Effect of crop type on winter bird populations at the University Field Station

Michelle Johnson

Abstract

The rapid declines of many farmland bird populations over the last 30 years have been blamed on agricultural intensification. By studying winter bird populations at a time when major food sources are most accessible, we can determine some of the causal factors behind these declines.

This study assesses the species diversity of major farmland habitats and the habitat preferences of birds in winter. Particular attention was paid to those species which have shown serious declines over the last 30 years. Seed-eaters all show a move from crops to woodland as winter progresses and invertebrate-eaters a move to grassland habitats. Insectivores show no clear habitat change throughout winter. Of the 5 major habitats studied, grassland had the highest diversity index. 12 of the 17 species studied showed positive preferences for permanent pasture. Land sown with crops proved very unproductive, only the dunnock *Prunella modularis,* showed any preference for land with autumn sown crops. This report also highlights the necessity of hedgerows in a farmland landscape. The majority of birds, especially those showing serious declines such as the yellowhammer *Emberiza citrinella* and house sparrow *Passer domesticus* were confined to the field margins at all times. This work backs up present knowledge we have on the effects of farming. From this, recommendations can be made to aid in reversing the declines of farmland bird species. These include; leaving land as stubble for as long as possible, maximising the diversity of farmland features, incorporating some permanent grass and woodland into farms and improving the management of field margins.

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1 Introduction

In recent years there has been increasing concern that modern farming techniques are having a large impact on British bird populations. The intensification of farming may be the major cause of the rapid decline of many farmland bird species. The main period of population decline is thought to have occurred between 1970 -1990 and agricultural intensification from the 1960s. The difficulty in finding causes of bird population losses is that agricultural intensification is not a single process, but has many components (Newton 2004). As these changes have been made more or less simultaneously the effect one change has had is often difficult to separate from another. By carrying out my research on a farm which has varying field structures, crops and sowing times some insight may be gained on the factors which affect many different bird species. There has been a vast amount of work dedicated to breeding bird populations in summer with much less concentrating on winter populations. The British Trust for Ornithology's (BTO) Common Bird Census (CBC) did not sample winter bird populations until 1999. Yet winter farm management is likely to increase summer breeding numbers (Robinson *et. al.* 2001).

1.1 Status of bird populations in Britain

Birdlife International has recently published an in-depth study on "Birds in Europe" (RSPB, 2004). Their findings reveal that 226 species of European birds are declining, rare or localised, causing great conservation concern across Europe. Bird populations in Britain have declined rapidly since the 1970s some experiencing more than 80% reductions including the tree sparrow *Passer montanus*, grey partridge *Perdix perdix* and corn bunting *Miliara calandra* (Robinson *et.al.* 2001). Figure 1.1 shows the species which have experienced the greatest declines in Britain.

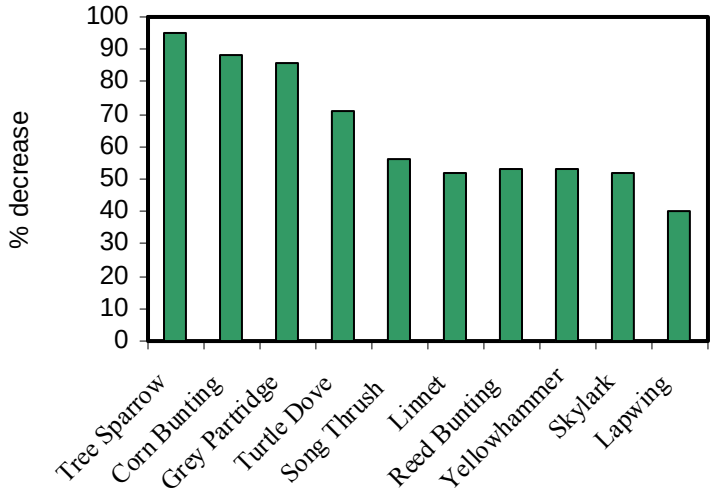


Figure 1.1: *Percentage decrease of declining species between 1970 and 1999. Based on figures taken from RSPB (2004).*

Figures suggest that the UK may surpass all other countries in Europe in our farmland bird losses (RSPB 2004a). Lowland farming accounts for two thirds of Britain's exploitable surfaces and is the largest bird habitat available (O'Connor & Shrubb, 1986). 120 bird species of European conservation concern breed and winter on British farmland (Donald *et.al.* 2000), thus demonstrating the importance of research into this area. Birds are useful indicators of the state of the environment, of all the taxonomic groups to census, birds are simpler to locate than most (Bibby *et al.* 2000). They are well known and easily recognizable, making them useful in environment impact surveys.

1.2 Farming in Britain

At the beginning of the 20th century, crop and animal husbandry coexisted on most farms. Post-war agricultural policies resulted in major changes on British farmland, including the Common Agricultural Policy (CAP) set by the EU. CAP subsidises farmers proportionally to production so farmers increase intensification to receive more finance. Specialising in either crop or animal farming will increase production, for example the development of synthetic fertilizers has reduced the need for livestock to produce manure and made redundant the need for non-cereal crops and fallows, which maintained soil fertility and pest control (Atkinson *et. al.* 2002). The most

important changes implemented included an increase in the application of synthetic fertilizers and pesticides, removal and narrowing of field margins, changes in the management of grassland and changes in the timing of sowing and harvesting operations. This intensification has lead to greatly increased yields. In Britain, wheat yields increased by 66% between 1970 and 1990 (Chamberlain *et. al.* 2000). A considerable consequence of these changes is the replacement of heterogeneity in habitat structure with homogeneity (Benton *et. al.* 2003). For example the need for efficient machinery to increase yields called for the removal of hedgerows to increase field size which improves maneuverability, as a result mosaics of habitats are lost. Another notable change is the swap from spring to autumn sown cereals primarily barley and winter wheat. This allows rapid growth of the crop in spring and therefore larger yield, but also reduces the availability of seed-rich winter stubbles (Robinson, 1999). The increased use of chemicals such as herbicides, pesticides and fungicides have had considerable consequences on bird populations, some effects have been through direct mortality, but the principal effect is on the ecology of farmland (Mead 2000). The chemicals applied have removed weeds from fields, meaning insects which depend on these are lost, and the application of pesticides removes the rest. A large source of food for birds has thus been lost. Field margins also suffer due to spray drift.

1.3 Winter farmland habitats

The non-breeding seasons of farmland bird populations are often overlooked when considering conservation strategies, but this means underestimating the importance of the winter habitat. It has been suggested that for many bird species mortality outside of the breeding season has been the major factor behind the large population declines (Henderson *et al.* 2004). Studying winter bird populations is important as this is the time of year when major food sources such as crops, crop residues, arable weed seeds, hedgerow fruits and soil- and surface-dwelling invertebrates are most accessible (Shrubb 2003). Invertebrates should be easier to find due to the larger area of bare ground, seeds and fruits are more abundant in autumn but decline in quantity through winter and harvested crops leave stubble, crop waste and accessible seeds (Shrubb 2003). Winter bird populations can therefore give an indication of the level of the whole biodiversity of the farm. Weather is also an important factor affecting bird numbers over winter. Severe winters mostly affect insectivorous birds, such as the

dunnock *Prunella modularis*, wren *Troglodytes troglodytes* and robin *Erithacus rubecula*, resulting in large decreases in breeding numbers (BTO, 2004). The importance of the major winter habitats found on the farm are described below.

1.3.1 Field margins

Hedgerows are vital in preserving farmland biodiversity. They provide shelter, feeding and breeding sites and act as wildlife corridors for numerous species. The majority of birds which forage in farmland fields will still remain very close to the hedge (Hinsley & Bellamy, 2000). Many British farmland birds are of woodland origin dating from a time when woodland covered most of the country. These birds adapted to the remnants left as hedgerows when much of the woodland was reclaimed by man for settlements and food production (O'Conner & Shrubb, 1986). Hedgerows can therefore provide birds with elements of a semi-natural habitat (Hinsley and Bellamy, 2000). Hedgerows are lost to housing, road building and industrial development but the major loss is due to changing farming methods. Increased mechanisation resulted in small fields being amalgamated together to improve manoeuvrability. The move away from mixed farming means stock proof barriers are no longer required and hedgerows are sometimes seen as unprofitable use of space by farmers.

Management of hedgerows can therefore play a key role in conserving biodiversity. Farmers will often trim hedges to keep them neat and to prevent them from taking up space which could be used by crops. If this is carried out too early, berries and seeds which form a large part of the diet for many bird species are lost. Flailing hedges destroys any remaining nests and kills immature insects which are the breeding stock for the following year.

1.3.2 Arable crops

Very few birds feed directly on the crops themselves. Those which do include; gamebirds, pigeons, jackdaws *Corvus monedula*, skylarks *Alauda arvensis*, greenfinches *Carduelis chloris* and sparrows. Cropped land which is left as stubble over winter is a very important habitat for seed eating birds especially declining species such as the yellowhammer *Emberiza citronella*, tree sparrow *Passer montanus* and linnet *Carduelis cannabina* who feed on the spilt cereal grain (O'Conner &

Shrubb, 1986). The availability of over-winter stubble fields has fallen considerably since the 1970s and the quantity of seeds on remaining fields has also declined. It has been estimated that the seed bank in arable land has dropped to less than a tenth of what it was 50 years ago (Mead 2000). It therefore seems important to either provide overwinter stubbles on farms or alternatives such as game cover crops (these usually comprise species such as kale, quinoa and maize) (Moorcroft 2002).

Fields with winter cereals are generally avoided by both granivorous and insectivorous birds as they hold few seeds and invertebrates are reduced, due to disturbance from cultivation. Wood pigeons *Columba palumbus* are an exception to most species as they can survive well in winter, grazing on growing crops especially autumn sown oilseed rape (Mead 2000).

1.3.3 Grassland

Grassland is a very important habitat during the winter months. Species that forage on invertebrates show a preference for pasture fields over ley grass or stubble as their main food of earthworms and insect larvae are less likely to be disturbed (Robinson & Sutherland 1999). Winter is an important time for invertebrate feeders, as invertebrates (e.g. worms and slugs) are largely unavailable in the dry summer period and large influxes of immigrant lapwings *Vanellus vanellus*, starlings *Sturnus vulgaris*, thrushes and other ground feeding species are characteristic in winter (O'Conner & Shrubb, 1986). Pasture is usually described as grassland which is less than five years old, and ley as grassland which has been present for more than five years. Benton *et. a.l* (2002) propose that by increasing the amount of non-cropped land on farms, key insect populations will be maximized and therefore farmland birds will benefit. Grassland is important for seed eaters who will often prefer older grass as there are significantly more weeds (Shrubb 2003). Grassland is also important for raptors such as kestrels *Falco tinnunculus* and barn owls *Tyto alba* who rely on it for hunting (O'Conner & Shrubb, 1986).

