BTO Research Report No. 312

BIRDS EYE WALL'S: Partnership for Sustainability

Progress Report on the Use of Pea Fields by Birds

Author

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A report by the British Trust for Ornithology

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CONTENTS

Page No.

LIST OF FIGURES

Page No.

.

LIST OF APPENDICES

Page No.

1. EXECUTIVE SUMMARY

1. As part of Birds Eye Wall's Partnership for Sustainability programme the BTO carried out a month by month breeding season survey of pea fields and adjacent crops, for birds on 20, 19 and 5 and 9 farm sites (for 1999, 2000, 2001 & 2002 respectively) in the east of England. The fieldwork included an intensive study of Skylarks on five East Anglian farms (using timed point counts). Elsewhere the spatial distribution of birds on peas was analysed in relation to pesticide versus non-pesticide treated field margins in 2001 and 2002 only.

2. The study revealed that higher densities of species and a greater abundance of most species were recorded on pea fields compared to cereal fields. This was true for seed-eating passerines (finches and buntings) also but for these species preferred crops were spring cereals or oilseed rape rather than peas. Peas were especially important for Lapwing (in Humberside) and Skylark (all sites) whose numbers approached those recorded on weedy fallows, and Yellow Wagtails were present in relatively high densities.

3. As a rule, in March bare soil was avoided by most species, and far greater use was made of sparse or developing pea crops (i.e. from April to June). Because of this, it was clear that farm activities, such as rolling, should best be performed either before April or quickly after the peas had been drilled, in order to protect the clutches of Skylarks and Lapwings.

4. Thrushes, finches and buntings occurred at higher densities nearer field boundaries, and would probably benefit from field margin conservation strips. From intensive studies, Skylarks would only use marginal strips where these occurred on open boundaries between two fields (e.g. beetle banks).

5. The majority of species occurred at higher densities on unsprayed margins than sprayed margins, but the difference was not statistically significant. The strongest difference was for insectivorous bird species (thrushes, wagtails and Dunnocks) and Grey Partridge but there was virtually no difference in the densities of buntings on the two treatment types.

6. Skylarks breeding on peas appeared to continue into June and possibly July, thereby potentially raising more offspring than on cereals. However, when not tied to a breeding site, birds used pea fields much less frequently and often foraged beyond the pea-field boundary. Overall, the mosaic created by pea crops, cereals and other crop types on rotational farms may help to maintain both foraging and breeding habitat for longer over the summer season.

7. The main focus of study should now concentrate on the species for which peas are especially important. These include Lapwings, Skylarks and Yellow Wagtails, although it is likely that other insectivorous birds would benefit (i.e. young Grey Partridge, thrushes, Dunnocks, Swallows and martins and Whitethroat), especially from reductions in herbicide or insecticide applications that can reduce invertebrate prey. For Lapwings, there may be additional field management criteria, such as the timing of rolling or drilling, that can be manipulated to help protect pairs that attempt to breed within pea crops.

   Breeding Lapwings will form the basis of study in the proceeding year ahead. Attention will be focused on their frequency of occurrence within peas crops, management threats to breeding birds and their offspring and the foraging location and requirements of Lapwing broods.

2. INTRODUCTION

One of the most important long-term changes in land-use patterns to have occurred on farmland in the UK in the last 30 years, has been the replacement of spring crops with winter cereals (Chamberlain *et al.* 1999). Together with an increased reliance on chemicals to control pests and weeds this progression towards cereal monocultures has led to simplified cropping patterns and a loss of structural variety in the landscape (O'Connor & Shrub 1986). Long-term declines in bird populations on arable farmland in the UK (Siriwardena *et al.* 1998) have been linked to general increases in arable intensification (Chamberlain *et al.* 1999) of which crop structure is a component. There is information to suggest that winter cereals become too dense from May onwards for birds such as Lapwing *Vanellus vanellus,* Skylark *Alauda arvensis,* Yellow Wagtail *Motacilla flava* and Blackbird *Turdus merula,* to either breed or forage in. Specifically, Lapwings are unable to raise chicks in winter wheat cereals without suitable adjacent habitat in which the chicks can forage (Wilson *et al* 2001), while Skylarks are unable to raise important second broods in later summer crops due to poor access to the ground on which to nest and forage. For Skylarks, this is in contrast to their potential to raise at least two broods in a season in shorter, sparser vegetation (Wilson *et al.* 1997).

If a measurable increase in the wildlife value of farmland is to be obtained on a national scale then attention to the contribution of whole-field management options will have to be considered under conservation initiatives. For some species of bird, such as Lapwing and Skylark, that nest within fields and avoid margins, within-crop initiatives are the only options available for their widespread conservation. On arable land, high breeding densities of Skylarks have been found in summer fallows of weedy composition (Henderson *et al*. 2001, Wilson *et al* 1997), but this valuable habitat only occupies a relatively small proportion of the tilled landscape (that is between 5% and 10%) and are funded under Government supported schemes such as Set-aside the Countryside Stewardship Scheme. However, a further source of crop heterogeneity and architectural variety to a cereal-based crop rotation, is added by break crops that are used to split the sequential use of land by the same crop type on a year by year basis, and so avoid accumulations of pernicious and resistant weeds (such as blackgrass *Alopercurus myosuroides*), or losses in soil fertility over time. Typical break crops, such as a legume (peas or beans) or brassicas, such as oilseed rape, can return nutrients to the soil (such as nitrogen in the case of legumes), allow weed control of grasses *Graminacae* including cereal crop volunteers but also introduce variety in content, structure and timing of husbandry. Theoretically, this could present bird species with greater variety of breeding and foraging opportunities. Another potential advantage of break crops and especially of legumes is that herbicides are frequently limited to pre-emergent treatments to avoid damage to the crop itself. As the crop grows, pesticides are employed often only in response to problems that arise during development. For spring peas, drilling date is also highly variable in practice with in-built flexibility in the control of crops and pests implying a potential to optimise crop management for both agronomic and wildlife benefits.

