British Trust for Ornithology

BTO Research Report No. 149

149

The ecology of seed-eating birds in relation to agricultural practices: current research and future directions

**Abstracts from a one day workshop held at The Nunnery, Thetford, Norfolk
8th September 1994**

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February 1995

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THE ECOLOGY OF SEED-EATING BIRDS IN RELATION TO AGRICULTURAL PRACTICES: CURRENT RESEARCH AND FUTURE DIRECTIONS

Published in February 1995 by the British Trust for Ornithology
The Nunnery, Thetford, Norfolk IP24 2PU, U.K.

ISBN 0 903793 51 2

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ACKNOWLEDGEMENTS

The work described in this report was funded by the following organisations:

H.Q.P. Crick, P.F. Donald & R.J. Fuller: Joint Nature Conservation Committee (on behalf of English Nature, Scottish Natural Heritage, the Countryside Council for Wales and DoE Northern Ireland).

S. Gates, R.A. Robinson, W.J. Sutherland & J.D. Wilson: Biotechnology and Biological Sciences Research Council.

A.D. Evans: Royal Society for the Protection of Birds.

N.J. Aebischer & N.W. Sotherton: The Game Conservancy Trust.

A.J. Burn & A.S. Cooke: English Nature.

J. Evans: Ministry of Agriculture, Fisheries & Food and the World Wide Fund for Nature UK.

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Those marked with an asterisk co-authored material presented at the workshop, but were unable to be present on the day.

2. INTRODUCTION

In recent years it has become apparent that populations of several farmland bird species are in steep decline in Britain. A higher proportion of farmland species is undergoing decline and range contraction than is the case for any other habitat. For several species these declines appeared to start in the mid-1970s which was a period when British agriculture was undergoing marked intensification (Fuller *et al.* in press). However, longer-term declines have been occurring in some species, notably Grey Partridge (Potts 1986). Whilst agricultural changes may not be the only relevant factors, it is highly probable that most of these population changes are driven by, or at least exacerbated by, the intensification of farming. Seed-eating species in particular have undergone large decreases in numbers. According to data collected by the British Trust for Ornithology through its Common Birds Census seven species have declined on lowland farmland by more than 50% over the period 1969-1991: Tree Sparrow, Corn Bunting, Grey Partridge, Turtle Dove, Reed Bunting, Linnet and Skylark. Each of these eats seeds as a substantial part of its diet, although most also eat insects, especially in the breeding season when insects are a critical part of the diet of the chicks of many farmland birds.

Several research projects are currently addressing various aspects of the declining farmland birds issue but these projects are largely operating in an independent manner. There is considerable scope for a more co-ordinated approach to the problem and it was against this background that a one day workshop was organised at the BTO Headquarters in Thetford in September 1994. The specific aims of the workshop were:

(1) To exchange information about current work.
(2) To identify areas of actual or potential overlap between projects.
(3) To assess the extent of current knowledge and priorities for future research.
(4) To identify areas for potential future collaboration.

This report presents abstracts of the papers presented and a summary of the main points that emerged from the general discussion.

References

Fuller, R.J., Gregory, R.D., Gibbons, D.W., Marchant, J.H., Wilson, J.D., Baillie, S.R. & Carter, N. (in press). Population declines and range contractions among lowland farmland birds in Britain. *Conservation Biology*.

Potts, G.R. (1986). *The Partridge: Pesticides, Predation and Conservation*. Collins, London.

3. ABSTRACTS

3.1 The role of long-term datasets

Humphrey Q.P. Crick, British Trust for Ornithology, The Nunnery, Thetford, Norfolk IP24 2PU.

Long-term datasets have a big role in (a) identifying trends in population size of granivorous passerines in farmland, (b) providing information on changes in demographic variables over time, and (c) allowing the analysis of associated changes in environmental factors that might have affected the populations. Long-term datasets of bird populations are of two main sorts: (a) extensive datasets, gathered by volunteers under direction by population biologists and (b) intensive local studies by research scientists. Extensive datasets are important in determining whether population declines have occurred, how unusual is a decline and how important is a decline; the generality of such results have significance to conservationists and policy makers. Intensive local studies provide detailed information that allows the understanding of factors affecting individual birds and are important for interpretation of extensive data but, on their own, are unlikely to have major political impact.