1.3.4 Woodland

Forest bird species account for nearly 80% of farmland birds, many of which now show preferences for hedgerow habitats on farmland. The presence of tree clusters on farms must therefore have a positive effect on the majority of farm species. Woodland

holds more species of breeding birds than any other major class of habitat in Britain and yet only constitutes 11% of the total land area (Fuller *et. al* 2001). Fuller *et.al* (2001) found that species numbers on farm plots increases linearly with the cover of farm woodland.

1.4 Aims of project

This study will attempt to gain some insight into factors affecting many different bird species populations.

- To locate the different habitat types available in a 1km square of farmland and measure the difference in species diversity on each site.
- To observe any changes in habitat use by birds across the winter season.
- To identify differences in the birds' preference for different habitat types.
- Identify farming practices which are detrimental/beneficial to bird populations.

2.0 Materials and Methods

2.1Study area

This study was carried out in West Yorkshire (fig 2.1) at the University of Leeds farm near Tadcaster. The sample area was a 1×1km square on the farm, taken from an Ordnance Survey map of Tadcaster (sheet SE 44/54), scale 1:25 000, (Fig 2.2). Using government agricultural statistics the 1×1 km square is classed as an arable area as the total agricultural land contains <25% cover of grassland. The land use in the sample square is summarized in Table 1. Counts were made from transects which followed the route of two dissecting tracks through the farm (fig 2.2), this allows all field types and farmland features such as hedgerows, buildings, patches of woodland and ponds to be taken into account. This method was chosen over a systematic approach which would have involved transects located equidistance apart through an equal number of different farm landscapes, as it is less time consuming and a greater number of habitats can be sampled in a shorter period of time. Also located along the transects are three of the four agroforestry blocks found on the farm. These sites were part of the research into silvoarable agroforestry, and for the last 4 years crops have not been planted between the trees.

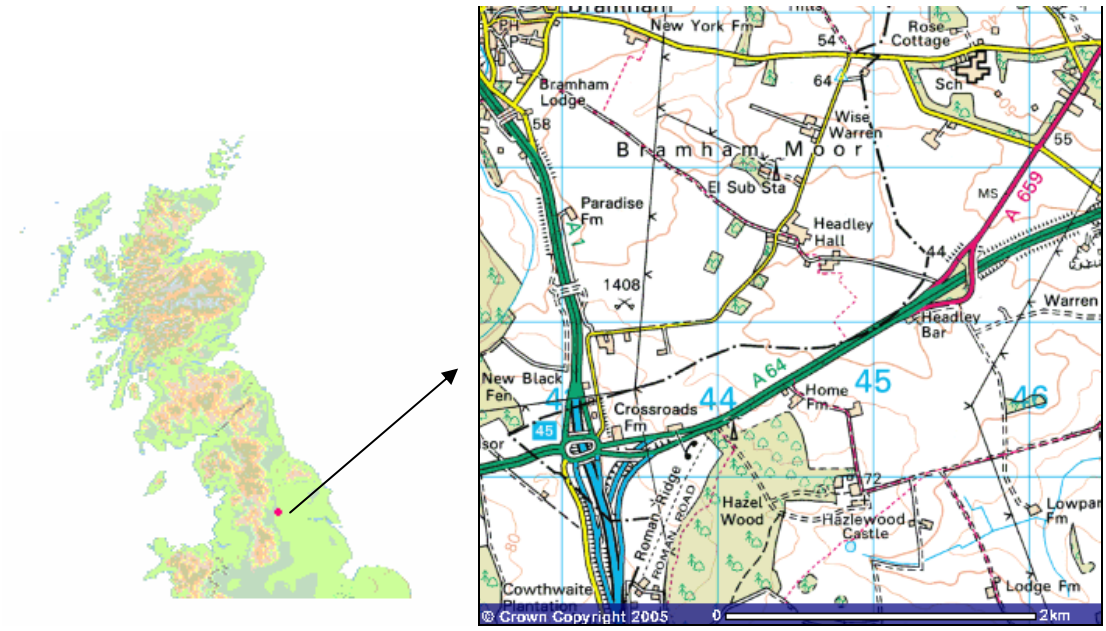


Figure 2.1: *Location in country and section of Ordnance Survey, sample area was taken from.* *Reproduced from Ordnance Survey map data by permission of Ordnance Survey, © Crown copyright*

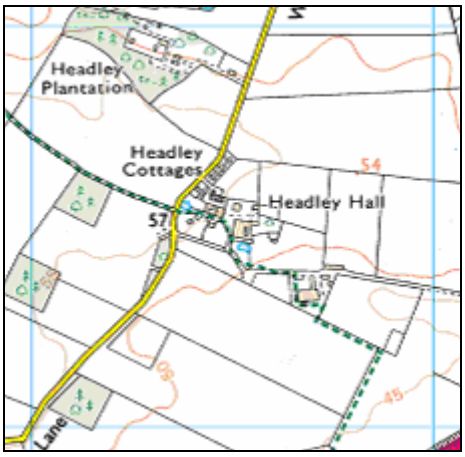


Fig 2.2: *1×1km square sample area, transect follows yellow road and dissecting track.*

A map showing the uses of each field on the farm is shown in Appendix 1**.**

2.2 Field methods

This study took place over the winter 2004/2005 from 12th October to 24th February. counts were made twice a week; during the morning at 0915 and during the afternoon at 0215. 22 visits were made in total. Counts were not made during periods of poor visibility, strong winds or heavy rain. Weather records for the day of each count were obtained from the weather station which is located on the farm.

Line transects were chosen over point counts as more ground can be covered in a fixed time, and therefore larger sample sizes can be generated efficiently (Bibby *et al.* 2000). The transects were walked slowly, taking approximately 2hrs30mins to complete. The order in which the transect was walked differed each visit to minimize the effects of time of day on the birds activities. Both sides of the transect were scanned at regular intervals using 10 × 50 binoculars and all birds sighted were recorded and marked on a large scale map of the sample area with reference to landscape features such as field boundaries and buildings. The presence of a short hedge did not prevent the sighting of birds in the adjacent fields. During stretches of taller hedges, the fields were inspected at field entrances. Only birds in the fields or hedgerows, or those which flew out or into fields were recorded. Birds observed in hedgerows were associated with the adjacent field when analyzing the results. In winter, birds flushed into the boundary are usually feeding on adjacent ground

(Henderson *et al.* 2004). Birds flying over the sample area were not included. Birds of prey such as kestrels and sparrow hawks were included if they were hovering over fields looking for prey. Care was taken to prevent double counting by observing the location of previously flushed individuals.

The hedge size and hedge structure was recorded along with the species of shrubs and trees found in the hedge. The hedges were divided into uniform and roughly equal lengths which usually equated to a field length. The average height and width of the sections were obtained from measurements at several points along the transect. The different species and percentage of species composition was recorded.

Seeds were sampled on 18th November. Random sites were chosen on fields which had held large and small numbers of bird sightings. Based on the method of Tucker (1992) 50mm deep soil cores were extracted with a steel cylinder. Washing and flotation methods were used to attempt to separate the seeds and record the densities of seed in each area.

Field type	**Area (ha)**	**% of total area**
Cereal stubble (up to 24 Jan)	8.2	8.1
Bare tilled	8.6	8.5
After stubble removed	16.8	16.7
Winter wheat	42.4	42.1
Oil seed rape	17.1	17.0
Total cultivated	**76.3**	**75.7**
Grass		
Ley (<5yrs)	0	0
Permanent (>5yrs)	16.7	16.6
Total grass	**16.7**	**16.6**
Woodland	6.3	6.3
Agroforestry	1.5	1.5
Total	**100.8**	

Table 2.1: Major land uses on farm. *Values taken from map of farm.*

2.3 Data analysis

This study analyzed the effects certain farming practices have on farmland bird populations in four ways: 1) by estimating the biological importance of each habitat by measuring the species diversity index; 2) by measuring the birds preference index for each habitat; 3) by looking at temporal changes in land use by different species and 4) by looking at the effect of hedge height, hedge width and field size on farm birds.

In this report a broad range of species were examined. Both common and rare species are included, as the aim is to look at the distribution patterns of all birds on the farm but particular attention will be paid to those birds who feature in the RSPB's red and amber lists (RSPB 2004). The RSPB has split the UK's birds into three categories red, amber and green. Birds in the red list category are either globally threatened or have had rapid (> or = 50%) decline in UK breeding population over the last 25 years or rapid (> or = 50%) contraction of UK breeding range over last 25 years. Birds in the amber list have shown moderate (25-49%) declines in breeding population or moderate (25-49%) contraction in UK breeding range over the last 25 years. For the birds in the green list there is no threat to the population's status.

To find out if there are any differences in habitat utilisation by birds between morning and afternoon a chi-squared test was carried out. Seven morning visits and seven afternoon visits were picked. The visits selected were those which had the afternoon visit within one to two days of the morning visit to try and minimise any bias in weather conditions.

The diversity index for each major habitat type was estimated using the Shannon-Weaver index; $H = -\Sigma p_i \ln p_i$, where p is the proportion of a particular species in a sample which is multiplied by the natural logarithm of itself. The product of all species in the sample are summed to obtain H. The higher the Shannon-weaver diversity index the higher the species diversity and equitability. The species richness

of an area can be used to determine how important or unimportant farm fields/habitats are.

A preference for particular crops or habitats was measured using Jacob's preference index (D) (Jacob 1974). $D = (r-p)/(r + p - 2rp)$ where r = the proportion of birds recorded on each crop type or farmland habitat and p = the proportionate available area of each habitat type. This index ranges from -1 (complete avoidance) to +1 (exclusive use), zero indicates that the field type was used in proportion to its availability. The proportion of each habitat can be taken from Table 2.1. The proportion of stubble and bare ground was calculated slightly differently. This is because the stubble fields were only available until the 24th Jan. They were then ploughed and left as bare earth. To calculate p for these, the proportion of the sample area they occupied has to be multiplied by the fraction of time they were present. The values for p are not taken from Table 2.1, as fields are included which are not visible from the transects. Instead the proportions will be worked out only for the landscape features which are visible from the transect.

To investigate whether certain birds move between habitats as winter progresses and some foods become scarce, the abundance of birds in each habitat were compared for October, November and December, January and February. Results for December and January were combined due to the small number of visits in these two months. The results are presented graphically in Figures 3.2 to 3.12.

Spearman's rank correlation was used to determine the effects of hedge height, hedge width, field size and seed densities on bird populations. Spearman's rank uses the ranks of x and y variables and discards the raw data.
Spearman's rank; $r_s = 1-\left[6\sum d^2/(n^3-n)\right]$ where n is the number of units in the sample, d is the difference between ranks, $\sum$ is the sum of and 6 is a constant. The values for r_s range from -1 through 0 to 1, -1 indicating perfect negative correlation, 0 no correlation and 1 perfect positive correlation.