Peas were the focus of a study with complimentary intensive (observational) and extensive (survey) protocols, designed to determine the potential role and contribution, of this particular spring sown crop, to ground-feeding birds and specifically to Lapwing and Skylark population densities on intensive lowland farmland.

3. METHODS

3.1 Relative Densities on Crops

In order to assess the relative densities of birds on peas, data was gathered from 56 pea crops from a total of 21 farms over four years, with a variable number of farms involved from year to year. Twelve farms were located in Humberside and nine in East Anglia. For comparison, pea crops were paired with neighbouring crops of either winter wheat, as the dominant crop of lowland England, or oilseed rape as the dominant break crop across lowland England. At each farm the pea crop moved location each year on a rotation, and on a subset of farms the pea and cereal fields were switched in consecutive years providing a control over boundary and soil characteristics and other nearby influences such as woods or streams.

For bird observations, five visits were made to each field pair between March and August in each year. On each visit, the perimeter of each field was walked and the position of all birds seen or heard on the field or boundary was recorded using codes and guidelines to create consistency in recording information between observers. Singing birds were recorded separately as an indication of breeding territoriality. Birds that were flushed or moving were recorded in the first location in that they were seen. No visits were made in heavy rain or in wind greater than Beaufort force four. Data provided baseline information on the comparative use of study crops by birds and on temporal changes in bird numbers on crop between years and within a season. Within a season, the timing of farm visits coincided with phases of pea development or management activities as follows:

1. Bare earth near drilling (March to May).
2. Post drilling with an emergent pea crop (April to May).
3. Peak flowering period (June to July).
4. Pre-harvest usage (June to August).
5. Post-harvest usage (June to August).

Bird densities were calculated either on an individual species basis or by amalgamating functional groups of species; that is, aerial insectivores (Swift *Apus apus*, and Swallow and martins Hirundines), insectivorous passerines (wagtails Motacillidae, Wren *Trogolodytes trogolodytes* , Dunnock *Prunella modularis*, thrushes Turdidae and warblers Syliviidae) and seed-eating passerines (sparrows Passeridae, finches Fringillidae and buntings Emberiziidae). Grey Partridge, Lapwing and Skylark were treated separately but the latter two species were not expected to yield analysable data sets since both species tend to avoid marginal areas of crops.

3.2 Intensive Observations of Breeding Skylarks

Several studies have implied that spring crops allow Skylark increased opportunities to breed for longer through the summer than winter cereals alone (Wilson *et al.* 1997, Chamberlain *et al.* 1999). On a subset of 10 field pairs of peas and winter wheat, the activity budgets of Skylarks were recorded during a series of one-hour observation periods between April and August 1999, 2000 and 2001. The aim was to separate breeding birds from other activities and to assess the relative densities of breeding birds in particular, in relation to crop type and crop development throughout the pea-growing season. An index of field use for breeding birds was provided by singing individuals while other flight activities were used as an index of general activities relating to foraging. Observations began by viewing either the pea or cereal field (reversed on

subsequent visits to control for diurnal variation in bird activities) to recorded song flight frequency (territory density was based on the maximum number of simultaneously singing birds) and the frequency of non-singing flight activities. The emphasis on the flight activity reflects the difficulty in following Skylarks below crop level to precise breeding or foraging locations but had the advantage of removing crop height as a confounding element of observation frequency.

3.3 The Effects of Pesticide Treatments on Birds Using Peas

A series of field trials was conducted on applications of herbicides and aphicides to the outer areas of crops, by boundaries. All parts of experimental pea crops were sprayed initially with pre-emergent herbicides (glyphosate). Trial areas of crops were then divided equally into alternating treated and non-treated sections for all subsequent applications of herbicides or insecticides ("pesticides"). Each section was between 100 m and 200 m long depending on the field size and of width 6 m in 2001 and 12 m in 2002. In total, there were 36 replicates from five farms in 2001 and 24 replicates from six fields in 2002.

All applications of herbicide and pesticides to each experimental field are tabulated in Table 2. Bird densities on untreated areas were tested against those on treated areas under the assumption that increased levels of invertebrates and weed seeds in unsprayed areas would attract birds in greater abundance than in sprayed sections. Bird count data are generally skewed and so appropriate transformations were incorporated into the analyses and resulting regression models tested for their 'goodness of fit' to either Poisson or Binomial distributions.

4. RESULTS

4.1 Spatial Distribution of Birds Between Crops

When all species were combined across all growing months (April to August), median densities of birds were higher on peas than winter cereals for 19 of 20 farms in 1999 (Wilcoxon Signed ranks: T=21, P<0.001) and for 17 of 18 farms in 2000 (Wilcoxon Signed ranks: T=19, P<0.001) (Figure 1a). Twenty out of 21 fields that switched from peas to cereals, or visa versa, in consecutive years, held higher bird densities on peas than on cereals (Wilcoxon Signed ranks: T=21, P<0.001), and overall there were significantly higher densities on peas (t-test: 2-tailed t=4.89, n=21, P<0.001; Pea-mean=3.1, SE=0.8; cereals-mean=0.81, SE=0.3; Figure 1b).

Compared to rape, peas supported lower combined densities of birds but the two crops supported different bird faunas (Figure 2a). Peas held significantly higher densities of Lapwing, Grey Partridge, Woodpigeons and Yellow Wagtail and higher densities of Skylarks, though the difference was not significant for this species. Lapwings were associated with 20 of all 41 pea fields and 12 of the 21 farms surveyed over four years, compared to only two records in winter cereals (in March/April only) from two farms and no records in rape (Figure 2a). Known breeding pairs of Lapwings were recorded on seven farms, but the status of most individuals was unknown. Skylarks were recoded in all fields (cereals, peas and rape) but were more abundant in peas than in rape, and both crops supported significantly higher densities of Skylarks than winter cereals. Seed-eating specialists, such as finches, buntings and sparrows were more abundant in rape than peas, as were Swifts and hirundines, Blackbird and Whitethroat, but all of these species were more abundant in peas than winter cereals (Figure 2a).

