or the headland (Tables 6 & 7). The time spent by Dunnocks and Blackbirds at different distances from the field edge is shown in Figures 6 and 7. Early-season crop feeding in Dunnocks was virtually confined to the extreme edge although in June and July the species spent more time in the crop itself (see below for further analyses of seasonal changes in feeding behaviour). Even in June and July more than 80% of their time feeding in fields was spent in the rotovated strip or headland. Blackbirds showed a similar seasonal trend to Dunnocks but an even greater amount of their time (>90%) was spent on the rotovation or in the headland.

It is possible, but unlikely, that our observations under-estimated the frequency of feeding in the far crop. Observations were made from the first tramlines or from the rotovated strip so that birds making prolonged feeding bouts in the far crop may have gone undetected. However, all birds flying out from hedges or woods were watched and their landing positions in crops noted. We are confident that the observed edge effects are real.

The concentration of songbirds around the edge of fields may reflect the distribution of food within the fields. Another possible relevant factor is the proximity of the edge as cover from predators.

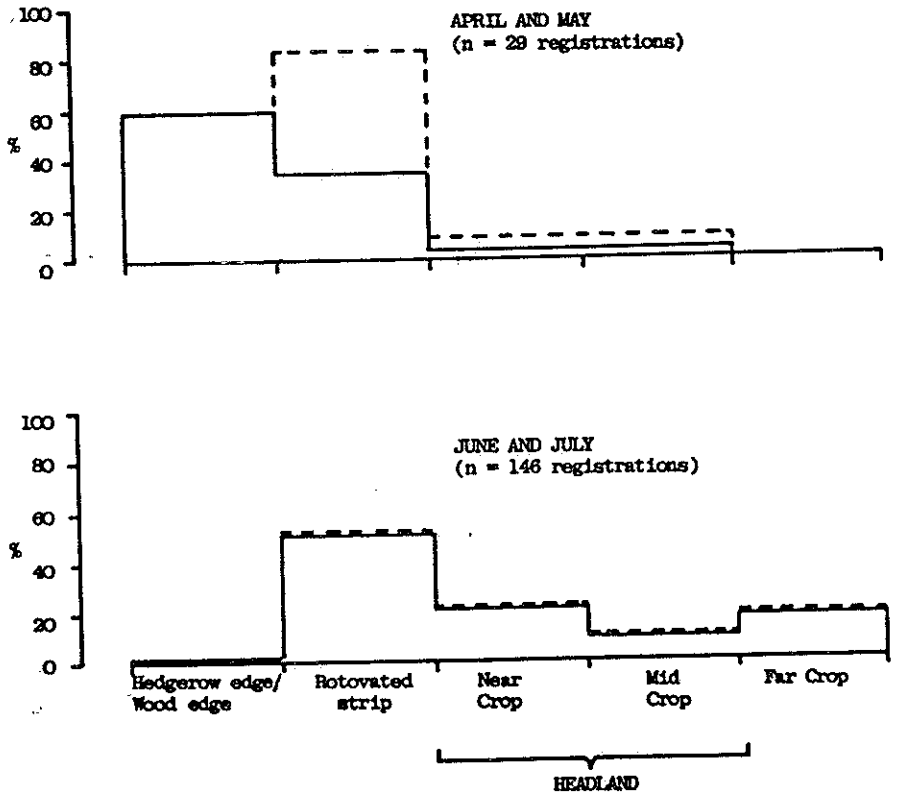

FIGURE 6. The time spent by feeding Dunnocks at different distances from the edge of the field as shown by numbers of registrations made during timed watches (see methods for further details). Broken lines exclude registrations on the grassy strip at the edge of the hedgerow/wood.

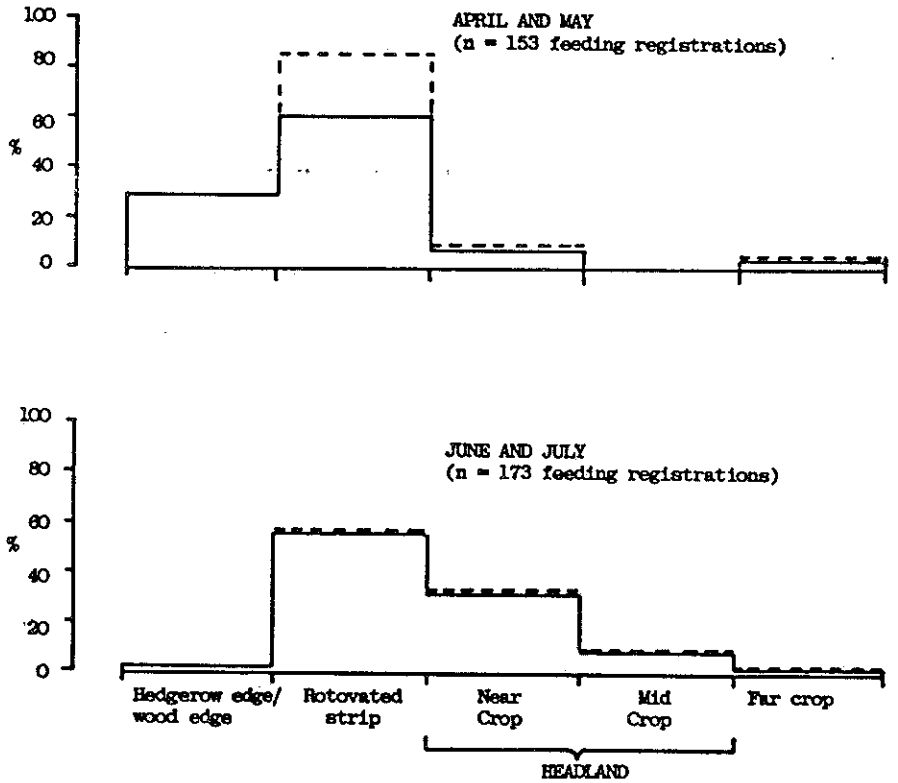

FIGURE 7. The time spent by feeding Blackbirds at different distances from the edge of the field as shown by numbers of registrations made during timed watches (see methods for further details). Broken lines exclude registrations on the grassy strip at the edge of the hedgerow/wood.

FACTORS INFLUENCING CROP-FEEDING IN SONGBIRDS

The edge habitat

The numbers of birds feeding in crops were generally greater by hedgerows than by woodlands. It has been shown above that a higher proportion of hedgerow species than of woodland species typically fed in crops. In fact, on timed watches, very few observations were made of any birds feeding in crops next to woods (Table 6). A small number of supplementary observations were made of Blackbirds, Dunnocks and Chaffinches feeding in crops next to woods. However, unlike the timed watches, these supplementary observations do not permit a systematic comparison of crop-feeding next to hedges and to woods so they have not been analysed in detail.

The frequency of crop-feeding next to hedges and to woods is compared for several species in Figure 8. All species seen feeding in crops during June and July are shown. Dunnock, Blackbird and Chaffinch all fed more frequently next to hedges. The last two species bred at high density in both woods and hedges, yet they comparatively rarely fed in crops next to woods. The relatively high frequency of crop-feeding by Dunnocks next to hedges was to be expected because the majority of Dunnocks nested in the hedges. By contrast, another hedgerow specialist, the Yellowhammer, was seen feeding next to woods as often as next to hedges.

Why should crop-feeding by songbirds be more frequent by hedges than woods when songbird densities in the woodland were so high? The most likely explanation is that for most species, the woodland itself is a far richer feeding habitat than the adjacent crop. Hedgerows probably offered poorer quality feeding habitat than woodland for both ground feeders and insectivorous species which feed in the foliage. For example, most of the hedges lacked mature trees, the canopy of which forms an important foraging niche in woods. Therefore, when nesting on the edge of woodland, songbirds may have little need to resort to feeding in crops. Furthermore, hedgerow territories will include a greater length of crop edge than woodland territories so that birds nesting along hedgerows are perhaps more likely to exploit the crop.