3.0 Results

Table 2.1 summarizes the land-use and landscape features in the 1×1km square. Autumn sown crops (winter wheat and oilseed rape) comprised 59.1% of the total area and permanent grassland only 16.6%. Including the agroforestry blocks, woodland makes up 7.8% of the sample area yet holds 23% of the recorded birds. Fields which were to be planted with sugar beet and potatoes were ploughed and left as bare ground throughout the study period. When analysing farm habitats, winter wheat and oilseed rape will be categorised together under the heading crops.

The hedgerows in the sample area are largely comprised of hawthorn with some elder, holly, ivy, dog rose, spindle and maple. A large section of the hedges were flailed at the beginning of November and others trimmed at a later date. The larger tree clusters in the sample area are mostly beech and pine, the tree species in the agroforestry blocks are ash, cherry, hazel and sycamore.

Weather records for the study period were obtained from the weather station located on the farm. Overall the winter was very dry, October was the warmest and wettest month with a total of 98.20 hours of rainfall and an average minimum temperature of 6.98□. December, the driest month had a total of only 22.8 hours of rainfall for the month and an average minimum temperature of 2.29□. January and February had minimum temperatures of 2.90□ and 1.65□ respectively.

The chi-squared test for changes in morning and afternoon habitat use was performed on the data in table 3.1. This table gives the total number of birds in each habitat for a total of fourteen visits.

	Crops	Grass	Stubble	Bare ground	Trees
AM	106	128	21	8	256
PM	88	117	5	23	244

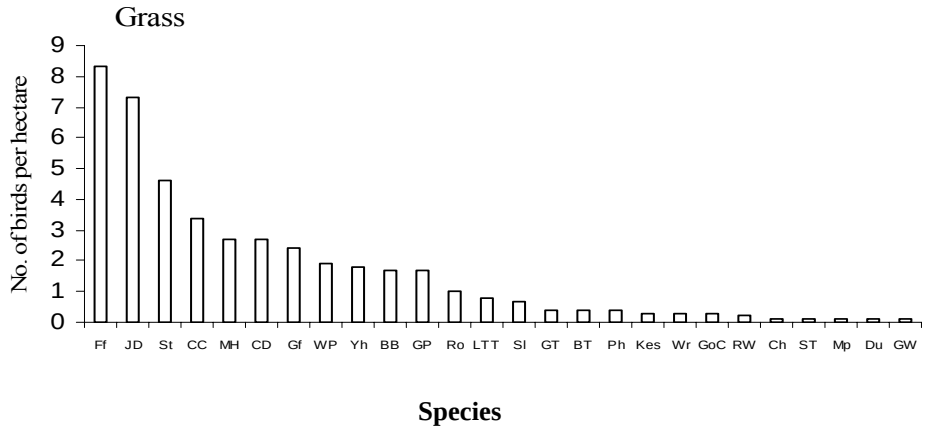
Table 3.1: *Data for chi-squared test*

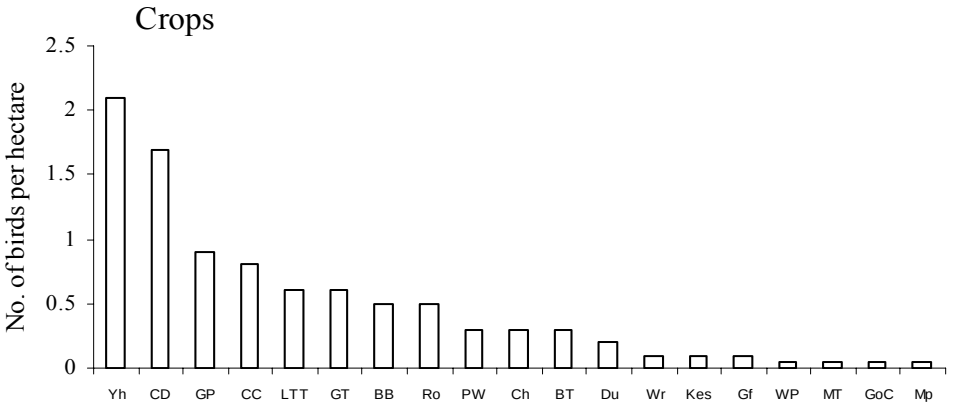
The null hypothesis (no difference between morning and afternoon numbers) can be accepted for crops, grass and trees but is rejected by chi-squared for both stubble and bare ground areas. The stubble and bare ground areas are significantly different at $P<0.01$ level, this suggests that stubble is not an important habitat for birds in the afternoon and vice-versa for bare ground. As there are no other major changes, for the rest of this section the observations used will be combined from both morning and afternoon visits.

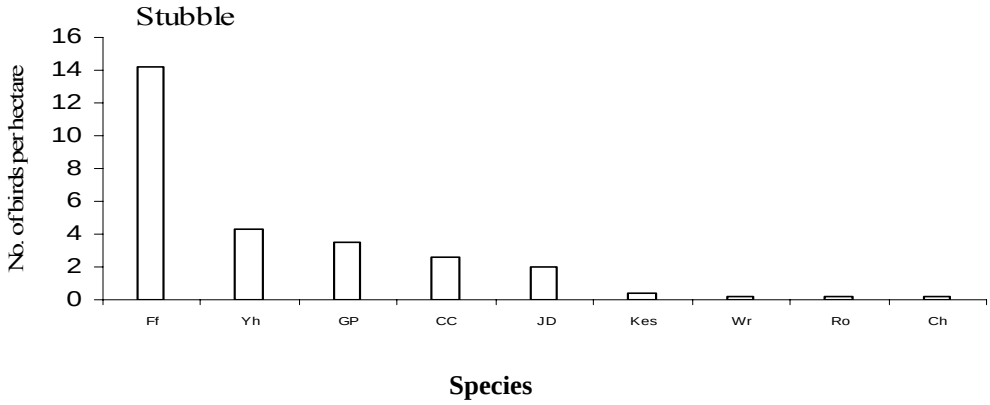
3.1 Species diversity

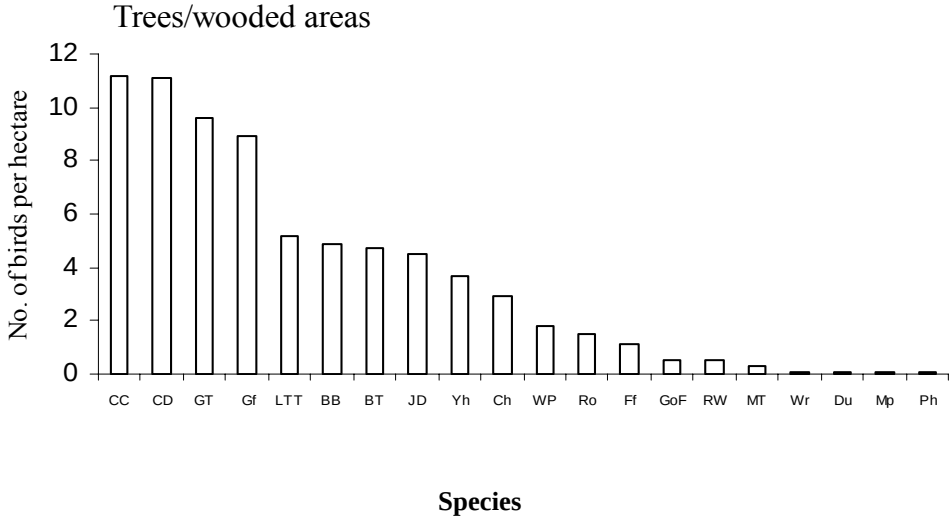
A total of 34 species were recorded during the study period with a total count of 2333 birds (see enclosed disk).

In total 5 major farm landscapes and features were closely studied in this report, these were permanent grass, crops, stubble, bare ground and wooded areas. Of all these habitats we can see from figure 3.1 that grassland holds the largest number of different species with trees and wooded areas following close behind. Wooded areas hold the greatest abundance of most species, crops and bare ground hold much fewer individuals per hectare. Although most species were also found in other farmland areas there were a few which seem to be grassland specialists such as field fares *Turdus pilaris*, starlings and skylarks. Looking at the number of occasions sighted in the Appendix 2, the sample size for all of these is however very small.




Crops
No. of birds per hectare
2.5
2
1.5
1
0.5
0
Yh CD GP CC LTT GT BB Ro PW Ch BT Du Wr Kes Gf WP MT GoC Mp
Species


Stubble
No. of birds per hectare
16
14
12
10
8
6
4
2
0
Ff Yh GP CC JD Kes Wr Ro Ch
Species


Trees/wooded areas
No. of birds per hectare
12
10
8
6
4
2
0
CC CD GT Gf LTT BB BT JD Yh Ch WP Ro Ff GoF RW MT Wr Du Mp Ph
Species