Among species, 28 out of 35 were recorded at higher mean density on peas than cereals (Wilcoxon signed ranks: T=28, P<0.01 and mean species richness (per summer) was significantly higher on peas than on winter cereals (t-test: 2-tailed t=9.45, n=21, P<0.001). There was no significant difference between peas and oilseed rape (t-test: 2-tailed: t=1.01, n=21, ns; Figure 2b).

4.2 Bird Numbers and Crop Development

With all species combined, peas supported higher densities of birds than winter cereals between May and August (P<0.05) when the difference between crops was statistically significant. Combined bird densities were higher only on winter cereals than peas during March and early April, but the difference was not significant (Figure 3a).

On peas, for combined species, peak densities occurred in late June and July, corresponding with the main period of flowering for spring crops (Figure 3a). Both hirundines and Yellow Wagtail showed a similar pattern of use, peaking on arrival in Britain (in April for Yellow Wagtail or May for hirundines), and again at flowering in July (Figure 3b).

4.3 Skylark Observations

The following results are based on data from 10 fields over three summer seasons from a total of 120 hours of observations. The numbers of bird species using peas and the density of Lapwing and Skylark are summarised in Figure 3 a, b & c in relation to the change of the development of the pea crop during the growing season. A greater range of species was recorded in pea crops

than winter cereals increasingly throughout the growing season and especially from May to August. Densities of Lapwings and Skylarks were highest on peas again from May to August. Changes to the composition of bird species using winter cereals, vining peas and oilseed rape respectively are shown in Figure 4.

From intensive observations of Skylarks, the mean densities of singing birds were higher on peas than on winter cereals, but on pea crops activity budgets revealed peak singing periods during early June (see Figure 4). Singing tends to indicate the presence of a breeding territory, and typically precludes egg-laying. June contrasts with a national average, when early May is recognised as the peak time for Skylarks to breed. Furthermore, the mean maximum count of Skylarks on cereals in this study occurred from late April to May. On peas, a dramatic drop in singing activity from mid to late June indicated that females were incubating eggs or broods. A simultaneous increase in flight frequency, other than that used for singing (Figure 4) signified that parents were provisioning broods and that fledged juveniles were at large. Either way, breeding in this species appeared to continue into June and possibly July, extending the season beyond that reached in cereal crops.

4.4 The Effects of Pesticide Treatments on Birds Using Peas

Fourteen out of 21 species occurred at higher density on unsprayed margins than sprayed margins while for seven species the opposite was true (Figure 6). However, for none of these species was the difference statistically significant, although for Grey Partridge the probability was $P<0.06$. When species were combined into species groups, all groups were recorded at higher density on unsprayed margins (Figure 6b) and the average was around 1.5 times higher, but again the difference was not statistically significant, although when all species were combined there was a probability of $P = 0.08$.

5. DISCUSSION

5.1 General Trends

The extensive survey revealed that a greater number of species and a greater abundance of most types of species were recorded on pea fields compared to cereal fields, including insectivores and seed-eating species. The densities of these species (particularly Skylarks) were typically less than one third lower than those recorded in prime farmland habitats in previous studies, such as rotational set-aside fallows (Henderson *et al*. 2000a). However, compared to other neighbouring crops, peas supported a distinctive bird fauna and in this way contributed to local biodiversity. Since the majority of the individual birds recorded during surveys were flushed from crops it is unlikely that differences between crops are solely explained by differences in detectability, perhaps with the exception of gamebirds. In particular, higher bird densities in peas compared to winter cereals included aerial feeding Swifts, Swallows and martins as well as singing Skylarks and so all were recorded in flight above crop height. Quail were detected by their call.

Compared to winter cereals, both peas and oilseed rape (the major break crop in the UK) supported high densities of all bird species groups (insectivorous and seed-eating species). Oilseed rape supported the highest densities of seed-eating birds such as finches (especially Linnet) and buntings (especially Reed Bunting and Yellowhammer). Peas, however, supported higher densities of Lapwings, Skylarks and Yellow Wagtails than rape, and each of these species is currently of high conservation status in the UK. No Lapwings were found on rape due to its tall structure. On peas, Lapwings were recorded (on at least one visit) on over a half of all fields visited, and especially in the Humberside region. Peas seemed to provide a habitat for both breeding pairs and foraging individuals and groups.

On peas, across the growing season, bare soil (in March) was avoided by most species, and at this stage densities of species such as Skylarks were higher in young winter cereal crops. Greater use was made of peas in sparse or developing pea crops from April to June (the key phase) and later into July (after the harvest, in July and August densities of Skylarks in particular dropped off considerably). As a consequence, farming activities before April were unlikely to have much affected the birds using the pea fields. However, crops rolled several weeks after drilling, would clearly pose some threat to ground nesting clutches of Skylarks and possibly Lapwings during late April and May. Compared to winter cereals singing Skylarks were most abundant in June and July implying that they were continuing to attempt breeding on peas later into the summer than was possible in winter cereals. In doing so, they are more likely to raise second brood and increase reproductive output. The value of peas in increasing heterogeneity within the crop rotation is therefore to increase both the breeding densities and reproductive output of this species. When foraging, Skylarks used pea fields much less frequently and often foraged beyond the pea-field boundary into neighbouring fields of oilseed rape, set-aside, or turnips.

For other species, aerial feeding species and Yellow Wagtail, used peas when first arriving from migration. They then appeared to disperse during May (probably onto breeding areas or territories) but returned to forage in peas during June and July and especially during the pea flowering phase.

Overall, the mosaic created by pea crops, cereals and other crop types on rotational farms will help to maintain foraging and breeding opportunities for this species throughout the summer and for a longer period over the summer than would be available from winter–sown cereals alone.

5.2 Margins and Pesticide Treatments

Since thrushes, finches and buntings occurred at higher densities nearer field boundaries, they would probably benefit from field margin conservation management. This is a fairly well established feature for boundary-based birds on farmland, and one that is also recognised in other studies of farmland birds (Henderson *et al*. 2000b). In general, however, although these species occurred at higher density in pea crop margins than in the crop interior, absolute numbers of birds in crop margins were low and low sample sizes contributed to low power in detecting differences between sprayed and non-sprayed treatments. Nevertheless, the general trend was for higher densities of birds on unsprayed areas. This was especially true for insectivorous species (Dunnock, thrush species and Yellow Wagtail) as well as Grey Partridge but was less apparent for finches and buntings. Skylarks and Lapwings tend only to use marginal strips of crops where they occur on open boundaries between fields.