The type of crop

It was possible that songbirds preferred to feed in certain crop types. If there were no such crop preferences then it would be valid to combine results obtained from different crops when attempting to assess seasonal trends in crop-feeding and the effects of leaving headlands unsprayed

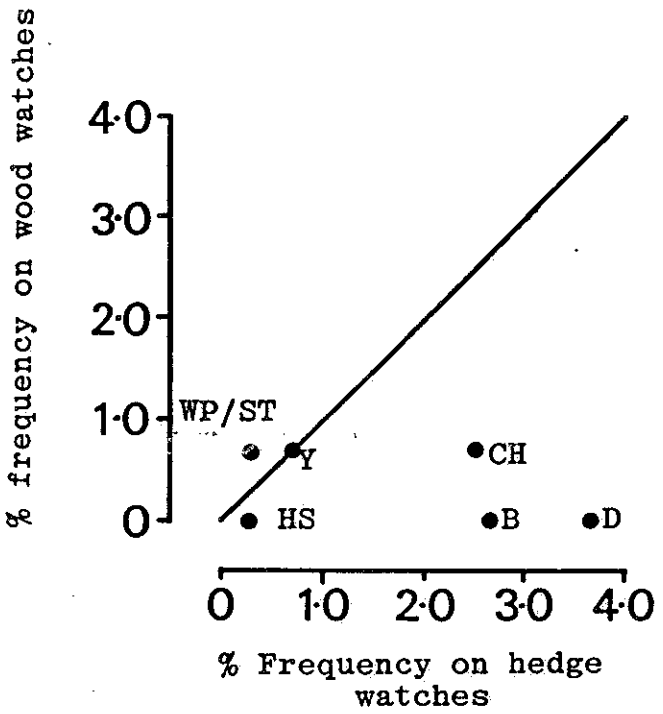

FIGURE 8. Birds feeding on cereal fields adjacent to hedges and woods in June and July, Manydown Farm 1984. (All species recorded in the crops are shown). The line marks equal frequency in the two habitats.

(see below). Accordingly, the feeding sites of Dunnocks, Blackbirds and Chaffinches were examined in relation to crop type (Tables 8, 9 and 10 respectively). To give sufficiently large samples, feeding bouts observed in winter barley and winter wheat were combined.

The presence of a rotovated strip gave a simple way of looking for evidence in heterogeneity of crop-feeding in birds. The percentage of feeding bouts centred on the rotovated strip was compared with the percentage performed in the crop itself. In view of the fact that detailed observation of birds wthin crops was frequently impossible (see above) this method of comparing feeding sites was considered the most robust. Birds feeding next to woods rarely fed in crops compared with birds feeding next to hedges (see above). Potentially, this could have biased results based on feeding bouts combined from both types of edge but in practice, this made very little difference because so few observations of feeding birds were made next to woods.

For Dunnock (Table 8), there was some indication ($P \approx 0.08$) that early-season feeding in crops was confined to the more advanced growth of winter cereals. However, the samples at this time of year were extremely small. The larger numbers of Dunnock observations later in the season showed no preference for spring or winter-sown cereals at that time ($P < 0.50$). For neither Blackbird nor Chaffinch was there any evidence of crop preferences (Tables 9 and 10).

Seasonal trends in crop-feeding

Information presented in Tables 6 and 7 suggested that there were seasonal trends in the crop-feeding of some songbirds. This section gives a more detailed analysis of these seasonal changes in use of crops.

Results from each separate visit on which timed watches were made are given separately for Dunnock, Blackbird and Chaffinch in Tables 11 - 14. The frequency with which each species was recorded is shown; for Blackbird the frequencies are given for both woodland edges and hedges.

Dunnocks were recorded feeding in crops more frequently after mid June. The frequencies in Table 11 indicate a marked increase in crop-feeding by Dunnocks between 12 June and 21 June. Blackbirds feeding next to woodlands were not seen feeding in crops at any time of the year, nor was there any suggestion that Blackbirds used rotovated strips more frequently at certain times of the year (Table 12). Although Blackbirds fed in crops next to hedges, there was little evidence of a seasonal change in the frequency of crop-feeding (Table 13). There may, however, have been a decline in July in the frequency with which Blackbirds were

recorded on rotovated strips. Chaffinches were not seen in crops until 21 June but thereafter were recorded in crops on all visits (Table 14).

The above analyses of the timed watches were based entirely on frequencies (i.e. presence - absence). Such results could be misleading because they take no account of the numbers of individuals involved nor of the time birds spent actually inside the crop. Therefore, further analyses were conducted of seasonal changes in the feeding sites of birds (Tables 15,16 & 17). The results are shown separately for sprayed and unsprayed headland and for different types of field boundaries.

In June and July a much higher percentage of the Dunnocks were feeding in crops compared with April and May (Table 15). For example, only 8% of Dunnocks feeding next to hedges in April and May were in the crops compared with 53% in June and July ($P<0.02$). With the exception of the sprayed headlands, for which very small samples of early-season Dunnocks were obtained, all the tests were statistically significant.

Blackbirds showed much the same trend as Dunnock with a higher percentage of birds recorded in crops later in the season than earlier (Table 16). For example, only 17% of Blackbirds feeding next hedges were in crops early in the season compared with 42% later in the season ($P<0.02$).

Chaffinches showed a similar pattern to the other species but no significant results were obtained (Table 17). Nevertheless, the seasonal trends in frequencies strongly suggested that there was a real increase in crop feeding by Chaffinches after mid June (Table 14). Presumably, the increase in use of crops was more strongly matched by an increase in use of the rotovated strip than with Dunnock and Blackbird so that no preference for crops could be detected in June and July.

Dunnock, Blackbird and Chaffinch were the species for which the largest samples were available. It is likely that other species showed seasonal trends. Yellowhammers were recorded more frequently in crops next to hedges late in the season (Table 7). In contrast, Robins ceased feeding in crops and rotovated strips at the end of May (Tables 6 and 7).

It is likely that the increase in crop-feeding in June and July was a response to a seasonal increase in food within the growing crop. However, this could not account for the trend shown by Robin.

Spraying regime in the headlands

This section presents the detailed comparisons of the use of sprayed and unsprayed headlands by feeding songbirds. The following comparative analyses have been conducted for sprayed and unsprayed headlands: time spent feeding in different parts of the crop; lengths of feeding bouts; relative use of the rotovated strip and the crop; the intensity of feeding along hedges in relation to breeding density.

Did birds spend more time in sprayed headlands than unsprayed headlands? Table 18 shows that in June and July Dunnocks spent considerably more time feeding in unsprayed than sprayed headlands. Dunnocks feeding in fields with sprayed headlands spent only an estimated 12% of their time in headlands compared with 57% of their time when in fields with unsprayed headlands. In fields with sprayed headlands Dunnocks spent a much larger amount of time in the rotovated strip (70% compared with 24% on strips next to sprayed headlands). In contrast, Blackbirds did not spend more time in unsprayed than sprayed headlands (Table 19). In June and July Blackbirds spent an estimated 50% of their time in sprayed headlands compared with 33% in unsprayed headlands.

The information in Tables 18 and 19 was an amalgam of feeding records from different individual birds. A valid question is whether the length of foraging bouts of individuals differ between fields with sprayed and unsprayed headlands? Feeding bouts were classed as either "short" (< 1 min.) or "long" (> 1 min.). The numbers of short and long bouts observed in fields with sprayed and unsprayed headlands were then compared (Table 20). Separate analyses were conducted for woodland edges and hedges, for different times of the year and for different feeding zones. Samples were large enough to permit eight analyses: two for Dunnock, five for Blackbird and one for Chaffinch. No significant differences were detected in the proportions of short or long feeding bouts on sprayed and unsprayed headlands.

A further analysis of feeding bouts was made in which the mean lengths of bouts were compared for fields with sprayed and unsprayed headlands. Details of, and results from, these analyses are given in Table 21. A total of 12 tests were made for different species, times of year, types of edge, feeding zones etc. However, no significant differences in lengths of feeding bouts could be detected between fields with sprayed and unsprayed headlands.

Feeding sites of songbirds were examined by comparing the proportions of feeding bouts that were on the rotovated strip and in the crop for fields with sprayed and unsprayed headlands. A significantly higher proportion of bouts in unsprayed than sprayed crops would indicate a preference for

feeding in unsprayed crops. It has been assumed that any differences in food availability and feeding behaviour of songbirds arising from the spraying regime should become apparent in June and July. Therefore, the results summarised and discussed below are those for June and July, although the April and May results are also given in the tables for comparison.