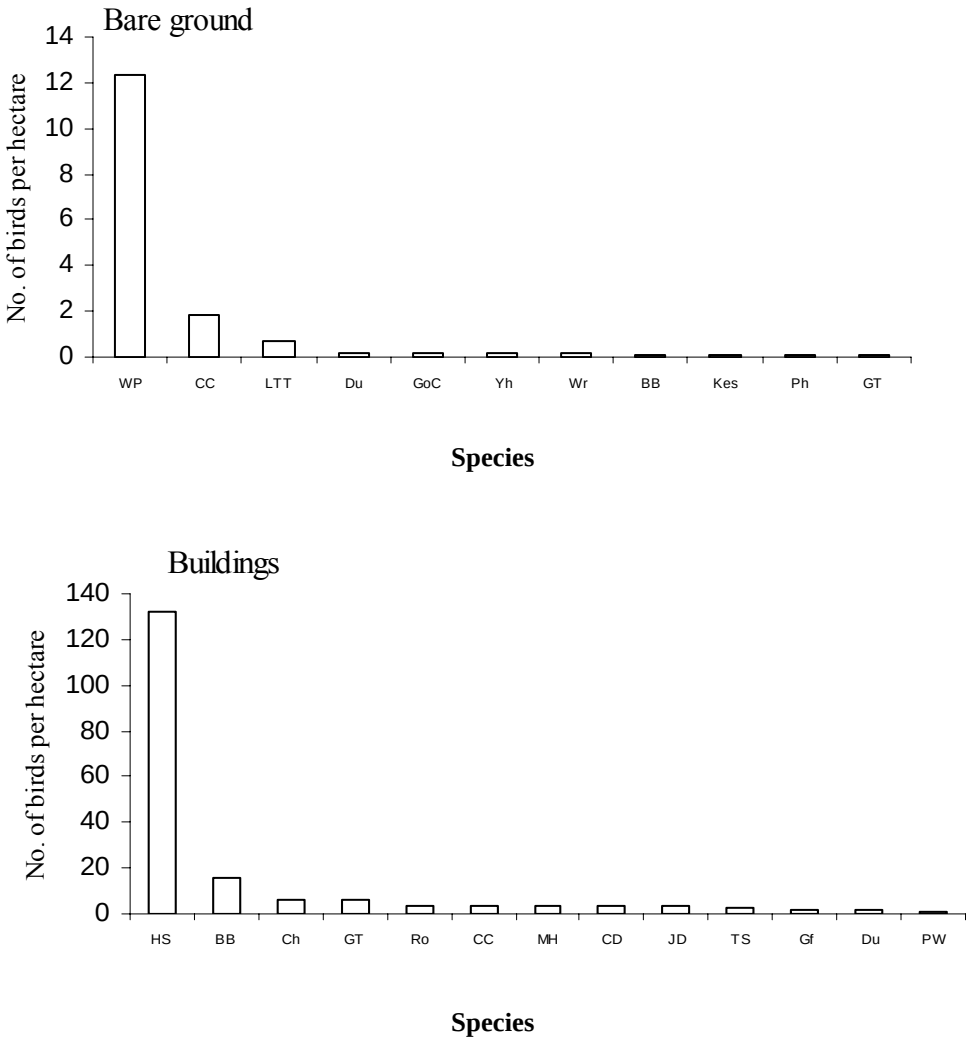


Figure 3.1: *Bird densities in each habitat type. Species codes are: Ff, fieldfare; JD, jackdaw; St, starling; CC, carrion crow; MH, moorhen; CD, collared dove; Gf, greenfinch; WP, wood pigeon; Yh, yellowhammer; BB, blackbird; GP, grey partridge; Ro, robin; LTT, long-tailed tit; Sl, skylark; GT, great tit; BT, blue tit; Kes, kestrel; Wr, wren; GoC, gold crest; Ch, chaffinch; ST, song thrush; Mp, magpie; Du, dunnock; GW, grey wagtail;PW, pied wagtail; MT, mistle thrush; HS, house sparrow; TS, tree sparrow; Ph, pheasant; GoF, gold finch.*

These graphs cannot be used to compare the preferences of different species. A larger number of one species such as the fieldfare does not correspond to a greater preference for grassland than blackbirds *Turdus merula*. Fieldfares flock together in winter whereas blackbirds are usually solitary and will never be found in numbers as large as the fieldfares. The ranking of birds across habitats can be compared to give a general idea of how preferences for each habitat differ.

Shannon-weaver diversity indices for each major habitat type are seen in table 3.7 below. Results which range from 1.5 to 3 are common.

	Crops	Grass	Stubble	Bare ground	Tree clusters	Agro-forestry
Shannon-Weaver index	2.51	2.53	1.61	0.96	2.45	2.08

Table 3.2: *Shannon-Weaver diversity indices for each habitat type*

According to this index, cropped areas, grass areas and tree clusters all had similar levels of diversity with grass being the most species rich. Areas of bare ground had very low species diversity. The diversity index is measured on an ordinal scale (ordinal numbers are used to indicate rank order), so an index of 4 does not mean it is twice as diverse as an index of 2 (Fowler *et.al* 1998). Although areas of crops and grass had very similar diversity indices, we must remember that crops occupy a much larger area in the sample area, and can therefore hold large numbers of birds. Grass occupies only 17% of the sample area and yet still has a greater diversity index.

3.2: Change in habitats across the season

Temporal changes in land use across the season can be determined from figures 3.2 to 3.12. Many of these species are currently declining and are on the RSPB's red or amber list. The birds are selected in order to ensure all diets are included.

3.2.1 Seed-eaters

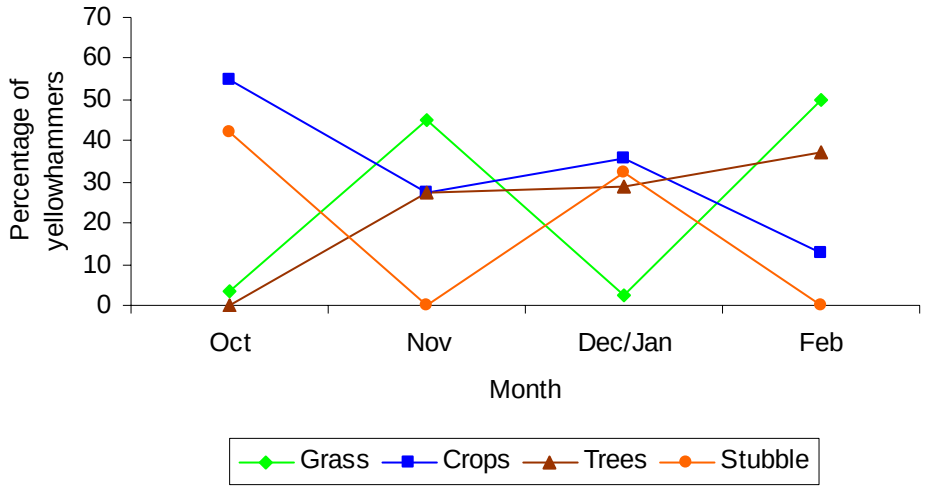


Figure 3.2: *Changes in yellowhammer habitats across the season.*

Yellowhammers are currently in the RSPB's red list category after going through a serious decline since 1970's. Only 3.2% of yellowhammers were found in grass in October compared with 45.2% in Nov and 50% in February. Despite the anomaly for December and January there looks to be increased preference for grass as winter progressed and a decrease in the preference for crops. A steady decline in the use of trees was also observed for yellowhammers through winter. Yellowhammers were always confined to the hedgerows and never observed in fields.

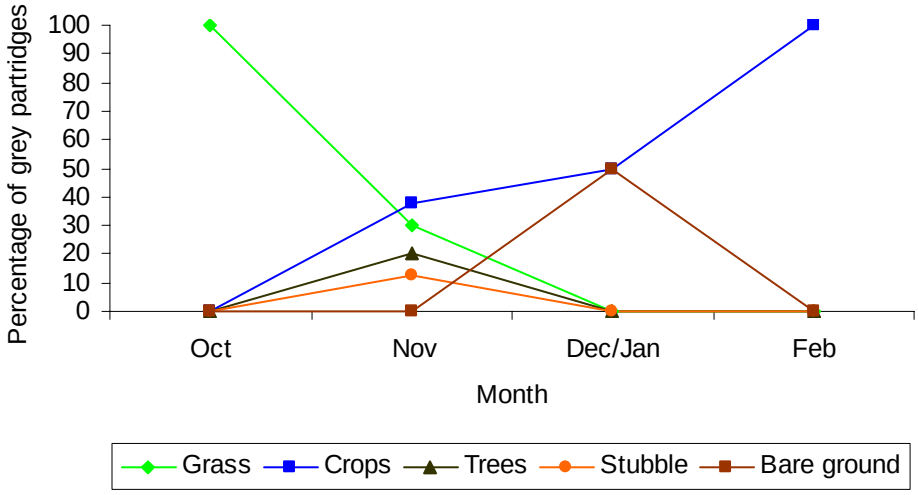


Figure 3.3: *Changes in grey partridge habitats across the season.*

Fig 3.2 shows the opposite occurs for grey partridges as winter progresses. During October 100% of the grey partridges were found in grass declining to 30% in

November and 0% for the rest of the winter visits. Grey partridges showed an increased preference for crops throughout winter from 0% in October, 37.5% in November, 50% in December and January and 100% in February. Grey partridges are also in the RSPB's red list category. Insects also make up part of the grey partridge diet.

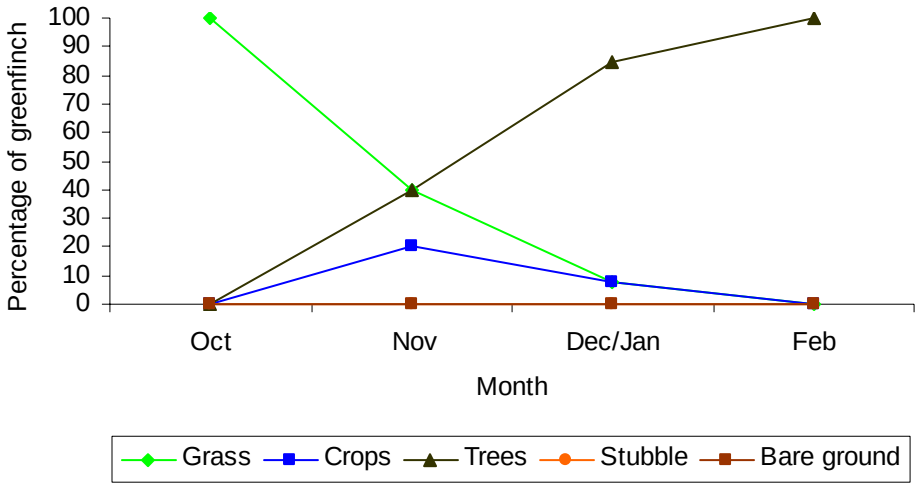


Figure 3.4: *Changes in greenfinch habitats across the season.*

Greenfinches show a steady increase in their selection for wooded habitats and similarly a steady decline in their use of grass habitats. Cropped land was a small feature of greenfinches habitats in the middle of winter, stubble and bare ground were never utilized by the greenfinches.

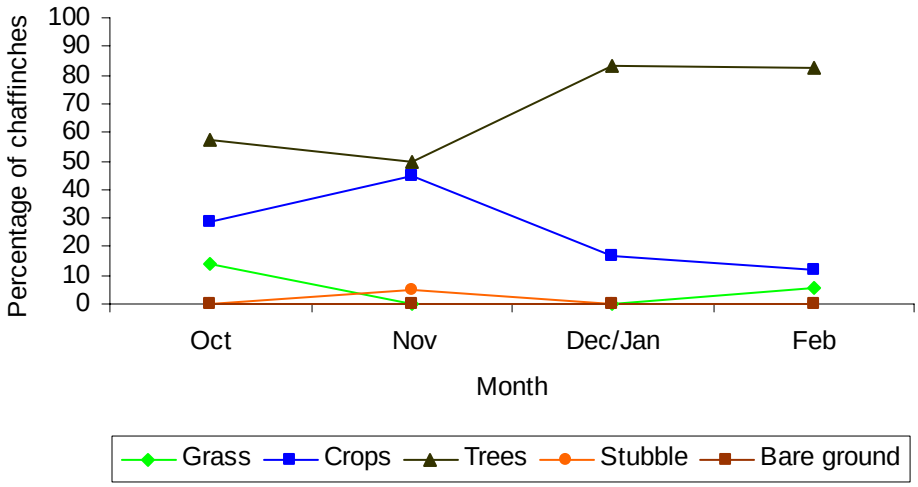


Figure 3.5: *Changes in chaffinch habitats across the season.*

Unlike the other seed-eaters selected, the chaffinch *Fringilla coelebs* does not show any great use of grassland. Chaffinches showed an increase in their use of trees across winter and a decrease in crop utilization. Chaffinches were never observed in areas of bare till and were spotted only once in a stubble area.