5.3 Conclusions

- In general, the densities of birds, including Grey Partridge, Lapwing, Skylark, hirundines (swallows and martins), wagtails, thrushes, finches and buntings were higher on peas than on winter wheat, especially in late spring and early summer (May to July). Densities of Lapwing, Skylark and Yellow Wagtail were also higher on peas than oilseed rape.

- The crop structure of peas presents extra breeding and foraging opportunities to Skylarks and possibly other species as the summer progressed and as neighbouring crop became too developed.

- The benefits of pea crops, for increasing biodiversity in birds on farmland currently arise from the addition of structural variation that the crop gives to the whole crop rotation or crop mosaic. At a farm level, peas support higher densities of both Skylarks and Lapwing (and possibly Yellow Wagtails) than the dominant crops, winter wheat and oilseed rape, and in this way offer improved niche structural and temporal (early and late summer) value to the farm landscape. This is especially likely for Lapwing and Skylark respectively. The flowering crop also attracts other insectivorous species.

- Within-crop management of peas has so far, proved less transparent as to its value for increasing bird biodiversity, even though there was a general trend towards higher densities of birds (especially insectivorous birds) on unsprayed margins of pea crops. These relationships were weak, mainly due to low numbers of birds using the margins and unless larger areas of crops are included in experiments, it may be difficult to fully assess the full potential value of within crop management manipulations to birds. Many bird species uses peas as source of food around flowering time and so restrictions on the use of insecticides, for example, at this time might prove informative. Greater benefits are likely to arise from altering the timing of some management practices, such as rolling in spring or harvesting (a consequence of drilling date) in summer, to the benefit of ground-nesting birds. Within the current research programme, these scenarios have not been tested (but see the recommendations below).

6. DEVELOPING MANAGEMENT STRATEGIES FOR THE CONSERVATION OF BIRDS IN PEAS

6.1 National Context

The Birds Eye Walls Sustainability programme has identified a suite of bird species for which peas offer potential conservation benefits and scope for management initiatives. Lapwing, Skylark and Yellow Wagtail are three species of particular interest that are of current national conservation concern and are included in the Government's Quality of Life Indicator for birds. The Government has a commitment to reverse the downward trend of the bird indicator by 2020. To achieve this target, contributions from across the arable sector, including areas outside of agri-environmental schemes, are likely to be necessary. The Birds Eye Walls initiative is advanced recognition of the contributions required across farming towards environmental welfare. It is well positioned to feed into national environmental recovery programmes.

Research is continuing to investigate ways of developing management strategies for most of the key species associated with peas. Such a strategy is outlined below for Lapwing. This is a conspicuous, and relatively high profile species that has been declining on farmland throughout lowland Britain.

6.2 Species Focus: Lapwing

Status and requirements

The Lapwing has declined by almost 50% in lowland Britain throughout the 1980s. This has largely been due to changes in agricultural practice and especially the loss of mixed farming (grassland and spring crops). Lapwings nest in short, sparse vegetation, fallow land or bare tillage from mid April to early June. Winter crops are too tall and dense, too early in the season to offer suitable conditions for either breeding or foraging. The 1980s trend towards winter sown crops and simplified rotations reduced the suitability of vast areas of farmland for this species.

Results from The Birds Eye Wall's Sustainability Programme

- A half of the 40 pea crops surveyed during the Birds Eye Walls Sustainability programme held breeding Lapwings. This was in contrast to only one Lapwing pair recorded in nearby winter cereals or rape.
- The main benefits of peas are the low growing young crops in April and May. Peas probably also offer Lapwings low levels of disturbance before June since management is often minimal and infrequent. Chicks are likely to move out of peas before the crop is harvested. There is circumstantial evidence, currently under study, that infrequent or piecemeal applications of herbicides and pesticides can benefit important food items of Lapwing such as ground beetles (e.g. Roy Brown *pers comm*.). The timing of drilling, between mid April and mid May and especially the time between drilling and rolling are the main threats to the nests and young of established breeding pairs.

Management potential for Lapwings on peas

For this species current information allows for a three point strategy which outlines potential areas of compromise within the management regime of crops.

1. **Rolling**: If birds are lured to breed between the crop being drilled and the crops being rolled then clutches are likely to be lost. Later laying birds (in May) are very unlikely to relay new clutches whereas birds laying in early April may have time to relay new clutches. Thus, the later a crop is drilled, the more important it is that drilling and rolling activities occur close together, preferably within one week.

    - *Management focus*: Where there is flexibility to reduce the time between drilling and rolling to less than one week, this is universally recommended to protect the clutches of nesting birds.

2. **Timing of drilling**: Early drilling (March to mid April) and late drilling (from mid May) are unlikely to threaten clutches of Lapwings but crops drilled between late April and mid May could threaten clutches already laid.

    - *Management focus*: where flexibility exists within a regional drilling programme, according to weather conditions and other constraints, then drilling in early May is best avoided. However, the importance of drilling date to Lapwings is still under study and not properly understood.

3. **Invertebrates**: Peas may also offer Lapwing chicks a valuable source of food. Low levels of herbicides and pesticides can depress ground beetle numbers on which Lapwings may feed. Flexibility may exist to reduce levels of applications to crops in some circumstances.

    - *Management focus*: Where crop monitoring and conditions predict low risk from contaminants or pests, reduced levels of chemical control should be considered, as these are likely to increase the population of beneficial ground beetles within crops.

Research is continuing on Lapwing and other species to develop specific and practical recommendations for pea crop management and the conservation of birds.