Dunnock feeding sites are shown in Table 22. For unsprayed headlands, 71% of all bouts were in crops, compared with 43% for sprayed headlands ($P<0.10$). For hedgerow-nesting Dunnocks alone, the respective percentages were 67% and 44% ($P<0.30$). This suggests some preference for feeding in unsprayed crops, but larger samples are needed to confirm this statistically. Chaffinches followed a similar trend to Dunnock with more than 60% of the birds feeding in crops with unsprayed headlands but less than 50% for sprayed headlands (Table 23). However, the samples of Chaffinches were too small to draw any conclusions.

In contrast, Blackbirds appeared to avoid feeding in unsprayed headlands (Table 24). Of all foraging bouts observed, only 29% of those in fields with unsprayed headlands were in crops compared with 53% for fields with sprayed headlands ($P<0.10$). For Blackbirds feeding next to hedges this difference between sprayed and unsprayed headlands was less pronounced, the respective percentages being 35% and 48% ($P<0.50$). It was shown above that Blackbirds comparatively rarely fed in crops next to woods. Therefore, could the result obtained for all the feeding bouts combined have arisen from the inclusion of woodland edges in the sample? This is unlikely because the sprayed and unsprayed samples contained exactly the same percentages (24%) of woodland edge observations.

If Blackbirds were avoiding unsprayed headlands why should this be? Possibly the birds found it more difficult to feed efficiently in the denser vegetation of sprayed headlands. It is well known that length - and presumably density - of vegetation negatively influences the choice of feeding site and feeding success of some ground-feeding species (e.g. Brough & Bridgman 1980). Those species most affected are likely to be those that feed on prey at or just below the surface of the ground. For such species, which include Blackbird, detection of cues from prey may be difficult in long vegetation.

As mentioned above (under Study Area) the take-up of herbicides applied in autumn 1982 to the winter cereals was very efficient. This probably resulted in less marked differences in weed growth between sprayed and unsprayed headlands on winter cereals than on spring barley. Therefore a separate analysis of feeding sites was conducted for spring barley crops in the hope that some firmer trends

might be detected in relation to the spraying regime. Unfortunately, the samples of birds seen in unsprayed spring barley (see above) were so small that it was impossible to analyse the data separately for different types of edge. Nevertheless, some interesting results emerged (Table 25), particularly for Dunnock which showed a significant preference (P=0.04) for feeding in unsprayed spring barley crops. Chaffinch showed a similar pattern to Dunnock although the result for this species was not statistically significant (P=0.14). Blackbird showed a preference (not quite significant, P=0.07) for sprayed spring barley crops.

One final comparison was made of songbird feeding in fields with sprayed and unsprayed headlands. If spraying affected the use of crops by feeding songbirds, one might expect the amount or intensity of feeding in crops to differ between samples of sprayed and unsprayed headlands. This hypothesis was tested by attempting to define the intensity of crop-usage by feeding Dunnocks, Blackbirds and Chaffinches along selected hedgerows next to sprayed and unsprayed hedges. Crop-usage was defined by relating the number of individuals seen feeding in the crop during timed watches, to the density of that species in the adjacent hedge. A hedge with many observations of crop-feeding birds per watch, but a relatively low breeding density, scored a higher crop-usage than a hedge with a higher density but fewer feeding observations per watch. The mean values of crop-usage for the two samples of hedges were then compared. The results and more details of the method are given in Table 26.

Average crop-usage by Blackbirds was greater in fields with sprayed headlands. Although this was consistent with the results obtained from the analysis of feeding sites the difference in mean crop-usage was not significant. Dunnocks showed equal crop-usage for sprayed and unsprayed headlands. Chaffinches showed greater usage of the unsprayed headlands but again the difference was not significant.

CONCLUDING DISCUSSION

THE SIGNIFICANCE OF UNSPRAYED HEADLANDS FOR SONGBIRDS

This section draws together and discusses those results which are relevant to the question of whether unsprayed headlands are beneficial to songbirds. The following section considers which questions remain unresolved by the present work.

Bird communities on farmland in southern England include many species (Williamson 1967). However, few species depend on the cultivated land for either nest sites or food (Murton 1971, this study). Cereal crops are presumably a poor feeding habitat for songbirds because the frequency with which birds were seen feeding on arable land at Manydown was very low. Both Murton (1971) and Green (1978) have emphasised the extreme fluctuations in food abundance that occur on arable land. The present study was confined to the use of cereal crops by songbirds, but Davis (1967) compared use of wheat with beans, rape and peas. He found that wheat was used less than the other crops by birds. This suggests that cereal crops may be less preferred as a feeding habitat than some other crops. Therefore, any management which improves the food resource for songbirds in cereal fields is most desirable.

The majority of the breeding species in the study area preferred woodland habitats. The songbird species that preferred to nest in hedgerows were Dunnock, Yellowhammer and Whitethroat, although Blackbird and Chaffinch were common in both hedges and woods. Only a small number of species were seen regularly feeding on the arable land and these were the typical hedgerow-nesting species. Birds nesting in woodland adjacent to fields made very little use of the cereal crops. It is possible, however, that woodland birds might exploit exceptionally rich feeding conditions in a nearby unsprayed headland, but there was no evidence that this happened in 1984. Consequently, any benefit from unsprayed headlands is likely to be restricted to those species nesting along hedgerows, notably Dunnock, Yellowhammer, Whitethroat, Chaffinch and Blackbird.

Hedgerow songbirds fed in the crops immediately adjacent to the hedge but rarely fed in the field crop (i.e. beyond the headland). It is likely that this was because most arthropods and seeds were present at the edges of fields. It may also be that some songbirds do not forage far from cover. Therefore, any increase in the amount of food at the edges of fields resulting from unsprayed headlands could be readily exploited by hedgerow birds.

The results obtained on the effects of unsprayed headlands on the feeding behaviour of songbirds in 1984 were not clear-cut. There was no indication that feeding intensity nor lengths of feeding bouts differed between sprayed and unsprayed headlands. However, there was suggestion of differences in the location of foraging birds between sprayed and unsprayed headlands. Statistical confirmation of such differences was generally lacking; this may have been a consequence of the strong take-up of the autumn herbicides which reduced the differential between experimental and control plots.

Dunnock, one of the main hedgerow specialists, showed some preference for feeding in unsprayed headlands. Dunnocks spent longer feeding in unsprayed than sprayed headlands. In fields with unsprayed headlands a higher proportion of Dunnocks fed in the crop (compared with the rotovated strip) than was the case with sprayed headlands. A significant result was obtained when only spring barley fields were examined, suggesting that the differential on winter cereal headlands may indeed have been reduced by the autumn herbicides. Chaffinches showed similar trends to Dunnocks, but no statistically significant results were obtained. In contrast, Blackbirds appeared to spend slightly more time in sprayed than unsprayed headlands and a greater proportion of Blackbirds was seen feeding in crops on sprayed than on unsprayed headlands.

Most of the hedgerow songbirds were present at low densities. Furthermore, the absolute frequency of feeding by songbirds on cultivated land was very low. These two factors made it difficult to collect large samples of feeding observations of the scarcer species. Unfortunately, insufficient data were collected for Yellowhammers and Whitethroats, two of the main hedgerow specialists, to assess their use of unsprayed headlands. Whitethroats were particularly scarce in the study area. A more detailed study of the possible benefits of unsprayed headlands to Whitethroats would be desirable (see below).

SUGGESTIONS FOR FUTURE WORK

The above results suggest that the use of agricultural chemicals in headlands may influence the extent to which some songbirds feed in crops. However, the 1984 results indicate that sampling studies are inadequate in the face of the low densities of songbirds present on much cereal farmland. This fact necessitates intensive studies of selected species. Such work would require the use of mist-netting and colour marking to create a sample of individually marked adults. Observation of these birds would increase the likelihood of detecting control-experiment differences in the use of cereal crops for feeding.

Such work should concentrate on those species which have been shown to prefer farmland to woodland as a breeding habitat, especially Dunnock, Yellowhammer and Whitethroat. A study of Whitethroat would be particularly valuable because it is the only migrant songbird typically associated with hedgerows yet it is a fairly scarce species in many areas. Unsprayed headlands may well prove beneficial to this species. Unfortunately, no useful information was collected on Whitethroats in 1984 because the densities at Manydown were extremely low and it would be desirable to locate additional study areas for this species.