It is important not only to have data on changes in population size but also on changes in survival and productivity to allow the cause of a decline to be pinpointed to a particular stage. For long-lived species, changes in demographic variables may be the first indication of decline. Although it would be most desirable to have data on food resources, such data are not available and environmental correlates have to be used as substitutes; analyses at regional scales allow comparisons of the effects of such environmental factors. Having identified problems from general monitoring programmes, the need for more specific extensive surveys may arise (e.g. BTO Corn Bunting surveys). Other species that might need such surveys are Linnet, Skylark, Tree Sparrow and Grey Partridge. The resulting data may pose questions that need to be answered by intensive work or further extensive data gathering.

The BTO's Integrated Population Monitoring programme gathers data on population changes, survival and productivity. Analyses of Common Birds Census data by Marchant & Gregory (in press) have shown significant changes in population size for most seed-eating birds (Table 3.1.1). Four declining species are not typical inhabitants of arable farms (Redpoll, Bullfinch, House Sparrow, Reed Bunting). Regional analysis shows that declines are most pronounced in the midlands and northern England and Wales and least evident in southwest England. Trends also differed between plots divided into grass, mixed and arable farm types. Declines in arable plots were strongest for most species, but not for Tree Sparrow (mixed & grass) or Yellowhammer (grass). The factors affecting the granivorous species evidently differ and suggest that underlying causes may be complex.

Survival analyses have not yet been undertaken but annual monitoring by the BTO's Nest Record Scheme has resulted in alerts being issued to JNCC because of significant long-term declines in nest survival for Linnet and Reed Bunting (Fig. 3.1.1). In a number of species, nest success and clutch size is improving, probably due to recovery after the effects of organochlorine pesticides in the 1950s and 1960s. A study of causes of nest losses among buntings has shown that while Yellowhammer and Reed Bunting have shown no changes in the relative importance of predation, agricultural and natural losses, losses due to agricultural processes have increased for Corn Bunting from 7% before 1970 to 21% after 1970 (Crick *et al.* 1994).

References

Crick, H.Q.P., Dudley, C., Evans, A.D. & Smith, K.W. (1994). Causes of nest failure among buntings in the UK. *Bird Study* 41: 88-94.

Marchant, J.H. & Gregory, R.D. (in press). Recent population changes among seed-eating passerines in the United Kingdom. *Proceedings of the 12th International Conference of IBCC and EOAC*. The Netherlands.

SPECIES	ANNUAL RATE OF CHANGE	SIGNI-FICANT	REGIONAL TRENDS	HABITAT TRENDS
Redpoll	−5.3%	Yes		
Tree Sparrow	−5.1%	Yes	SW>(SE=NW)>NE	M>G>A
Corn Bunting	−3.8%	Yes		
Bullfinch	−2.9%	Yes	NW>SE>NE>SW	G>M>A
Skylark	−2.5%	Yes	NE>(NW=SE)>SW	A>M>G
Linnet	−1.6%	Yes	NE>(NW & SE)	A>M
House Sparrow	−1.6%	Yes		
Reed Bunting	−1.5%	Yes	NE>SE	A>M(−ve) G(+ve)
Yellowhammer	−0.4%	No	NW	G
Goldfinch	−0.4%	No	NE	A(−ve) G(+ve)
Greenfinch	0.0%	No	NE(−ve) SE & SW (+ve)	None
Chaffinch	+0.7%	Yes	NE>SE>NW	A>M

Table 3.1.1 Annual rates of change for granivorous passerines, measured from Common Bird Census data gathered from 1977-1991 (from Marchant & Gregory, in press). Regional and habitat trends show significant results and indicates the relative magnitude of the regression slopes (N.B. north includes the midlands & Wales); A=arable, M=mixed, G=grass; no results are provided for species providing insufficient data.