Acknowledgements

The BTO are extremely grateful to the farmers and landowners who gave us permission to survey their land, and to all volunteer fieldworkers for their help and commitment to the survey. Jos van Oostrum (Birds Eye Wall's) provided logistic and farm liaison support which greatly assisted the progress of the survey. Within the BTO, our thanks extend to Nigel Clark (project supervisor), Dawn Balmer and Mike Armitage (intensive fieldwork staff), Nicola Read, Dawn Morris and Jane Wells for computer inputting of data records and again to Nicola Read for secretarial assistance.

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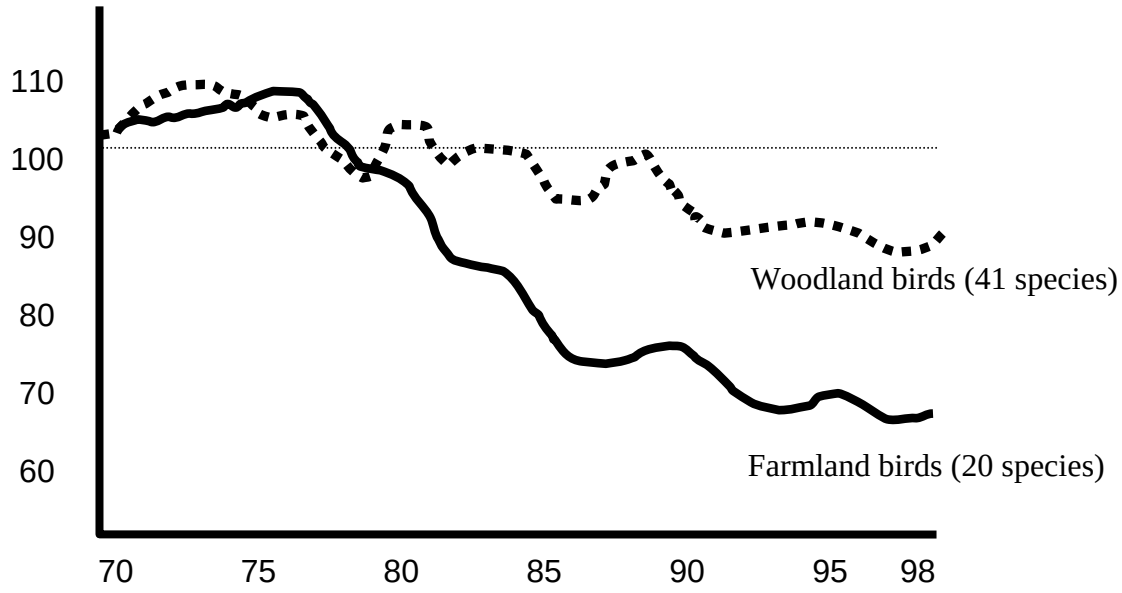


Figure 1 Relative change in the status of breeding birds within the UK national bird indicator for woodland and farmland between 1970 and 1998. The 20 species contributing to the farmland index are given in Appendix 1.