The important question of whether breeding performance of songbirds was influenced by leaving headlands unsprayed was not answered by the 1984 work. The obvious way to study breeding success would be to find large samples of nests. However, the densities of nests of most songbird species on farmland are low. A very substantial amount of fieldwork would have been required to find adequate samples of nests. Such intensive nest searching in 1984 would have precluded the collection of so much information on the feeding sites of birds. Furthermore, without prior detailed knowledge of which species fed in cereal crops, it was by no means certain which should be the target species for nest searches. There was also the real concern that intensive nest searching might cause disturbance to nesting Partridges.

Any future work could include nest-searching for Dunnock and Blackbird but hedgerow densities of other species may prove too low to find adequate samples of nests so alternative methods of studying breeding success and productivity would be needed. In 1984 an attempt was made to count and map the distribution of family parties of recently fledged juveniles but very few families were located and it proved impossible to obtain reliable counts of juveniles. There was no evidence from territory mapping of any marked influxes of birds into hedgerows adjacent to unsprayed headlands. A more promising approach would be systematic mist-netting of juveniles to produce indices of productivity. If time allowed, detailed studies of food and feeding behaviour (including feeding rates and examination of food loads brought to nestlings in control and experimental nests) would help identify the proximate factors influencing the use of headlands by feeding birds.

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APPENDIX Scientific names of birds with abbreviations in parenthesis.

(H)	Grey Heron	*Ardea cinerea*	
(MA)	Mallard	*Anas latyrhychos*	
(SH)	Sparrowhawk	*Accipiter nisus*	
(K)	Kestrel	*Falco tinnunculus*	
(HY)	Hobby	*Falco subbuteo*	
(RL)	Red legged Partridge	*Alectoris rufa*	
(P)	Grey Partridge	*Perdix perdix*	
(PH)	Pheasant	*Phasianus colchicus*	
(L)	Lapwing	*Vanellus vanellus*	
(BH)	Blackheaded Gull	*Larus ridibundus*	
(CN)	Common Tern	*Sterna hirundo*	
(SD)	Stock Dove	*Columba oenas*	
(WP)	Wood pigeon	*Columba palumbus*	
(CD)	Collared Dove	*Streptopelia decaocto*	
(TD)	Turtle Dove	*Streptopelia turtur*	
(CK)	Cuckoo	*Cuculus canorus*	
(SI)	Swift	*Apus apus*	
(GS)	Great Spotted Woodpecker	*Dendrocopos major*	
(S)	Skylark	*Alauda arvensis*	
(SL)	Swallow	*Hirundo rustica*	
(HM)	House Martin	*Delichon urbica*	
(MP)	Meadow Pipit	*Anthus pratensis*	
(YW)	Yellow Wagtail	*Motacilla flava*	
(PW)	Pied Wagtail	*Motacilla alba*	
(WR)	Wren	*Troglodytes troglodytes*	
(D)	Dunnock	*Prunella modularis*	
(R)	Robin	*Erithacus rubecula*	
(BX)	Black Redstart	*Phoenicurus ochruros*	
(RT)	Redstart	*Phoenicurus phoenicurus*	
(B)	Blackbird	*Turdus merula*	
(ST)	Song Thrush	*Turdus philomelos*	
(M)	Mistle Thrush	*Turdus viscivorus*	
(LW)	Lesser Whitethroat	*Sylvia curruca*	
(WH)	Whitethroat	*Sylvia communis*	
(GW)	Garden Warbler	*Sylvia borin*	
(BC)	Blackcap	*Sylvia atricapilla*	
(CC)	Chiffchaff	*Phylloscopus collybita*	
(WW)	Willow Warbler	*Phylloscopus trochilus*	
(GC)	Goldcrest	*Regulus regulus*	
(SF)	Spotted Flycatcher	*Muscicapa striata*	
(LT)	Long-tailed Tit	*Aegithalos caudatus*	
(MT)	Marsh Tit	*Parus palustris*	
(WT)	Willow Tit	*Parus montanus*	
(CT)	Coal Tit	*Parus ater*	
(BT)	Blue Tit	*Parus caeruleus*	
(GT)	Great Tit	*Parus major*	
(NH)	Nuthatch	*Sitta europaea*	
(TC)	Treecreeper	*Certhia familiaris*	
(J)	Jay	*Garrulus glandarius*	
(MG)	Magpie	*Pica pica*	
(JD)	Jackdaw	*Corvus monedula*	
(RO)	Rook	*Corvus frugilegus*	
(C)	Carrion Crow	*Corvus corone*	
(SG)	Starling	*Sturnus vulgaris*	
(HS)	House Sparrow	*Passer domesticus*	
(TS)	Tree Sparrow	*Passer montanus*	
(CH)	Chaffinch	*Fringilla coelebs*	
(GR)	Greenfinch	*Carduelis chloris*	
(GO)	Goldfinch	*Carduelis carduelis*	
(LI)	Linnet	*Carduelis cannabina*	
(BF)	Bullfinch	*Pyrrhula pyrrhula*	
(Y)	Yellowhammer	*Emberiza citrinella*	
(CB)	Corn Bunting	*Miliaria calandra*	

TABLE 1. Land-use in the study area at Manydown Farm 1984. Areas are given to the nearest hectare and lengths are in Km.

TOTAL AREA COVERED	562 ha
FARMLAND (FIELDS* & HEDGEROWS): TOTAL AREA	473 ha
APPROX AREA OF SPRING BARLEY	175 ha
" " " WINTER BARLEY	98 ha
" " " WINTER WHEAT	125 ha
" " " GRASS	24 ha
" " " OTHER CROPS	50 ha
LENGTH OF TALL HEDGEROWS	3.49 km
LENGTH OF SHORT HEDGEROWS	13.74 km
LENGTH OF FENCES/BANKS WITHOUT HEDGES	5.65 km
WOODLAND & SCRUB: TOTAL AREA	64 ha
AREA OF BROAD-LEAVED COPPICE	39 ha
" " MIXED/CONIFEROUS WOODLAND	7 ha
" " LINEAR WOODLAND/CLUMPS	11 ha
" " SCRUB (mainly railway embankments)	7 ha
HABITATIONS etc: TOTAL AREA	25 ha
AREA OF HOUSES & GARDENS	20 ha
AREA OF FARMSTEADS	5 ha

* All crop areas are approximate because, for convenience of calculation, it has been assumed that the crops extended to the edge of the fields although there was a rotovated strip and, in most cases, a hedge of variable width at the field edge. The land-use statistics include a 50m belt outside the strict edge of study plot because, in practice, birds were censused within this area.

TABLE 2. The chemical sprays applied to cereal fields at Manydown Farm in the autumn of 1983 and the spring of 1984. Numbers refer to the numbers of applications.

CROP	AUTUMN APPLICATIONS	SPRING APPLICATIONS
WINTER WHEAT	1 grass weed herbicide	2 fungicides 1 insecticide
WINTER BARLEY	1 grass weed herbicide 1 broad-leaved weed herbicide 1 fungicide 1 insecticide	2 fungicides
SPRING BARLEY	1 broad-spectrum herbicide to some fields (depended on the previous year's crop)	1 broad-leaved weed herbicide 1 fungicide

TABLE 3. Distribution of songbird territories between broad types of habitats at Manydown Farm in 1984. Densities are given in parentheses (territories/Km^2 for woodland, crops, gardens and territories/10km for hedgerows).