3.2.2 Invertebrate-eaters

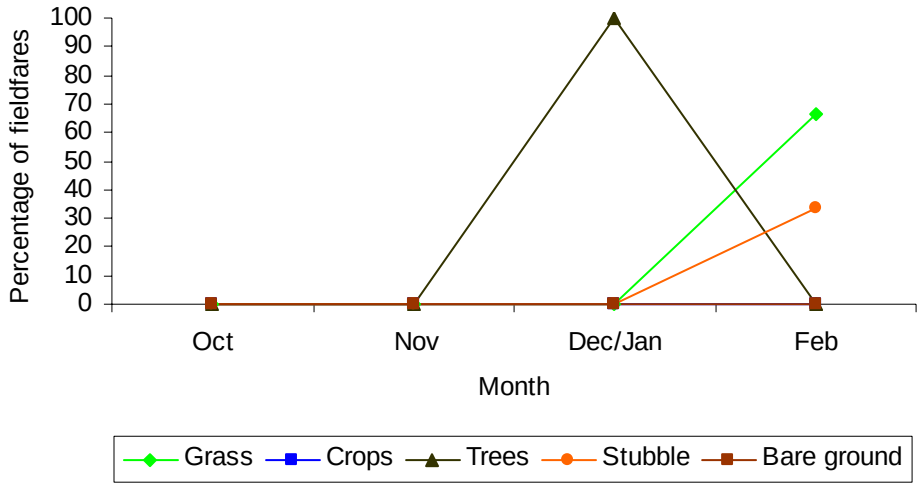


Figure 3.6: *Changes in fieldfare's habitat across the season.*

Fieldfares were not observed on the farm until the end of January when they were found in tree clusters. During February over 60% of fieldfares were found in grass fields and the rest in fields with stubble. Fieldfares will also eat berries when they are in season. Fieldfares are placed in the RSPB's amber category.

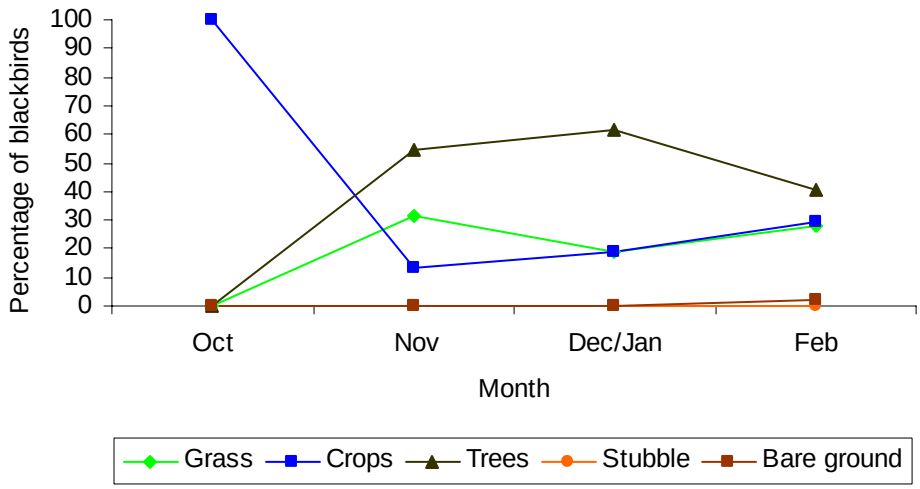


Figure 3.7: *Changes in blackbird habitats across the season.*

Apart from October, blackbirds seem to utilise trees, grass and crops throughout winter with no major switches as winter progresses. In common with fieldfares, berries also form a large part of the blackbirds' diet in the winter months.

3.2.3Insect-eaters

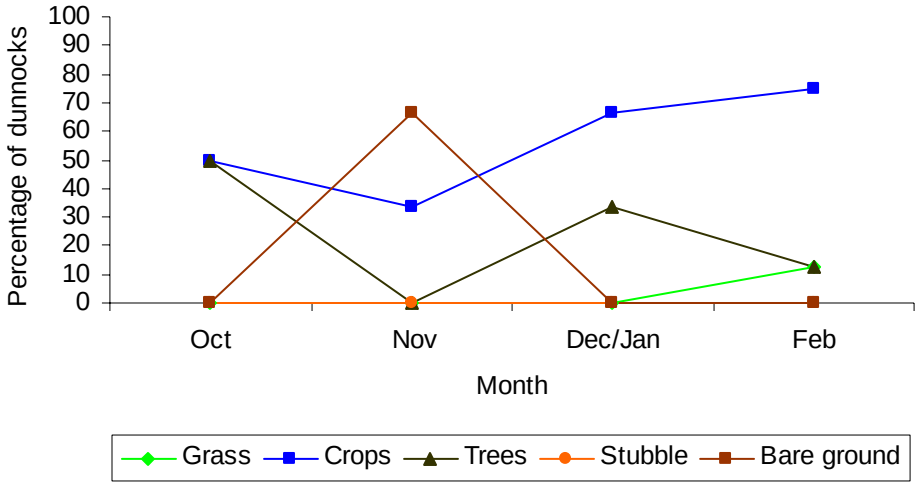


Figure 3.8: *Changes in Dunnock's habitat across the season.*

Dunnocks have been found in all habitats except stubble across the winter. They were present in crops throughout but only found in grassland in February and bare earth in November.

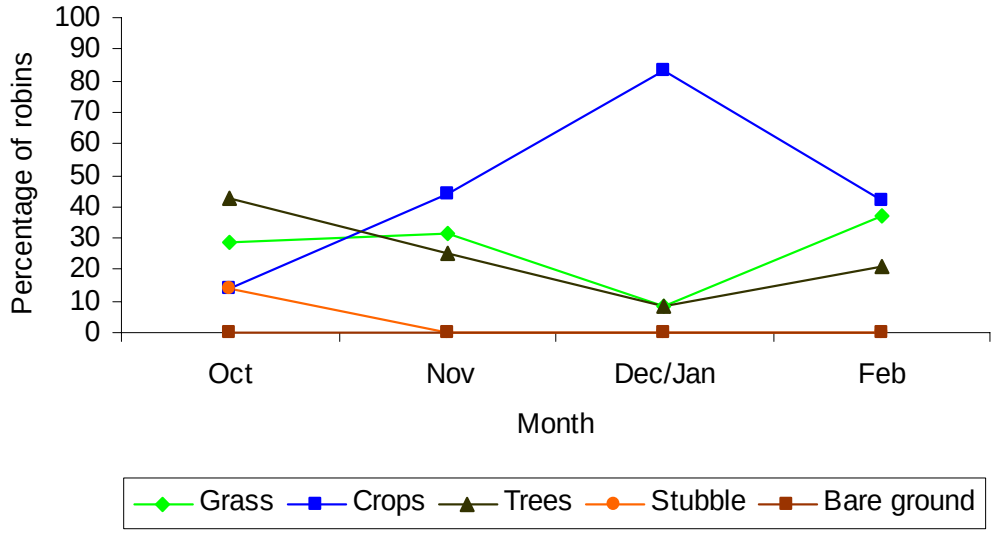


Figure 3.9: *Changes in robin habitats across the season.*

Excluding crops robins do not show any major habitat changes across the season. They are never found in fields which are bare and are most often found in fields

planted with crops. Grassland and trees are also a prominent habitat feature across the winter.

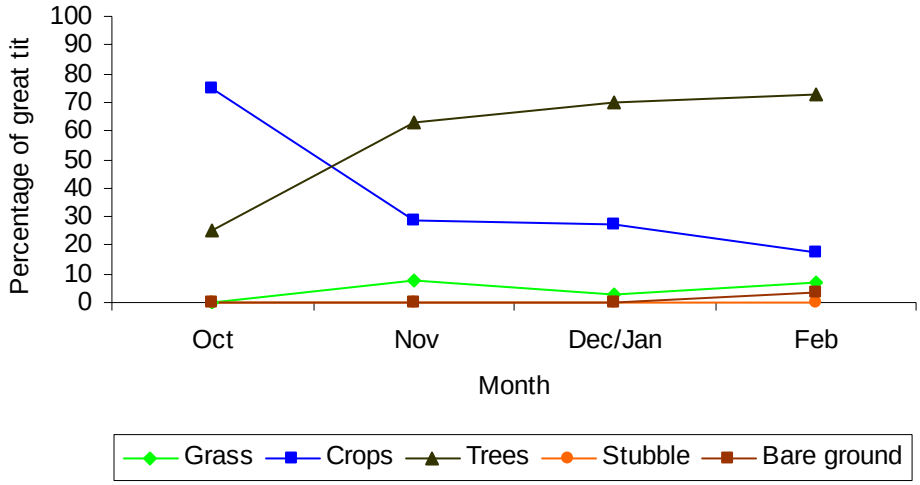


Figure 3.10: *Changes in great tit habitats across the season*

Great tits *Parus major* showed an increased preference for trees throughout the winter and a decrease in preference of crops. Grass made up a very small percentage of the great tit's habitat in winter. Great tits never utilised stubble fields and only one great tit was found in proximity to bare ground in February.