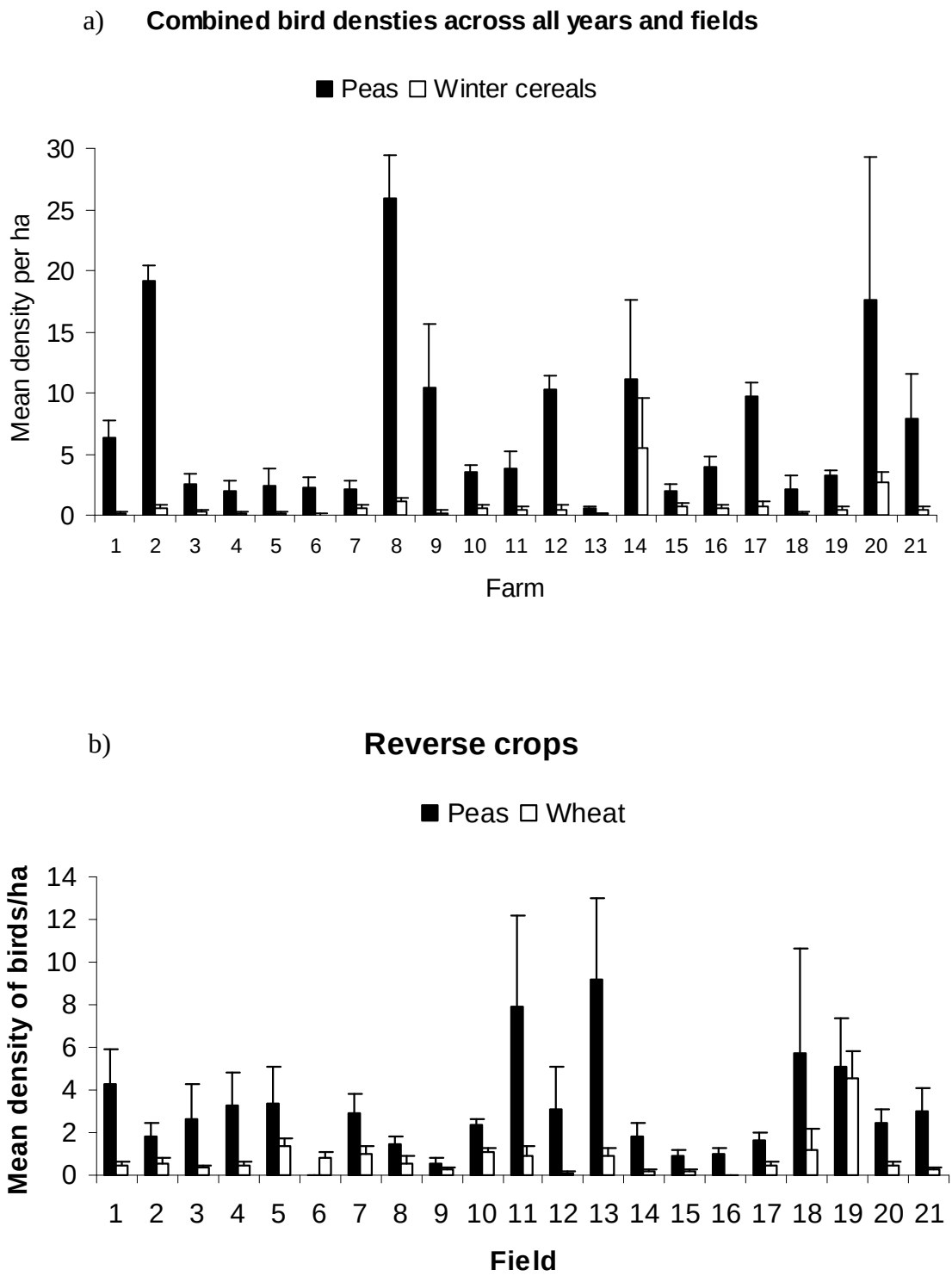
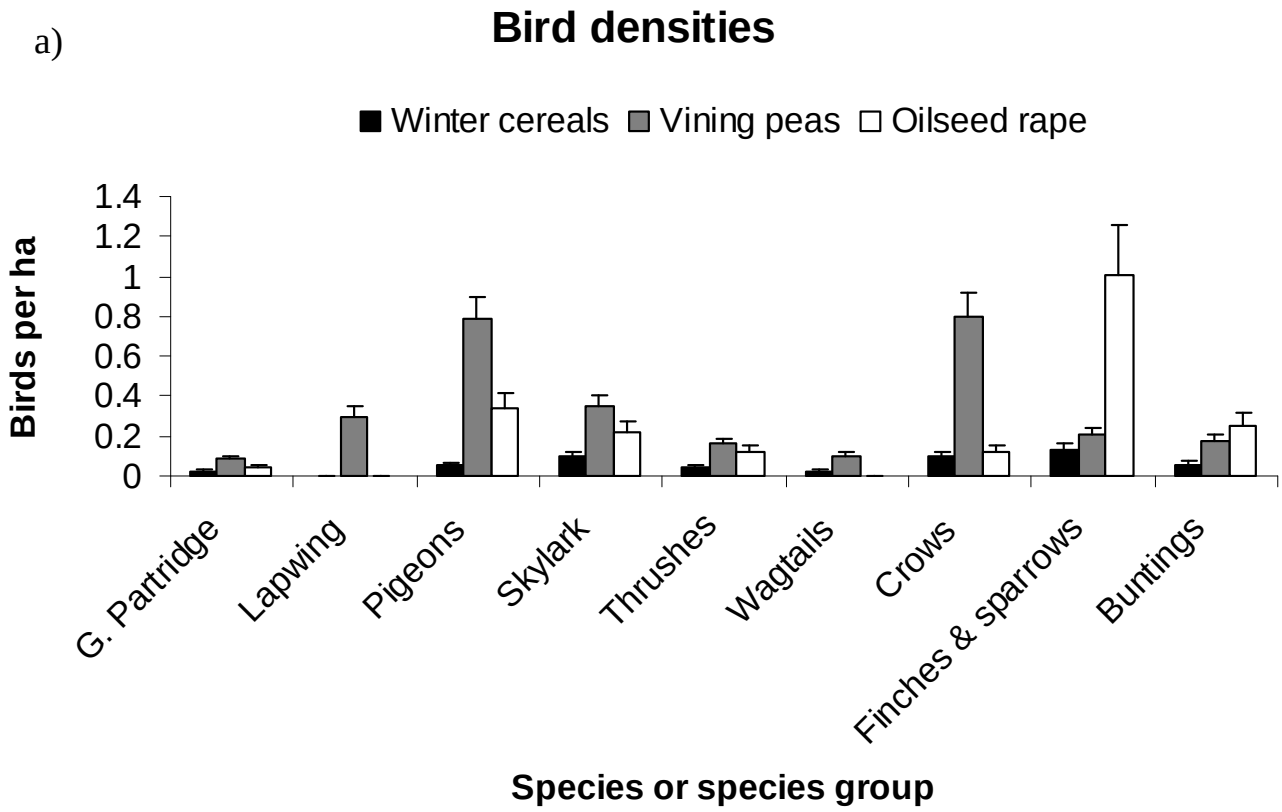


Figure 2 Densities of birds on peas and winter cereal for (a) all crops and (b) crops which switched in consecutive years from peas to winter wheat or winter wheat to peas.

a)



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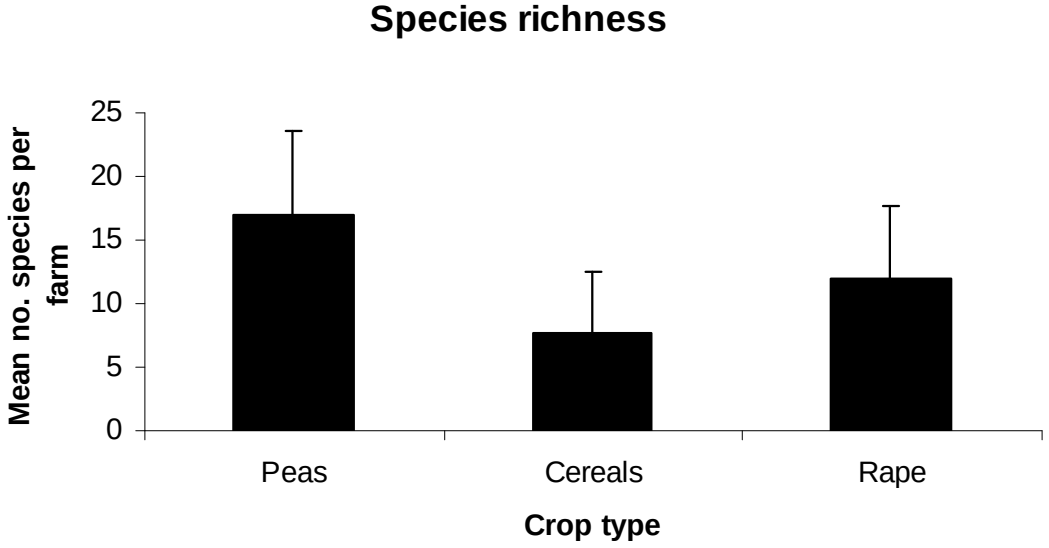


Figure 3 Comparative densities (a) and species richness (b) of birds on peas, winter cereals and oilseed rape (all plots combined).