SPECIES	TOTAL TERRITORIES	WOODLAND & SCRUB (0.64km^2)	HEDGEROWS (17.23km)	CEREAL CROPS (3.99km^2)	GARDENS/FARMSTEADS (0.25km^2)
Skylark	106			82.2 (20.6)	
Pied Wagtail	6				6.0 (24)
Wren	84	58.0 (91)	7.6 (4.4)		18.4 (74)
Dunnock	80	25.4 (40)	36.2 (21.0)		18.0 (72)
Robin	75	64.4 (101)	4.8 (2.8)		5.8 (23)
Blackbird	150	69.2 (108)	36.2 (21.0)		43.4 (174)
Song Thrush	15	9.6 (15)	0.4 (0.2)		5.0 (20)
Mistle Thrush	20	13.2 (21)	2.4 (1.4)		4.2 (17)
Lesser Whitethroat	1	1.0 (2)			
Whitethroat	10	2.0 (3)	7.8 (4.5)		0.2 (<1)
Garden Warbler	9	9.0 (14)			
Blackcap	27	23.2 (36)	1.2 (0.7)		2.6 (10)
Chiffchaff	2	2.0 (3)			
Willow Warbler	39	34.8 (54)	1.4 (0.8)		2.8 (11)
Goldcrest	12	9.4 (15)	1.0 (0.6)		1.6 (6)
Spotted Flycatcher	4	3.0 (5)	0.4 (0.2)		0.6 (2)
Long-tailed Tit	12	9.2 (14)	2.2 (1.3)		0.6 (2)
Marsh Tit	9	9.0 (14)			
Willow Tit	4	4.0 (6)			
Coal Tit	13	9.6 (15)	1.2 (0.7)		2.2 (9)
Blue Tit	91	64.4 (101)	14.4 (8.4)		12.2 (49)
Great Tit	54	36.2 (57)	8.8 (5.1)		9.0 (36)
Nuthatch	12	12.0 (19)			
Treecreeper	6	6.0 (9)			
Starling	14	4.0 (6)			10.0 (40)
Chaffinch	203	106.8 (167)	49.4 (28.7)		42.4 (170)
Greenfinch	29	10.6 (17)	5.8 (3.4)		12.6 (50)
Goldfinch	6	2.4 (4)	1.4 (0.8)		2.0 (8)
Linnet	17	3.2 (5)	5.8 (3.4)		8.0 (32)
Bullfinch	4	3.6 (6)	0.2 (0.1)		0.2 (<1)
Yellowhammer	62	15.2 (24)	31.6 (18.3)		8.8 (35)
Corn Bunting	5		1.0 (0.6)	1.8 (0.5)	0.2 (<1)

Notes:

1. The total territories are for the entire area surveyed; details of the habitats are given in Table 1 and in the text.
2. Territories were allocated to habitats (to the nearest 0.2 territory) according to the distribution of registrations between habitats.
3. The numbers of territories in the different habitats do not always agree with the totals because some habitats (eg. grass, field boundaries which were not hedgerows) have been omitted from the table.
4. The following non-songbirds were recorded holding territory: Sparrowhawk, Kestrel, Red-legged Partridge, Grey Partridge, Pheasant, Lapwing, Stock Dove, Woodpigeon, Collared Dove, Turtle Dove, Cuckoo, Great Spotted Woodpecker, Swallow, House Martin, Jay, Magpie, Jackdaw, Rook, Carrion Crow, House Sparrow.
5. Other species recorded during the census were Grey Heron, Mallard, Hobby, Black-headed Gull, Common Tern, Swift, Meadow Pipit, Yellow Wagtail, Redstart, Black Redstart and Tree Sparrow.
6. Scientific names of birds are given in Appendix 1.

TABLE 4. The densities of selected bird species breeding along hedgerows adjacent to sprayed and unsprayed headlands.

	HEDGEROWS BY SPRAYED HEADLANDS (n=11 hedges)		HEDGEROWS BY UNSPRAYED HEADLANDS (n=13 hedges)		Statistical difference between the mean densities (Mann Whitney Test, two-tailed)
	Mean density (territories/100m)	Range of density	Mean density (territories/100m)	Range of density	
BLACKBIRD	0.26	(0 -0.47)	0.30	(0.06-0.75)	u=50, not significant
DUNNOCK	0.22	(0.06-0.40)	0.31	(0 -0.53)	u=42, not significant
ROBIN	0.03	(0 -0.30)	0.06	(0 -0.33)	u=67, not significant
WHITETHROAT	0.07	(0 -0.29)	0.03	(0 -0.15)	u=57, not significant
CHAFFINCH	0.27	(0. -0.91)	0.33	(0. -0.65)	u=56, not significant
YELLOWHAMMER	0.25	(0 -0.75)	0.19	(0 -0.58)	u=64, not significant

Note: 1. All hedgerows in the study areas were included in the samples with the exception of hedges less than 200m, roadside hedgerows and hedgerows with tracks on both sides.

2. The two samples contained similar proportions of short and tall hedgerows: the sprayed sample included 8 short and 3 tall hedges; the unsprayed sample contained 9 short and 4 tall hedges.

TABLE 5. A summary of the feeding positions of all bird species (excluding gamebirds) observed on cereal fields at Manydown Farm in 1984. The species are arranged approximately in order of the distance from the field edge at which they were seen. An asterisk indicates that the species was observed at a particular distance from the field edge; brackets indicate that the species was observed only rarely. Three broad groups of species can be recognised: I - species seen only at the extreme edge of fields, II - species which mainly utilise the outer 100m of fields although the majority of records were within 50m of the edge, III species which avoided field edges.

	SPECIES	ROTOVATED STRIP	HEADLAND 0-6m	FIELD CROP 6-100m	CENTRE OF FIELD
I	Great Tit	(*)			
	Wren	(*)			
	Willow Warbler	(*)			
	Jackdaw	(*)			
	Robin	*	*		
	Magpie	(*)	(*)		
II	Woodpigeon	*	*	(*)	
	Song Thrush	*	*	(*)	
	Blackbird	*	*	*	
	Dunnock	*	*	*	
	Chaffinch	*	*	*	
	Linnet	(*)	(*)	(*)	
	Mistle Thrush	*	*	*	
	House Sparrow	*	*	*	(*)
	Yellowhammer	*	*	*	(*)
III	Rook	(*)	(*)	*	*
	Stock Dove				(*)
	Skylark		(*)	*	*
	Lapwing			(*)	*

TABLE 6. The frequency with which songbird species were recorded on farmland adjacent to woodlands. The number of timed watches during which the species was recorded is given with the percentage in brackets.

		APRIL & MAY (n=132 watches)	JUNE & JULY (n=145 watches)
DUNNOCK	WOOD EDGE	1 (0.8%)	0
	ROTOVATION	1 (0.8%)	0
	HEADLAND	0	0
	FIELD CROP	0	0
ROBIN	WOOD EDGE	2 (1.5%)	0
	ROTOVATION	6 (4.5%)	0
	HEADLAND	1 (0.8%)	0
	FIELD CROP	0	0
BLACKBIRD	WOOD EDGE	5 (3.8%)	7 (4.8%)
	ROTOVATION	5 (3.8%)	19(13.1%)
	HEADLAND	0	0
	FIELD CROP	0	0
SONG THRUSH	WOOD EDGE	1 (0.8%)	0
	ROTOVATION	2 (1.5%)	0
	HEADLAND	1 (0.8%)	1 (0.7%)
	FIELD CROP	0	0
MISTLE THRUSH	WOOD EDGE	0	1 (0.7%)
	ROTOVATION	0	2 (1.4%)
	HEADLAND	0	0
	FIELD CROP	0	0
CHAFFINCH	WOOD EDGE	0	0
	ROTOVATION	1 (0.8%)	0
	HEADLAND	2 (1.5%)	1 (0.7%)
	FIELD CROP	0	0
YELLOWHAMMER	WOOD EDGE	0	0
	ROTOVATION	1 (0.8%)	0
	HEADLAND	1 (0.8%)	1 (0.7%)
	FIELD CROP	0	0

TABLE 7. The frequency with which songbird species were recorded on farmland adjacent to hedgerows. The number of timed watches during which the species was recorded is given with the percentage in brackets.