3.2.4 Raptors

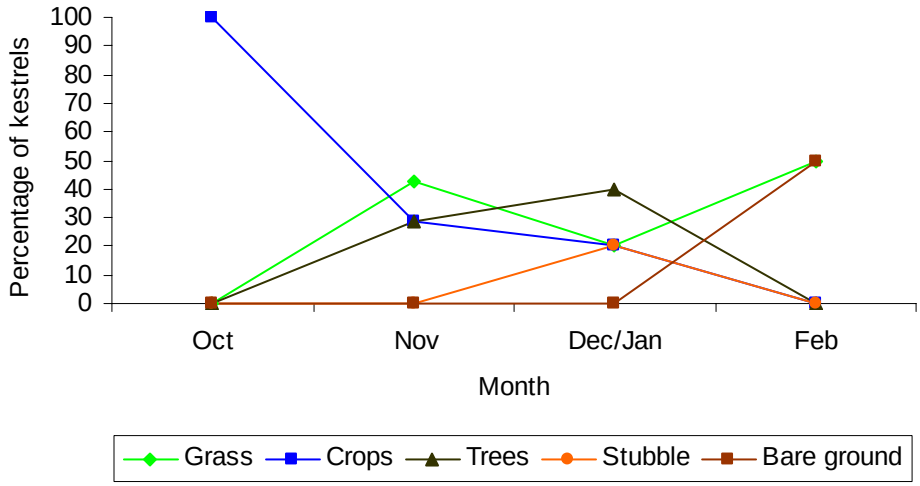


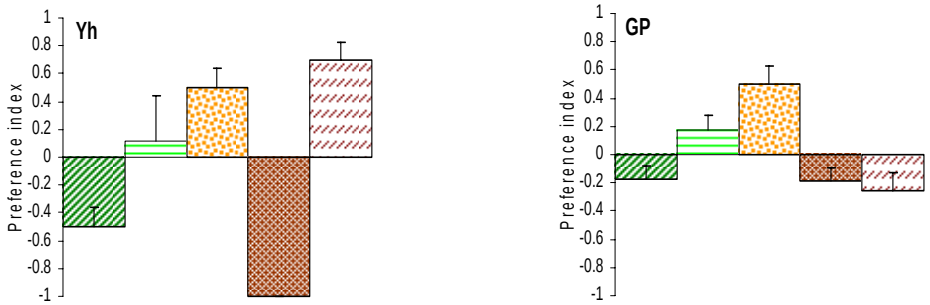
Figure 3.11: *Changes in kestrel habitats across the season.*

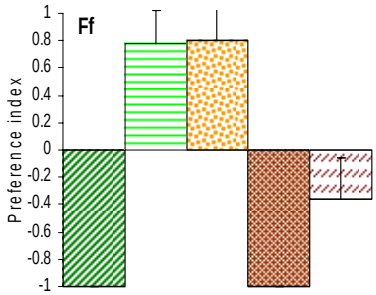
Kestrels show a steady decline in their usage of crop areas for hunting and an increase in grassland, but overall look very widespread. This graph suggests kestrels are a widespread in winter.

Based on the associations in figures 3.2 to 3.11, 7 species show changes in their habitat preferences across the season. This gives an indication of how food availability can change, forcing birds to change their diet in order to survive. For the seed eaters a definite increase in the use of woodland habitat is observed. Crops and grassland are featured habitats throughout the winter. Stubble is used to a lesser extent and bare earth plays are very small role. The invertebrate eaters show an increase in the use of grassland and woodland habitats throughout winter with no other major changes observed. Insectivores seem to be widespread and make use of the range of habitats with no clear evident changes. We cannot tell from these graphs if there is an actual positive preference for these habitats, or whether the high abundances of some birds in certain landscapes is due to the high proportion of this farm landscape in the sample square.

3.3 Preference indices

We can take into account the area of each habitat studied and the preferences of birds by using Jacob's preference index (1974), this can be used to determine whether habitats are used in proportion to their availability or if some habitats are positively selected or avoided. Values range from -1 to +1 indicating complete avoidance and exclusive use respectively. Zero indicates that the field type was used in proportion to its availability. D values for the preference indices and r and p values can be seen in Appendix 3. Figure 3.12 presents the habitat preferences of many bird species found in the sample area.




Ff
Preference index
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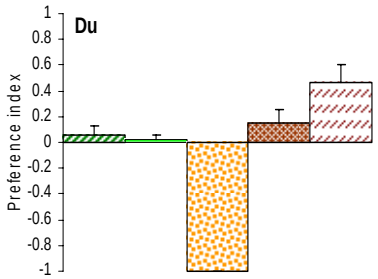
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1


Du
Preference index
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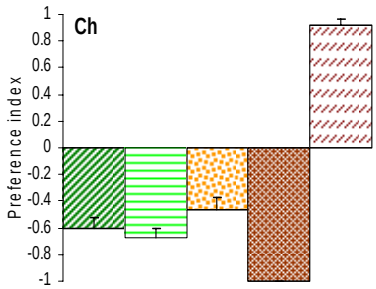
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1


Ch
Preference index
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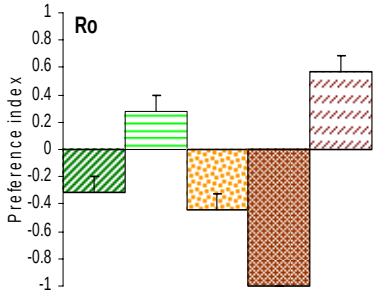
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1


Ro
Preference index
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0
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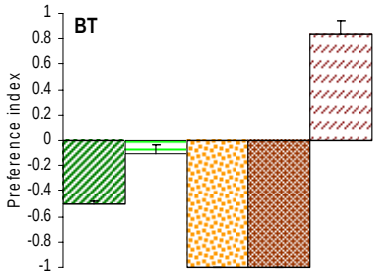
-0.8
-1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Preference index
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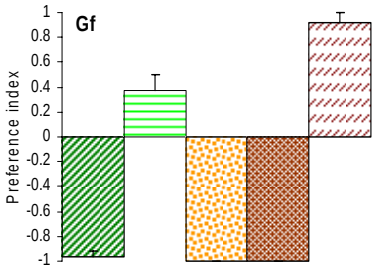
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1


Gf
Preference index
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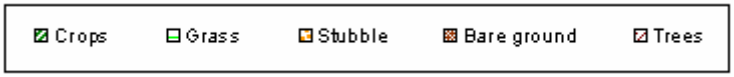
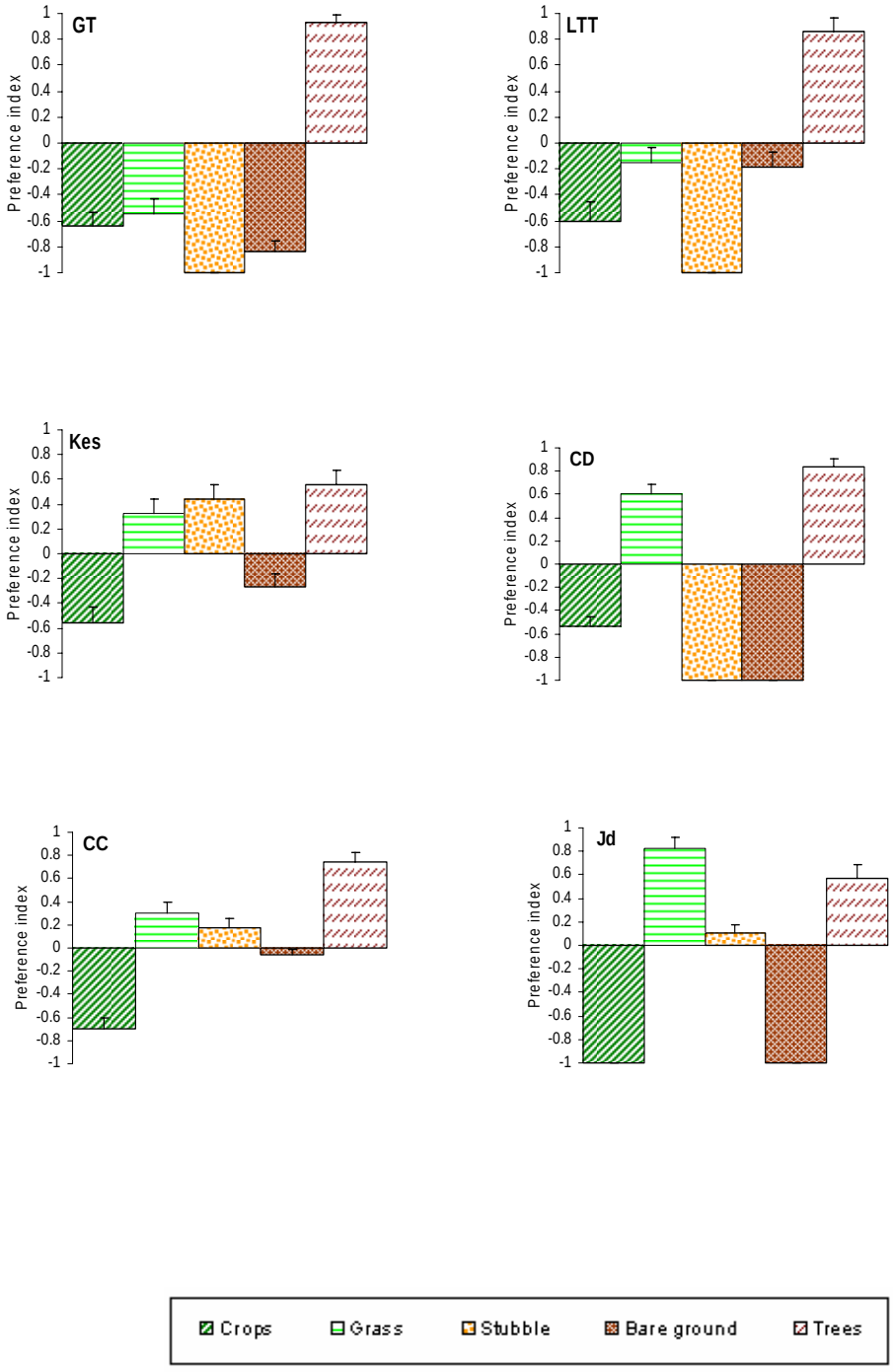
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1


Crops
Grass
Stubble
Bare ground
Trees


GT
LTT
Kes
CD
CC
Jd
Preference index
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
Crops
Grass
Stubble
Bare ground
Trees