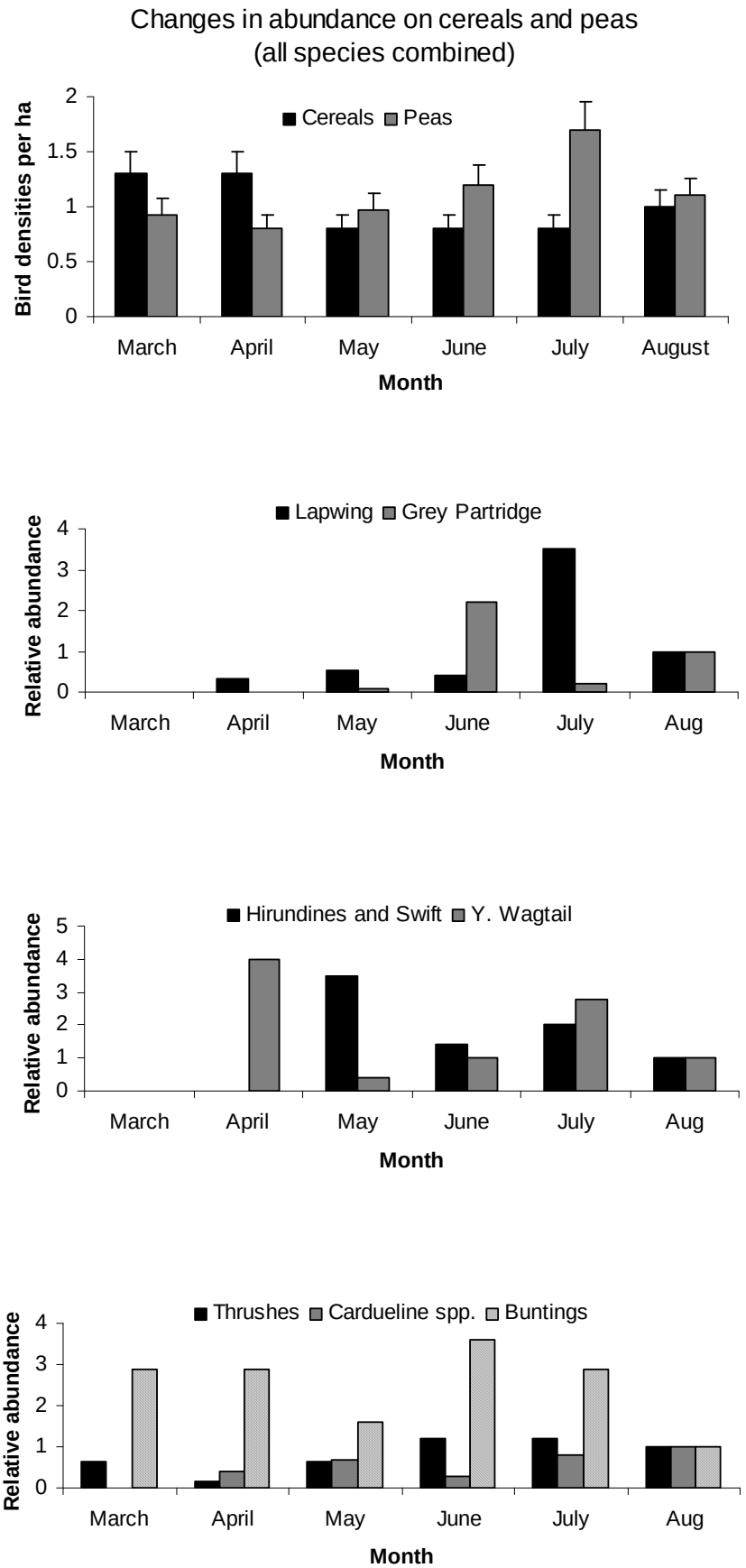
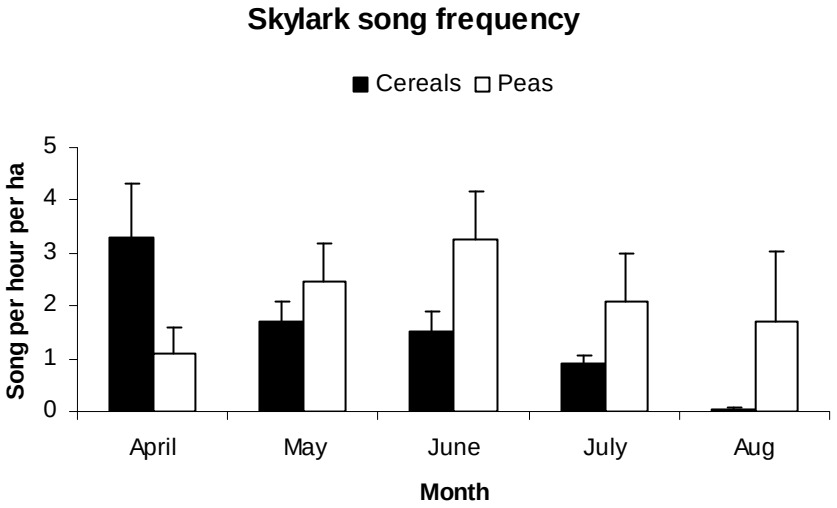
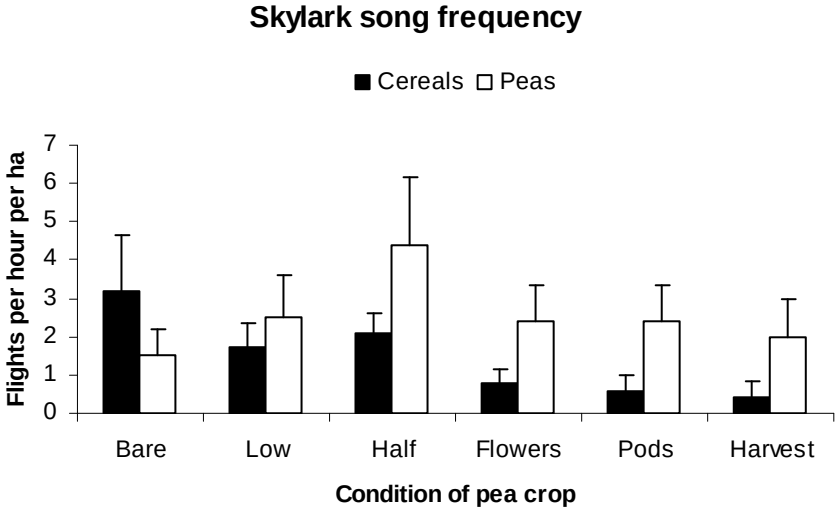


Figure 4 (a) Change in the densities (+/-SD) of birds on cereals and peas during the growing period of peas. In (b), (c) and (d) we show relative changes in bird densities over the pea growing period on peas only for seven species or species groups.