		APRIL & MAY (n=265 watches)	JUNE & JULY (n=405 watches)
SKYLARK	HEDGE BASE	0	0
	ROTOVATION	0	0
	HEADLAND	0	0
	FIELD CROP	0	1 (0.3%)
DUNNOCK	HEDGE BASE	10 (3.8%)	1 (0.3%)
	ROTOVATION	3 (1.1%)	11 (2.7%)
	HEADLAND	2 (0.8%)	12 (3.0%)
	FIELD CROP	0	3 (0.7%)
ROBIN	HEDGE BASE	2 (0.8%)	0
	ROTOVATION	5 (1.9%)	0
	HEADLAND	2 (0.8%)	0
	FIELD CROP	0	0
BLACKBIRD	HEDGE BASE	10 (3.8%)	1 (0.3%)
	ROTOVATION	17 (6.4%)	21 (5.2%)
	HEADLAND	4 (1.5%)	10 (2.5%)
	FIELD CROP	1 (0.4%)	1 (0.3%)
SONG THRUSH	HEDGE BASE	0	0
	ROTOVATION	0	0
	HEADLAND	0	1 (0.3%)
	FIELD CROP	0	0
MISTLE THRUSH	HEDGE BASE	0	1 (0.3%)
	ROTOVATION	0	0
	HEADLAND	0	0
	FIELD CROP	0	0
WILLOW WARBLER	HEDGE BASE	0	0
	ROTOVATION	0	2 (0.5%)
	HEADLAND	0	0
	FIELD CROP	0	0
STARLING	HEDGE BASE	0	0
	ROTOVATION	0	1 (0.3%)
	HEADLAND	0	0
	FIELD CROP	0	0
GREAT TIT	HEDGE BASE	1 (0.4%)	0
	ROTOVATION	0	0
	HEADLAND	0	0
	FIELD CROP	0	0
HOUSE SPARROW	HEDGE BASE	0	0
	ROTOVATION	1 (0.4%)	1 (0.3%)
	HEADLAND	1 (0.4%)	0
	FIELD CROP	1 (0.4%)	1 (0.3%)
CHAFFINCH	HEDGE BASE	0	0
	ROTOVATION	5 (1.9%)	7 (1.7%)
	HEADLAND	0	6 (1.5%)
	FIELD CROP	0	5 (1.2%)
YELLOWHAMMER	HEDGE BASE	2 (0.8%)	0
	ROTOVATION	2 (0.8%)	4 (1.0%)
	HEADLAND	0	2 (0.5%)
	FIELD CROP	0	1 (0.3%)

TABLE 8. Feeding sites of Dunnocks in different types of crops. Results are shown separately for early (April and May) and late (June and July) observations.

APRIL AND MAY

	Spring barley	Winter barley & Winter wheat
Edge	7	4
Crop	0	4

Fisher Exact Test, both tails, P = 0.08 (n.s.)

JUNE & JULY

	Spring barley	Winter barley & winter wheat
Edge	16 (50%)	5 (31%)
Crop	16 (50%)	11 (69%)

$X^2 = 0.857$, $P < 0.50$ (n.s.)

Note: 1. Results have been combined from all types of field boundaries.

2. All feeding bouts recorded whether on timed watches or as supplementary observations have been included. This is valid because the same methods were employed in each instance.

3. A feeding bout was classified as 'edge' or 'crop' according to where the majority of 15 second feeding records were observed. One bout was excluded from the analyses because it contained equal records inside and outside the crop.

4. 'Edge' = the rotovated strip. 'Crop' = the headland and the main crop.

TABLE 9. Feeding sites of Blackbirds in different types of crops. Results are shown separately for early (April & May) and late (June & July) observations.

APRIL & MAY

	Spring barley	Winter barley & winter wheat
Edge	31 (82%)	15 (88%)
Crop	7 (18%)	2 (12%)

Fisher Exact Test, both tails. P = 0.83 (n.s.)

JUNE & JULY

	Spring barley	Winter barley & winter wheat
Edge	22 (59%)	20 (71%)
Crop	15 (41%)	8 (29%)

$X^2 = 0.544$, $P < 0.50$ (n.s.)

Note: 1. Results have been combined from all types of field boundaries.

2. All feeding bouts recorded whether on timed watches or as supplementary observations have been included. This is valid because the same methods were employed. in each instance.

3. A feeding bout was classified as 'edge' or 'crop' according to where the majority of 15 second feeding records were observed. Four bouts were excluded from the analyses because they contained equal records inside and outside the crop.

4. 'Edge' = the rotovated strip. 'Crop' = the headland and the main crop.

TABLE 10. Feeding sites of Chaffinches in different types of crops. Results are shown separately for early (April & May) and late (June & July) observations.

APRIL & MAY

	Spring barley	Winter barley & winter wheat
Edge	6	6
Crop	4	3

Fisher Exact Test, both tails P = 0.70 (n.s.)

JUNE & JULY

	Spring barley	Winter barley & winter wheat
Edge	7 (58%)	5 (36%)
Crop	5 (42%)	9 (64%)

$X^2 = 0.576$, $P < 0.50$ (n.s.)

Notes:

1. Results have been combined from all types of field boundaries.
2. All feeding bouts recorded whether on timed watches or as supplementary observations have been included. This is valid because the same methods were employed in each instance.
3. A feeding bout was classified as 'edge' or 'crop' according to where the majority of 15 second feeding records were observed. Two bouts were excluded from the analyses because they contained equal records inside and outside the crop.
4. 'Edge' = the rotovated strip. 'Crop' = the headland and the main crop.

TABLE 11. The frequency with which Dunnocks were recorded feeding adjacent to hedgerows. The number of timed watches during which the species was recorded is given with the percentage frequency in parenthesis.

	VISIT 1 17 April (n=44)	VISIT 2 1 May (n=88)	VISIT 3 15 May (n=50)	VISIT 4 30 May (n=83)	VISIT 5 12 June (n=84)	VISIT 6 21 June (n=87)	VISIT 7 22 June (n=85)	VISIT 8 3 July (n=77)	VISIT 9 17 July (n=72)
HEDGEROW BASE	1 (2.3%)	8 (9.1%)	0	1 (1.2%)	0	1 (1.1%)	0	0	0
ROTOVATED STRIP	0	2 (2.1%)	1 (2.0%)	0	1 (1.2%)	4 (4.6%)	2 (2.4%)	3 (3.9%)	1 (1.4%)
HEADLAND CROP	0	0	0	2 (2.4%)	0	4 (4.6%)	3 (3.5%)	2 (2.6%)	3 (4.2%)
FIELD CROP	0	0	0	0	0	1 (1.1%)	2 (2.4%)	0	0

Notes: 1. Only the starting date of each visit is given. Visits were of 1 to 3 days duration.

2. There was no significant agreement between visits in the frequency with which Dunnocks were recorded in the different zones (Kendall's coefficient of concordance = 0.26, $P > 0.05$).

TABLE 12. The frequency with which Blackbirds were recorded feeding adjacent to woodlands. The number of timed watches during which the species was recorded is given with the percentage frequency in parentheses.

	VISIT 1 17 April (n=33)	VISIT 2 1 May (n=35)	VISIT 3 15 May (n=28)	VISIT 4 30 May (n=36)	VISIT 5 12 June (n=36)	VISIT 6 21 June (n=36)	VISIT 7 22 June (n=21)	VISIT 8 3 July (n=26)	VISIT 9 17 July (n=26)
WOODLAND EDGE	2 (6.1%)	2 (5.7%)	1 (3.6%)	0	0	0	1 (4.8%)	0	0
ROTOVATED STRIP	2 (6.1%)	2 (5.7%)	0	1 (2.8%)	2 (5.6%)	0	2 (9.5%)	2 (7.7%)	1 (3.8%)
HEADLAND CROP	0	0	0	0	0	0	0	0	0
FIELD CROP	0	0	0	0	0	0	0	0	0

Notes: 1. Only the starting date of each visit is given. Visits were of 1 to 3 days duration.

2. There was significant agreement between the visits in the frequency with which Blackbirds were recorded in the different zones (Kendall's coefficient of concordance, $w = 0.59$, $P < 0.01$).

TABLE 13. The frequency with which Blackbirds were recorded feeding adjacent to hedgerows. The number of timed watches during which the species was recorded is given with the percentage frequency in parentheses.

	VISIT 1 17 April (n=44)	VISIT 2 1 May (n=88)	VISIT 3 15 May (n=50)	VISIT 4 30 May (n=83)	VISIT 5 12 June (n=84)	VISIT 6 21 June (n=87)	VISIT 7 22 June (n=85)	VISIT 8 3 July (n=77)	VISIT 9 17 July (n=72)
HEDGEROW BASE	2 (4.5%)	3 (3.4%)	3 (6.0%)	2 (2.4%)	0	0	0	1 (1.3%)	0
ROTOVATED STRIP	1 (2.3%)	7 (8.0%)	4 (8.0%)	5 (6.0%)	3 (3.6%)	6 (6.9%)	7 (8.2%)	2 (2.6%)	3 (4.2%)
HEADLAND CROP	0	2 (2.3%)	1 (2.0%)	1 (1.2%)	2 (2.4%)	2 (2.3%)	2 (2.4%)	2 (2.6%)	2 (2.8%)
FIELD CROP	0	1 (1.1%)	0	0	0	0	0	1 (1.3%)	0

Note: 1. Only the starting date of each visit is given. Visits were of 1 to 3 days duration.