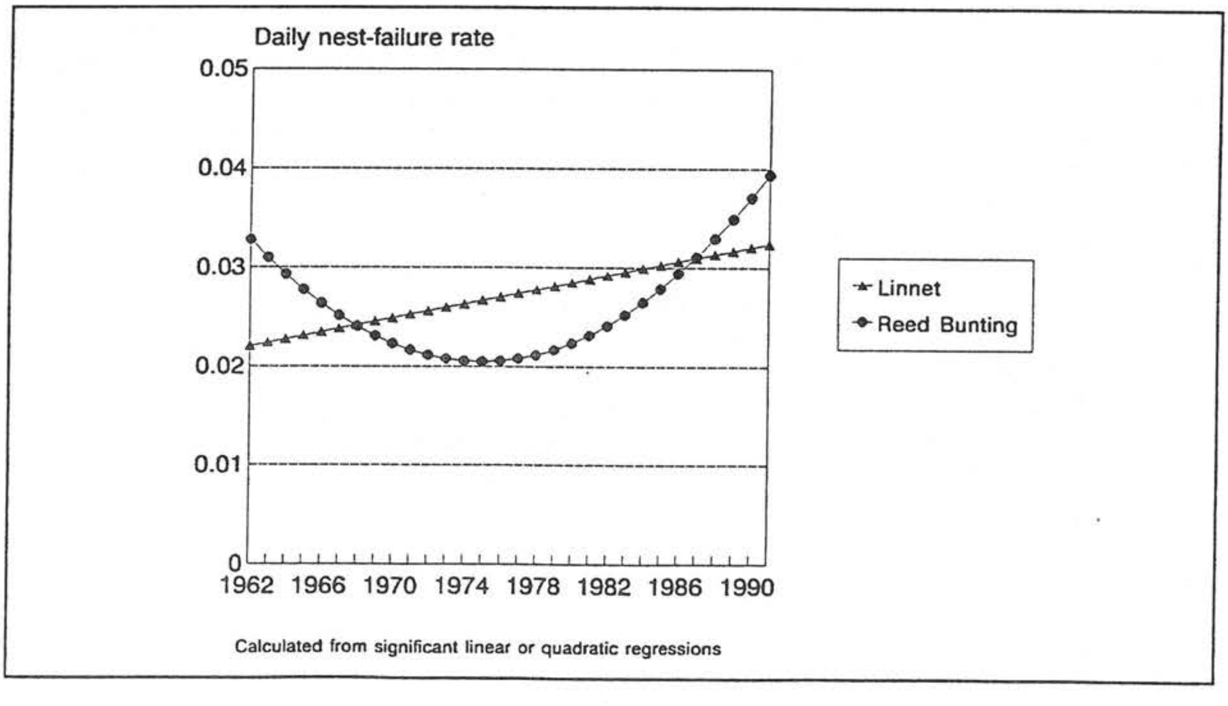

Figure 3.1.1 Long-term trends in nest failure rates measured from egg-laying to fledging.

3.2 Corn Bunting population declines and agricultural change

Paul F. Donald, British Trust for Ornithology, The Nunnery, Thetford, Norfolk IP24 2PU.

Severe declines in the British Corn Bunting population since the mid-1970s are temporally correlated with a number of changes in agricultural practice. The current British population has been calculated at around 20,000 territories. The agricultural changes most likely to be responsible for the observed declines are the switch from spring to autumn sowing of cereals, increased use of pesticides, changes in grassland management, increased regional specialisation resulting in the loss of traditional rotations and improved harvesting and storage efficiency. However no single possible cause of the declines has been proved to be uniquely or even partly responsible despite considerable work on the species at a number of spatial scales. The species appears to be enigmatic in terms of its habitat selection and population changes on individual farms correlate poorly with agricultural changes. However declines have been greatest (at least in terms of range) in areas of higher altitude holding less arable land and more farmland grass, although whether altitude or land-use type is more important is not clear. Areas abandoned by Corn Buntings between the two Atlases of Breeding Birds were less suitable areas than those where birds were retained (i.e. they were more similar to areas which were not occupied in either Atlas). Corn Bunting productivity has not apparently declined, suggesting that adult (winter?) mortality might be the critical factor. The hypothesis that populations have declined because of declines in winter food supplies is perhaps the most convincing at present. A national survey (Donald & Evans 1994) showed that stubbles, particularly those rich in weeds, are the most important habitat for wintering Corn Buntings (Fig. 3.2.1). As winter stubble area is largely dependent upon the area of spring-sown cereals, the loss of these to winter sown varieties may be an important factor in the decline. There is a very strong positive correlation between the Corn Bunting CBC index and the area of spring cereals planted in the previous year (Fig. 3.2.2). The introduction of rotational set-aside gives an opportunity to assess the hypothesis that a reduction in winter food supplies has been responsible for the decline. If the loss of winter stubbles has been a major factor in the decline of this species, the introduction of rotational set-aside might be expected to reverse recent population declines. Anecdotal evidence suggests that this may indeed be happening.