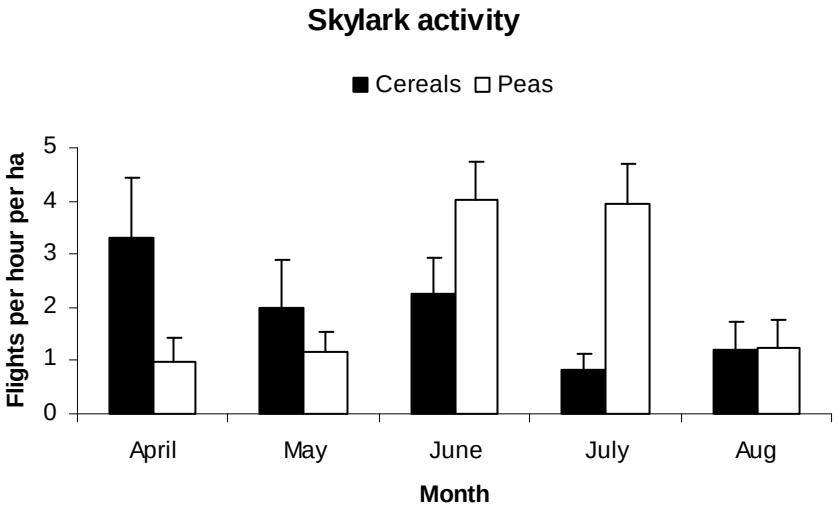


Figure 5 Change in the densities (+/-SD) of Skylarks on cereals and peas during the main pea growing period – April to August. In (a) and (b), song frequency is shown in relation to month and pea crop status respectively. In (c) Skylark flight activity is shown in relation to month.

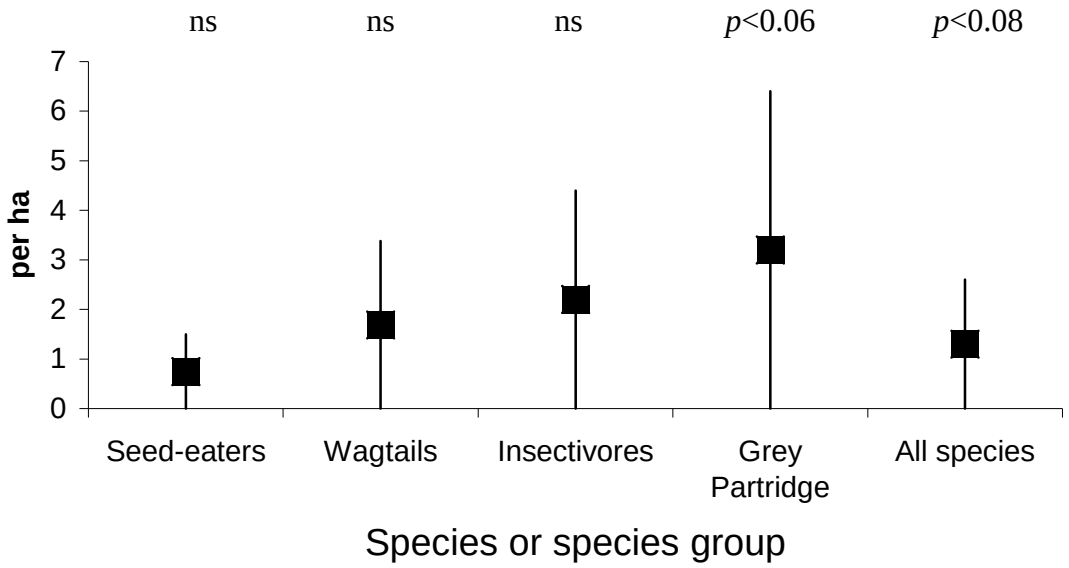


Figure 6 Crop treatments: relative mean densities (and 95% confidence limits) of Grey Partridge and four species groups on non-sprayed margins relative to sprayed crop margins on peas. Zero is the null expected value.

APPENDIX 1

Specific Research Programme for 2003

Aims:

1. Accurately assess the frequency of use of peas by breeding Lapwings.
2. Assess crop usage by breeding Lapwings and whether they use peas solely to locate nests or whether chicks are also able to forage there before fledging.
3. Identify the important period of use of peas by Lapwings and relate this to the management activities that potentially compromise breeding success.
4. Assess the use of sprayed and unsprayed sections of pea crops by all birds including Lapwing adults and chicks.

Protocol:

1. In early April or late March it will be necessary to find as many "breeding" Lapwings as possible. This is essential in order to obtain a sample of birds for study, and will rely on help from as many farmers a possible. If they can report potentially breeding pairs on fields allocated for pea crops (and maybe also nearby set-aside or cereals) then the sites and pairs can be visited for observational suitability.

2. Once located, each Lapwing pair will be visited repeatedly between April and June for two-hour observation periods, during which foraging activities and time budgets will be recorded. Time budgets will include activities such as display or courtship that indicate breeding intentions, and mobbing behaviour that indicate defence of a nest territory. Assessments will also be made of the proportion of the time spent foraging within the pea crop itself relative to nearby habitats or crops. Foraging behaviour will also be collected from chicks as and when they hatch.