2. There was significant agreement between visits in the frequency with which Blackbirds were recorded in the different zones (Kendall's coefficient of concordance = 0.69, $P < 0.001$).

TABLE 14. The frequency with which Chaffinches were recorded feeding adjacent to hedgerows. The number of timed watches during which the species was recorded is given with the percentage frequency in parentheses.

	VISIT 1 17 April (n=44)	VISIT 2 1 May (n=88)	VISIT 3 15 May (n=50)	VISIT 4 30 May (n=83)	VISIT 5 12 June (n=84)	VISIT 6 21 June (n=87)	VISIT 7 22 June (n=85)	VISIT 8 3 July (n=77)	VISIT 9 17 July (n=72)
HEDGEROW BASE	0	0	0	0	0	0	0	0	0
ROTOVATED STRIP	0	3 (3.4%)	1 (2.0%)	0	1 (1.2%)	0	3 (3.5%)	3 (3.9%)	1 (1.4%)
HEADLAND CROP	0	0	0	0	0	0	3 (3.5%)	1 (1.3%)	2 (2.8%)
FIELD CROP	0	0	0	0	0	3 (3.4%)	0	0	2 (2.8%)

Notes: 1. Only the starting date of each visit is given. Visits were of 1 to 3 days duration.

2. There was significant agreement between the visits in the frequency with which Chaffinches were recorded in the different zones (Kendall's coefficient of concordance = 0.30, $P < 0.05$).

TABLE 15. The feeding sites of Dunnocks in relation to the time of year. Results are shown for sprayed and unsprayed headlands and for different types of field boundaries.

		SPRAYED		UNSPRAYED			ALL OBSERVATIONS (SPRAYED & UNSPRAYED)	
		April & May	June & July	April & May	June & July		April & May	June & July
WOODLAND & HEDGEROW COMBINED	Edge	4	16	8 (73%)	6 (29%)	Edge	12 (80%)	22 (45%)
	Crop	0	12	3 (27%)	15 (71%)	Crop	3 (20%)	27 (55%)
		Fisher Exact, P= 0.26 (n.s.)		X^2= 4.07, P< 0.05			X^2= 4.36, P< 0.05	

		SPRAYED		UNSPRAYED			ALL OBSERVATIONS (SPRAYED & UNSPRAYED)	
		April & May	June & July	April & May	June & July		April & May	June & July
HEDGEROWS ONLY	Edge	4	15	7 (88%)	6 (33%)	Edge	11 (92%)	21 (47%)
	Crop	0	12	1 (13%)	12 (67%)	Crop	1 (8%)	24 (53%)
		Fisher Exact, P= 0.24 (n.s.)		X^2= 4.51, P< 0.05			X^2= 6.07, P< 0.02	

Notes: 1. All feeding bouts recorded, whether on timed watches or as supplementary observations, have been included. This is valid because the same methods were employed in each instance.

2. A feeding bout was classified as 'edge' or 'crop' according to where the majority of 15 second feeding records were observed. One bout was excluded from the analyses because it contained equal numbers of records inside and outside the crop.

3. "Edge" = the rotovated strip. "Crop"= the headland and the main crop.

TABLE 16. Feeding sites of Blackbirds in relation to the time of year. Results are shown for sprayed and unsprayed headlands and for different types of field boundaries.

		SPRAYED		UNSPRAYED		ALL OBSERVATIONS (SPRAYED & UNSPRAYED)	
		April & May	June & July	April & May	June & July	April & May	June & July
WOODLAND & HEDGEROWS COMBINED	Edge	28 (78%)	18 (47%)	25 (93%)	24 (71%)	53 (84%)	42 (58%)
	Crop	8 (22%)	20 (53%)	2 (7%)	10 (29%)	10 (16%)	30 (42%)
		$X^2 = 6.03$, $P < 0.02$		$X^2 = 3.32$, $P < 0.10$ (n.s.)		$X^2 = 9.52$, $P < 0.01$	

		SPRAYED		UNSPRAYED		ALL OBSERVATIONS (SPRAYED & UNSPRAYED)	
		April & May	June & July	April & May	June & July	April & May	June & July
HEDGEROWS ONLY	Edge	24 (77%)	15 (52%)	19 (90%)	17 (65%)	43 (83%)	32 (58%)
	Crop	7 (23%)	14 (48%)	2 (10%)	9 (35%)	9 (17%)	23 (42%)
		$X^2 = 3.29$, $P < 0.10$ (n.s.)		$X^2 = 2.80$, $P < 0.10$ (n.s.)		$X^2 = 6.54$, $P < 0.02$	

Notes: 1. All feeding bouts recorded, whether on timed watches or as supplementary observations, have been included. This is valid because the same methods were employed in each instance.

2. A feeding bout was classified as 'edge' or crop' according to where the majority of 15 second feeding records were observed. Four bouts were excluded from the analyses because they contained equal records inside and outside the crop.

3. "Edge" = the rotovated strip. "Crop" = the headland and the main crop.

TABLE 17. Feeding sites of Chaffinches in relation to the time of year. Results are shown for sprayed and unsprayed headlands and for different types of field boundaries.

		SPRAYED		UNSPRAYED			ALL OBSERVATIONS (SPRAYED & UNSPRAYED)	
		April & May	June & July		April & May	June & July		April & May	June & July
WOODLAND & HEDGEROWS COMBINED	Edge	13 (68%)	10 (53%)	Edge	1	3	Edge	14 (67%)	13 (48%)
	Crop	6 (32%)	9 (47%)	Crop	1	5	Crop	7 (33%)	14 (52%)
	$X^2 = 0.44$, $P < 0.70$ (n.s.)			(not tested)			$X^2 = 0.98$, $P < 0.50$ (n.s.)		

		SPRAYED		UNSPRAYED			ALL OBSERVATIONS (SPRAYED & UNSPRAYED)	
		April & May	June & July		April & May	June & July		April & May	June & July
HEDGEROWS ONLY	Edge	11 (79%)	10 (59%)	Edge	1	3	Edge	12 (75%)	13 (52%)
	Crop	3 (21%)	7 (41%)	Crop	1	5	Crop	4 (25%)	12 (48%)
	$X^2 = 0.62$, $P < 0.50$ (n.s.)			(not tested)			$X^2 = 1.31$, $P < 0.30$ (n.s.)		

Notes:
1. All feeding bouts recorded, whether on timed watches, or as supplementary observations have been recorded. This is valid becuase the same methods were employed in each instance.
2. A feeding bout was classified as 'edge' or 'crop' according to where the majority of 15 second feeding records were observed. One bout was excluded from the analyses because it contained equal numbers of records inside and outside the crop.
3. "Edge" = the rotovated strip. "Crop" = the headland and the main crop.

TABLE 18. The time spent by feeding Dunnocks at various distances from the hedgerow in June and July as shown by numbers of registrations made during timed watches (see methods for further details).

	Hedgerow edge	Rotovated strip	Headland	Field Crop	
FIELDS WITH SPRAYED HEADLANDS	0	59 (70%)	10 (12%)	15 (18%)	n=84 registrations from 17 birds
FIELDS WITH UNSPRAYED HEADLANDS	1 (2%)	15 (24%)	35 (57%)	11 (18%)	n=62 registrations from 13 birds

Note: Samples of Dunnocks observed feeding adjacent to woods and adjacent to hedges in April & May were too small for analysis.

TABLE 19. The time spent by feeding Blackbirds at various distances from hedgerows as shown by numbers of registrations made during timed watches (see methods for further details).