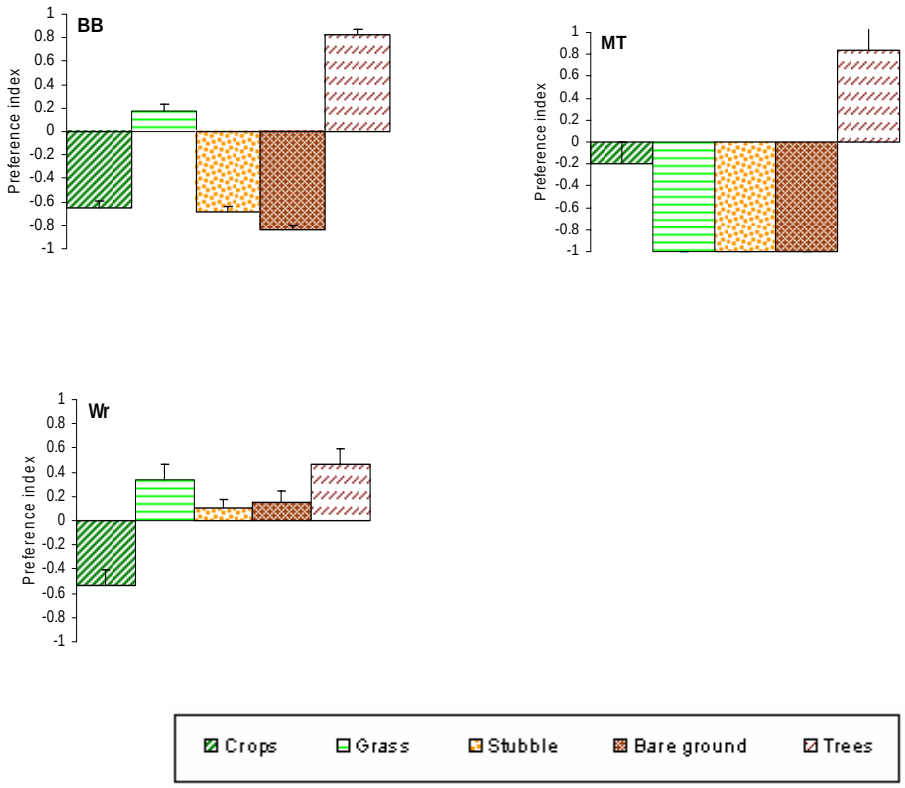


Fig 3.12: *Jacobs preference index for birds and habitat type*. Species codes are Yh, yellowhammer; GP, grey partridge; Ff, fieldfare; Du, dunnock; Ro, robin; Gf, greenfinch; Ch, chaffinch; GT, great tit; BT, blue tit; LTT, long-tailed tit; Kes, kestrel; CD, collared dove; CC, carrion crow; Jd, jackdaw; BB, blackbird; MT, mistle thrush; Wr, wren;

These graphs clearly present the preferences of many farm birds. The standard errors calculated for the indices are presented as error bars on the graphs. The exact values can be seen in Appendix 3. Of the 17 species selected 16 avoided cropped areas and 14 bare earth, the dunnock showed a very weak preference for both. The wren also showed a preference for bare earth. Trees were preferred by all but the fieldfares and grey partridges. Grass was preferred by 12 of the species. Only the tits, chaffinches and mistle thrushes *Turdus viscivorus* avoided grassland.

If we place the birds into diet based functional groups such as seed eaters (finches, sparrows and buntings), insect eaters and invertebrate eaters we can understand the birds' preferences. We can see for the seed eaters that crops are always avoided. Trees are highly selected by yellowhammers along with a positive selection for stubble and grass, bare earth is also avoided. Greenfinches showed a positive preference for grass

and trees and avoided the other three habitats. Collared doves which are known to feed primarily on grain showed a strong preference for trees and a preference for grass they completely avoided both stubble and bare earth. Chaffinches only showed a preference for trees. The grey partridge which eats leaves and insects along with seeds, preferred both stubble and grass and the carrion crows *Corvus corone* and jackdaws which also have a mixed diet both preferred grass, trees and stubble. Insect Eaters which include the tits, wren, robin and dunnock all showed a preference for tree clusters, the great tits, blue tits *Parus caeruleus* and long-tailed tits *Aegithalos caudatus* all avoided every other habitat. Dunnocks also showed slight preferences for crops, grass and bare earth, the only other habitat the robin showed a positive preference for was grass. The wren showed a preference for all habitats apart from autumn-sown crops. Fieldfares who feed on invertebrates and berries showed strong preferences for grass and stubble. The mistle thrush a relative of the fieldfare and blackbird showed only a preference for woodland. The kestrel a bird of prey, avoided both crops and bare earth and showed a medium preference for the other three habitats.

3.4 Effects of hedge height, width and field size

The Spearman's rank correlation coefficient for hedge height and the total number of birds is 0.06. For hedge width the coefficient is -0.09 both of these results indicate no correlation between the number of birds found in the hedgerow and the height and width of the hedgerow. Spearman's rank correlation coefficient was also measured for the effects of hedge height and width on yellowhammers. Yellowhammers were selected as an example species as hedgerows are known to be important for their survival, and in this study yellowhammers were always confined to the field boundaries. The Spearman's rank coefficient for yellowhammers is -0.05 for hedge height and 0.21 for hedge width. Again there is no correlation with the bird population and hedge height. There appears to be a very small positive correlation for hedge width and yellowhammer populations but this is too insignificant to base any conclusions upon it. The Spearman's rank coefficient for birds and field size is 0.19, again this is a very weak positive correlation. The ranked data can be seen in Appendix 4. A correlation could not be provided for the seed densities in fields and bird numbers as no seeds were observed in the soil samples and the test was therefore inconclusive.

4.0 Discussion

It must first be acknowledged that the spatial variation of all species differed and the distribution of farmland birds was very species-specific. There are however some general patterns that emerge from this report, such as the general negative relationship between birds and intensively farmed areas such as fields sown in autumn crops and also the general positive relationship with areas of permanent pasture and hedgerows. In common with the study of Atkinson *et. al.* (2002) only a few of the farmland species selected were widespread across the farming landscape. Many species showed some degree of habitat specialization. We can thereby determine the preferences of many species.

4.1 Changes in habitat throughout winter

I will first determine whether some species move between habitats as winter progresses. In common with the study by Tucker (1992), no temporal trends in habitat preference throughout the winter were recorded in invertebrate-feeding birds. However temporal changes were observed in seed-eaters, especially the yellowhammer, greenfinch and chaffinch. Yellowhammers showed a definite increase in the use of permanent grass and a steady decline in the use of autumn-sown cereals. As stated in Robinson & Sutherland (1999) habitat preferences are likely to be related to food availability so for seed-eating species the density of birds is likely to be related to the density of seeds in the soil. Later in the year any seeds left over from the previous crop or from autumn drilling are depleted by birds as time progresses and therefore the yellowhammers will move to another source of seeds. In this case grassland where many seeds are obtained from weeds (Robinson *et. al.* 2001). Greenfinches and chaffinches increasingly used tree clusters as winter progressed and preferences for crops and grass declined. Although greenfinches do eat green matter (Collinge, 1924), it is likely that it was the newly drilled seeds and seeds left over from the previous year that the birds were eating. The chaffinches and greenfinches will move away from these fields when the seeds are depleted or become unavailable. Grey partridges showed an increase in preference for fields with autumn-sown crops as winter progressed. Game birds are another of the few bird species which will feed

directly on crops, so can make use of this typically unproductive habitat when seeds elsewhere are depleted. I would therefore conclude that for granivorous birds, woodland and grassland becomes a very important habitat as winter advances. As with the invertebrate-feeders, insectivorous birds such as the dunnock and robin showed no major changes in habitat preference throughout winter. The great tit did however show a slight increase in the use of trees and a steady decline in the use of fields planted with autumn-sown crops. Insects are unlikely to change habitats throughout winter and consequently insectivorous birds have no need to change habitats. Tree foliage is a good source of insects throughout the year, and many insectivorous birds can afford to be woodland specialists.

4.2 Habitat preferences

The only species which showed a preference for fields planted with crops was the dunnock. The dunnock did not show a strong preference for any habitat but did show a strong avoidance of stubble fields. This suggests that another factor may be playing an important part in habitat selection of dunnocks. We know that dunnocks are a very timid species and are traditionally a bird of woodland edge and scrub, hence are well suited to hedgerows bordering fields (O'Conner & Shrubb 1986). Hedgerows are vital for their survival and severe treatment of hedgerows in farmland has been blamed for local declines of dunnocks (Mead 2000). Dunnocks are insectivores and can therefore take insects from hedgerows so unlike seed-eaters are not so dependent on the adjacent field for food. I believe that it is hedgerow quality which attracts dunnocks to specific areas, not the surrounding habitat. Fields planted with autumn-sown cereals have little to offer for most species. Efficient modern harvesting leaves little waste behind in terms of seeds and cultivation of the land reduces densities of invertebrates (Robinson & Sutherland, 1999). Gamebirds, pigeons, jackdaws, skylarks and greenfinches are some of the few birds which will feed directly on crops. Although the result for the diversity index was moderately high it would be expected that more birds occur in a habitat which is widespread. This does not necessarily suggest the birds are selecting this habitat through choice. We can see from the preference indices that 94% of the birds selected, avoid land sown with crops. These results are unsurprising and we can thus conclude that farms with a large area of crop cover are likely to hold fewer bird species than those which promote heterogeneity. Providing a

variety of habitats is expected to provide a variety of organisms which will exploit those habitats (Benton *et. al.* 2003).

This study appears to support the conclusion of Atkinson *et. al* (2002), regarding the importance of grassland habitats in farmland. Not only is the Shannon-Weaver index highest for grassland, indicating high species diversity and equitability, 12 of the 17 species selected showed a positive preference for grassland. The only species which avoided grassland were the blue tits, great tits, long-tailed tits, chaffinch and mistle thrush. The tits are all insectivores and are therefore not expected to forage in grassland. Chaffinches eat only insects and seeds, looking at their preference index chart we can see that woodland must be a source of both. All seed-eaters studied, apart from the chaffinch showed a preference for grassland these were the yellowhammer, greenfinch, collared dove, grey partridge, crow and jackdaw. The study of birds in winter by Atkinson *et. al* (2002) found that gamebirds (e.g. grey partridge*)* and buntings (e.g. yellowhammer*)* were most often associated with arable areas. This study does not support their conclusion, yellowhammers and grey partridges both avoided land sown with crops. House sparrows *Passer domesticus* were not subjected to the Jacob's preference index as they were only ever observed in the hedges surrounding gardens. House sparrows are seed eaters and thus are likely to feed from grass using the hedges as a refuge. Newton (2004) concludes that the main causal factor for the decline of seed-eating birds was the decline in food supply rather than the reduction in habitat. These results indicate that grassland is an important winter source of food for seed-eaters. The skylark a species which has undergone serious declines on farmland was observed on only three occasions and only ever on grassland, skylarks are a species whose decline can be attributed to the loss of habitat (Newton 2004), this may suggest that grassland is the limiting factor of skylark populations. Feeders of invertebrates such as the fieldfare, dunnock, starling and blackbird also showed a preference for grassland. Tucker (1992) discovered that all invertebrate-feeders studied had a positive preference for grassland and avoided all other field types. Atkinson *et. al.* (2002) also associate mistle thrushes with pasture but in this study mistle thrushes were observed only in woodland and fields sown with winter wheat. They showed a preference for woodland only. Only 4 individuals were sighted so little significance can be placed on these results. The starling another species which has shown serious declines was observed on only 4 of the 22 visits to

the farm, on 3 of these occasions they were observed on grassland. Starlings are strongly associated with human activity (Gregory & Baillie 1998) and many do well in city gardens feeding on invertebrates, berries and scraps. The song thrush *Turdus philomelos* placed in the RSPB's red list is another feeder of invertebrates and berries, we would expect to see them in pasture fields along with fieldfares and blackbirds. The song thrush was observed on only three occasions, 3 birds were located in grassland and 1 bird in woodland, a total of 4 birds is a worrying number for a once common farm bird. However Gregory & Baillie (1998) suggest that farmland is only one of a number key habitat types for the song thrush. An increase in farmland pasture may benefit invertebrate-eaters by providing an undisturbed source of abundant ground dwelling invertebrates. Kestrels are carnivorous birds and will hunt where there is likely to be an abundance of small mammals. In this study kestrels showed a positive preference for grassland. This may suggest that grassland held the kestrels principle prey, the field vole *Microtus agrestis* (Newton 2004).
When available in only a small abundance, grass is still a very valuable habitat. Although the Shannon-weaver index does not take area into account, the index is still highest for grassland and grassland accounts for only 28% of the land covered by crops.