	Hedgerow edge	Rotovated strip	Headland	Field Crop	
APRIL & MAY					
FIELDS WITH SPRAYED HEADLANDS	27 (33%)	47 (57%)	3 (4%)	6 (7%)	n=83 registrations from 18 birds
FIELDS WITH UNSPRAYED HEADLANDS	9 (19%)	31 (66%)	7 (15%)	0	n=47 registrations from 7 birds
JUNE & JULY					
FIELDS WITH SPRAYED HEADLANDS	0	56 (48%)	59 (50%)	2 (2%)	n=117 registrations from 21 birds
FIELDS WITH UNSPRAYED HEADLANDS	3 (9%)	19 (58%)	11 (33%)	0	n=33 registrations from 9 birds

Note: Samples of Blackbirds observed feeding adjacent to woods were too small for analysis.

TABLE 20. Comparison of the numbers of "short" and "long" feeding bouts of Dunnocks, Blackbirds and Chaffinches in fields with sprayed and unsprayed headlands as shown by timed watches.

SPECIES	TIME OF YEAR	FEEDING ZONE	FIELDS WITH SPRAYED HEADLANDS		FIELD WITH UNSPRAYED HEADLANDS		COMPARISON OF SPRAYED AND UNSPRAYED
			SHORT BOUTS	LONG BOUTS	SHORT BOUTS	LONG BOUTS	
Dunnock	June & July	Edge by hedges	6	4	6	1	n.s.
Dunnock	June & July	Crop by hedges	6	3	5	2	n.s.
Blackbird	April & May	Edge by hedges	12	6	2	4	n.s.
Blackbird	June & July	Edge by hedges	11	4	7	1	n.s.
Blackbird	June & July	Edge by hedges & woods	16	5	8	1	n.s.
Blackbird	June & July	Crop by hedges	5	5	2	1	n.s.
Blackbird	June & July	Crop by hedge & woods	5	5	3	1	n.s.
Chaffinch	June & July	Crop by hedges	5	3	4	0	n.s.

Notes: 1. "Edge" = visible hedgerow/woodland edge including rotovated strip; "Crop" = headland and main body of the crop.

2. A long feeding bout was one lasting more than one minute; all others were short feeding bouts.

3. The frequency distributions of long and short bouts on sprayed and unsprayed fields were compared by Fisher Exact Test; n.s. = no significant difference between the two treatments.

TABLE 22. Feeding sites of Dunnocks in relation to the use of agricultural chemicals in headlands. Results are shown separately for early (April and May) and late (June and July) observations and for different types of field boundary.

		APRIL & MAY			JUNE & JULY	
		Sprayed	Unsprayed		Sprayed	Unsprayed
WOODLAND & HEDGEROWS COMBINED	Edge	4	8	Edge	16 (57%)	6 (29%)
	Crop	0	3	Crop	12 (43%)	15 (71%)
		Fisher Exact, P = 0.72 (n.s.)			X^2 = 2.89, P < 0.10 (n.s.)	

		APRIL & MAY			JUNE & JULY	
		Sprayed	Unsprayed		Sprayed	Unsprayed
HEDGEROWS ONLY	Edge	4	7	Edge	15 (56%)	6 (33%)
	Crop	0	1	Crop	12 (44%)	12 (67%)
		(not tested)			X^2 = 1.34, P < 0.30 (n.s.)	

Notes: 1. All feeding bouts recorded, whether on timed watches, or as supplementary observations, have been included. This is valid because the same methods were employed in each instance.

2. A feeding bout was classified as 'edge' or 'crop' according to where the majority of 15 second feeding records were observed. One bout was excluded from the analyses because it containd equal numbers of records inside and outside the crop.

3. "Edge" = the rotovated strip. "Crop" = the headland and the main crop.

TABLE 23. Feeding sites of Chaffinches in relation to the use of agricultural chemicals in headlands. Results are shown separately for early (April & May) and late (June & July) observations and for different types of field boundary.

		APRIL & MAY			JUNE & JULY	
		Sprayed	Unsprayed		Sprayed	Unsprayed
WOODLAND & HEDGEROWS COMBINED	Edge	13	1	Edge	10 (53%)	3 (38%)
	Crop	6	1	Crop	9 (47%)	5 (63%)
		(not tested)			$X^2 = 0.09$, $P < 0.80$ (n.s.)	

		APRIL & MAY			JUNE & JULY	
		Sprayed	Unsprayed		Sprayed	Unsprayed
HEDGEROWS ONLY	Edge	11	1	Edge	10 (59%)	3 (38%)
	Crop	3	1	Crop	7 (41%)	5 (63%)
		(not tested)			$X^2 = 0.32$, $P < 0.70$ (n.s.)	

Notes: 1. All feeding bouts recorded, whether on timed watches or as supplementary observations, have been included. This is valid because the same methods were employed in each instance.

2. A feeding bout was classified as 'edge' or 'crop' according to where the majority of 15 second feeding records were observed. One bout was excluded from the analyses because it contained equal numbers of records inside and outside the crop. All the birds recorded on the edge used the rotovated strip.

3. "Edge" = the rotovated strip. "Crop" = the headland and the main crop.

TABLE 24. Feeding sites of Blackbirds in relation to the use of agricultural chemicals in headlands. Results are shown separately for early (April and May) and late (June and July) observations and for different types of field boundary.

		APRIL & MAY		JUNE & JULY	
		Sprayed	Unsprayed	Sprayed	Unsprayed
WOODLAND & HEDGEROWS COMBINED	Edge	28 (78%)	25 (93%)	18 (47%)	24 (71%)
	Crop	8 (22%)	2 (7%)	20 (53%)	10 (29%)
		$X^2 = 1.55$, $P < 0.30$ (n.s.)		$X^2 = 3.08$, $P < 0.10$ (n.s.)	

		APRIL & MAY		JUNE & JULY	
		Sprayed	Unsprayed	Sprayed	Unsprayed
HEDGEROWS ONLY	Edge	24 (77%)	19 (90%)	15 (52%)	17 (65%)
	Crop	7 (23%)	2 (10%)	14 (48%)	9 (35%)
		$X^2 = 0.72$, $P < 0.50$ (n.s.)		$X^2 = 0.57$, $P < 0.50$ (n.s.)	

Notes:
1. All feeding bouts recorded, whether on timed watches or as supplementary observations, have been included. This is valid because the same methods were employed in each instance.
2. A feeding bout was classified as 'edge' or 'crop' according to where the majority of 15 second feeding records were observed. Four bouts were excluded from the analyses because they contained equal records inside and outside the crop.
3. "Edge" = the rotovated strip. "Crop" = the headland and the main crop.

TABLE 25. Feeding sites of songbirds on spring barley fields in June and July in relation to the use of agricultural chemicals in headlands.

BLACKBIRD	Sprayed	Unsprayed
Edge	17 (57%)	6 (100%)
Crop	13 (43%)	0

Fisher Exact Test (both tails)

P = 0.07 (n.s.)

DUNNOCK	Sprayed	Unsprayed
Edge	16 (59%)	0
Crop	11 (41%)	5 (100%)

Fisher Exact Test (both tails)

P = 0.04

CHAFFINCH	Sprayed	Unsprayed
Edge	11 (65%)	0
Crop	6 (35%)	3 (100%)

Fisher Exact Test (both tails)

P = 0.14 (n.s.)

Note: 1. Results have been combined from all types of field boundaries.

2. All feeding bouts recorded whether on timed watches or as supplementary observations have been included. This is valid because the same methods were employed in each instance.

3. A feeding bout was classified as 'edge' or 'crop' according to where the majority of 15 second feeding records were observed.

4. 'Edge' = the rotovated strip. 'Crop' = the headland and the main crop.

TABLE 26 Intensity of use of cereal crops by songbirds in June and July (see below for method of calculating indices of crop usage).

SPECIES	MEAN INDEX OF CROP USAGE: SPRAYED HEADLANDS (n = 13 hedges)	UNSPRAYED HEADLANDS (n = 10 hedges)	MANN WHITNEY U TEST
BLACKBIRD	0.17	0.06	n.s.
DUNNOCK	0.11	0.11	n.s.
CHAFFINCH	0.04	0.11	n.s.

Note: The index of crop usage (C) relates the number of birds observed feeding in the crop on timed watches to the density of birds breeding along the hedge:

$$C_{ih} = \frac{N_{ih}}{W_h \; d_{ih}}$$

where, N = number of birds of species i observed feeding in the crop along hedgerow h on all the timed watches in June and July, W = number of timed watches conducted along hedgerow h and d = density of species i along hedgerow h (territories/100m).