Stubble fields were preferred by a surprisingly small number of bird species. Of the 17 species selected only 7 showed any preference for stubble fields. These were the yellowhammer, grey partridge, fieldfare, kestrel, wren, carrion crow and jackdaw. Stubble fields hold the greatest relative densities of seeds than any other field types (Robinson & Sutherland 1999). We would therefore expect the likes of greenfinches and chaffinches to show a preference for these fields. The lack of seed-eating birds in the stubble fields can be explained by the relative abundance of stubble present. The stubble fields accounted for only 8.2% of the sample area and were present for only 13 of the 22 visits. It is likely that the seeds in these fields would be very quickly depleted leaving nothing to offer seed-eating birds later in the season. For most seed-eating birds mortality is low in the early winter period and much higher in the late winter period when food sources have been depleted (Robinson & Sutherland 2002). After the 10th December the stubble fields were ploughed leaving only bare till behind. One small section of stubble was left in one of the grass fields. The winter diet of yellowhammers consists almost exclusively of seeds (Moorcroft *et. al.* 2002),

we would therefore expect the provision of over winter stubbles to play an important part in reversing the population declines of yellowhammers and other granivores. It can be seen from Figure 3.2 that yellowhammers make the most use of stubble fields over any of the other species selected. The linnet an attractive farm bird now placed in the RSPB's red list category is another bird which relies almost solely on seeds in winter. Linnets were observed on only one occasion in this study, not in a stubble field as we would expect but at the base of a hedge surrounding an oilseed rape field. The lack of linnets can be explained by seed abundances in winter, seed eaters often fare the worst in winter especially if seeds and fruits decline early on. If the winter seed supply is low, linnets will move out of Britain (Mead, 2000). Grain and seeds also form the diet of the collared dove, yet in this study they completely avoided the stubble fields. O'Conner & Shrubb (1986), propose that collared doves are dependent on human activities for food. Bradbury *et. al.* (2004) found in field-trials, winter granivorous passerines and skylarks increased numbers in response to stewardship habitats such as increasing over-winter stubble.

Fieldfares and grey partridges were the only species out of the 16 studied to avoid tree clusters. Fieldfares were only ever observed in trees, stubble and grass the latter two held large flocks of 50 and more, the trees held eight individuals on only one occasion. The Shannon-Weaver diversity index was very high for both the agroforestry blocks and tree clusters on the farm. Considering the agroforestry blocks in total make up only 1.5% of the sample area and woodland 6.3%, we would expect woodland to have the highest diversity index if the area of all habitats was of equal size. In this study the woodland category included both the agroforestry blocks on the farm and tree clusters. The largest tree cluster on the farm comprises mainly beech and pine, both are good sources of seeds and nuts for birds, the coniferous pine is also a good source of insects for birds. The agroforestry blocks are planted with ash, cherry, hazel and sycamore, all popular trees for birds. Blue tits, great tits, long-tailed tits and chaffinches showed a preference for woodland areas only. Tree foliage is a rich source of insects and is therefore likely to attract large numbers of other insect eaters such as the robin, dunnock and wren. Beech trees are the source of one of the chaffinches favourite foods in early winter, this is beech mast (a nut of the beech tree). The large tree copse on the farm is made up of largely beech and pine and hence is a good source of food for the chaffinches. Trees are not only used as a source of

food but also as shelter for many birds. Very small birds such as the goldcrest *Regulus regulus*, wren and robin can undergo severe declines in numbers after a severe winter. A pine forest is therefore a popular refuge for many small bird species. Goldcrests were observed on eight occasions in all habitats except stubble. They were always confined to hedgerows or tree clusters on the farm. The Goldcrests, an insectivorous bird, is the smallest breeding bird in Britain and categorized as an amber species by the RSPB. The presence of large numbers of tits suggest that food is not the limiting factor for goldcrests. Perhaps the improvement of hedgerows and woodland on farmland will reduce the decline of this tiny bird. It is not surprising that woodland areas on the farm have high diversity indices. The majority of farmland birds were originally woodland species, from a time when the whole of England was covered with forest. They have now adapted to farmland habitats. Half of Europe's farmland birds have an unfavourable conservation status and yet 95% of woodland birds have favourable conservation status (Twirek 2001). Woodland specialists are doing very well with the current density of woodland. It may therefore not be the case that extra woodland will improve the status of other bird species. In fact Fuller *et. al* (2001) suggest that saturating farmland with woodland or hedgerows does not necessarily result in increased levels of species richness or the same bird species composition found in woodland. They believe that managed woodland habitat should be regarded as a complementary habitat not as an alternative.

Land left as bare earth has the lowest of all Shannon-Weaver diversity indices and only the dunnock and wren show any preference for this habitat. The wren, like the dunnock, was probably not attracted by food supply but to the quality of field boundaries in the sample area. Bare till has very little to provide bird species, any seeds at the surface are lost during cultivations and invertebrates have been disturbed or buried (O'Conner & Shrubb, 1986). For several bird species it would be advantageous to leave fields as stubble for as long as possible before ploughing and drilling with autumn-sown crops.

Apart from the importance of grassland, woodland and stubble fields another major conclusion I have reached is that hedgerows are a vital part of farmland. Without them arable farms are very poor habitats for birds. Only a small majority of the species recorded were found away from field boundaries and in the fields themselves.

The birds which were observed away from field boundaries included fieldfares, starlings, skylarks, grey partridges, pheasants and mistle thrushes. All other species were confined to the hedgerows. Field margins are a major source of seeds and berries. Very few weeds are found within fields especially those sprayed with herbicide, thus most are found around field edges (Robinson & Sutherland, 1999). For most bird species to exist on farmland at all, the majority of fields must have a hedgerow boundary or division. The boundary does not always need to be a hedge, yellowhammers are found to significantly select grass margins (Perkins 2002). Grass-only strips and wild strips may also benefit small mammals and thus improve the success of hunting by raptors, such as the kestrel (Vickery *et. al.* 2002).
Species classed as hedgerow specialists are the dunnock, yellowhammer, goldcrest and greenfinch (Fuller *et .al* 2001). I do not believe management strategies such as providing large areas of grassland, stubble or winter bird crops will make a substantial difference to farmland bird populations if hedgerow management is not also considered. Although no correlation was found for hedge height/width and bird numbers in this study, this does not suggest that hedge quality is not important for farmland birds. The quality of hedgerows on the farm are varied some are species rich containing hawthorn, holly, ivy, maple and spindle others are very homogenous. There are other factors which need to be taken into account when explaining the lack of correlation. For example many of the tall hedges have large gaps at the bottom and in the middle, making many of them useless for sheltering. Some hedges on the farm were flailed in December leaving many of the hedges of no use to birds, figure 4.0. Simple rules based on the timing and frequency of cutting can be applied to help promote most bird species. Hedgerows should be trimmed in rotation, so not all hedgerows are cut in the same year (Hinsley & Bellamy, 2000). Cutting should also be left until late in the winter, so fruit and seeds are left long as possible.

Figure 4.0: *Example of flailed hedgerow on the farm.*

Fuller *et. al.* (2001) explains that the habitat needs of hedgerow specialists show considerable variation. Hedgerow structures which support the highest number of bird species and highest densities of birds are not necessarily the best for these species. They found that the linnet was most abundant in low hedges without mature trees. The greenfinch was most abundant in wide hedges with many mature trees and yellowhammers most abundant in hedges of intermediate width. Short, narrow hedges are however unfavourable to most species (Hinsley & Bellamy, 2000) There is no single hedgerow management procedure that can meet the needs of all birds of a certain location (Hinsley & Bellamy, 2000). Management strategies that maintain a diversity of hedgerow structures are therefore advantageous.

4.3 Sampling errors

Several conclusions have come out of this report, but several key features of agricultural practice were not investigated. Hedgerow quality on the farm was not measured. I cannot therefore conclude which hedges will be beneficial to declining species, especially hedgerow specialists such as the yellowhammer. Knowing the relative seed densities in different field types may have allowed for clear explanations of habitat preferences and movement between habitats. I can provide no obvious explanation for the lack of results of the seed sampling. The seeds may be either too

small to observe with the naked eye, depleted already by birds or maybe just not present in the soil.

A perfect method for counting birds does not exist (Bibby *et. al.* 2000). Considering the time available I believe the transect and method chosen for this report was the best in which to obtain a large sample of data from across all farm areas. However bias may be introduced by selecting routes for accessibility, in my case selecting roads and tracks. It is difficult to compare numbers of different bird species, some are noisy and conspicuous others quiet and timid. In winter especially, some birds flock together to exploit available sources of food, but many other birds are solitary. We cannot therefore determine which birds are more abundant than others. The aim of this report was not to compare abundances, but to compare habitat preferences. This is possible without knowing the densities of birds, only their distribution across different habitats.

4.4 Conclusion

This report demonstrates that by understanding bird distribution patterns, habitat preferences and diet we can determine the importance of certain landscape features. This report has concluded the importance of grassland, stubble and hedgerows for seed-eating birds, grassland for invertebrate feeding birds and woodland for insectivorous birds. The species studied in this report all show different spatial variation and therefore different habitat preferences. The distributions of farmland birds are very species-specific and consequently when applying conservation strategies to benefit one species this may be to the detriment of another. The only suggestion is to ensure that diversity is maintained. Although this study found that very few birds actually preferred land planted with crops, Robinson *et. al.* (2001) found that the majority of seed-eating species were most abundant in landscapes containing areas of arable land than in areas of total pasture.

Many of the main features of this report back up present knowledge we have on the effects of farming and bird populations. It is imperative that this knowledge is applied to farmland, in order to reverse the serious declines of some farmland species. There are initiatives such as countryside stewardship schemes (CSS) and the pilot arable stewardship schemes in place to encourage sensitive land management. Payments are

made for specific management actions which enhance biodiversity in farmland. It is however, farmers' attitudes which will have the greatest influence on how new technologies are applied (Robinson & Sutherland, 2002). Agricultural policies to promote biodiversity must also allow for practical and productive farming.

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