Studies into the decline of this species are hampered by small numbers of Nest Record Cards and ringing recoveries and poor knowledge of diet, movements and of population dynamics. National surveys and the analysis of existing long-term data sets have produced much information about the species in Britain (numbers, habitat selection, distribution, population trends etc.) and have allowed us to formulate and, in some cases, test hypotheses. Some hypotheses remain untested by these approaches and future research needs to be designed with specific hypothesis testing in mind.

References

Donald, P.F. & Evans, A.D. (1994). Habitat selection by Corn Buntings *Miliaria calandra* in winter. *Bird Study* 41: 199-210.

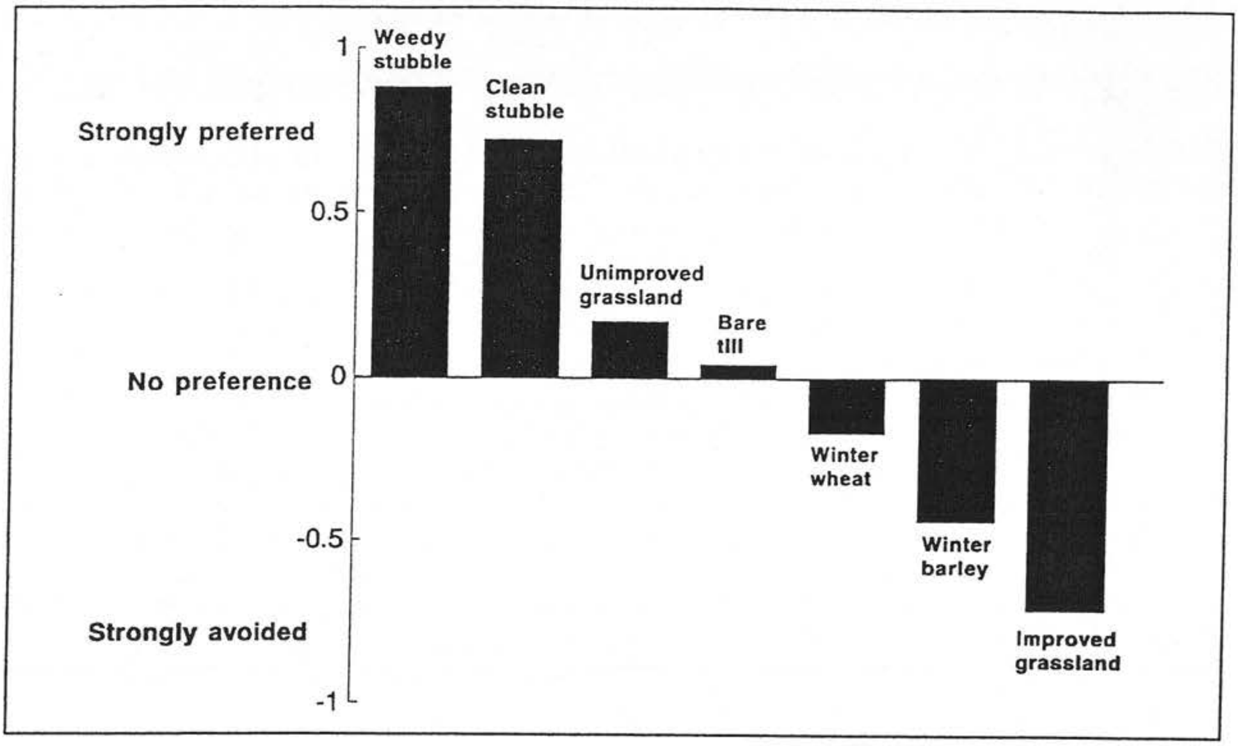

Figure 3.2.1 Jacobs Preference Indices for six major farmland types in winter. The index ranges from +1, indicating exclusive usage, to −1, indicating complete avoidance. Data are based upon the results from randomly-selected tetrads.

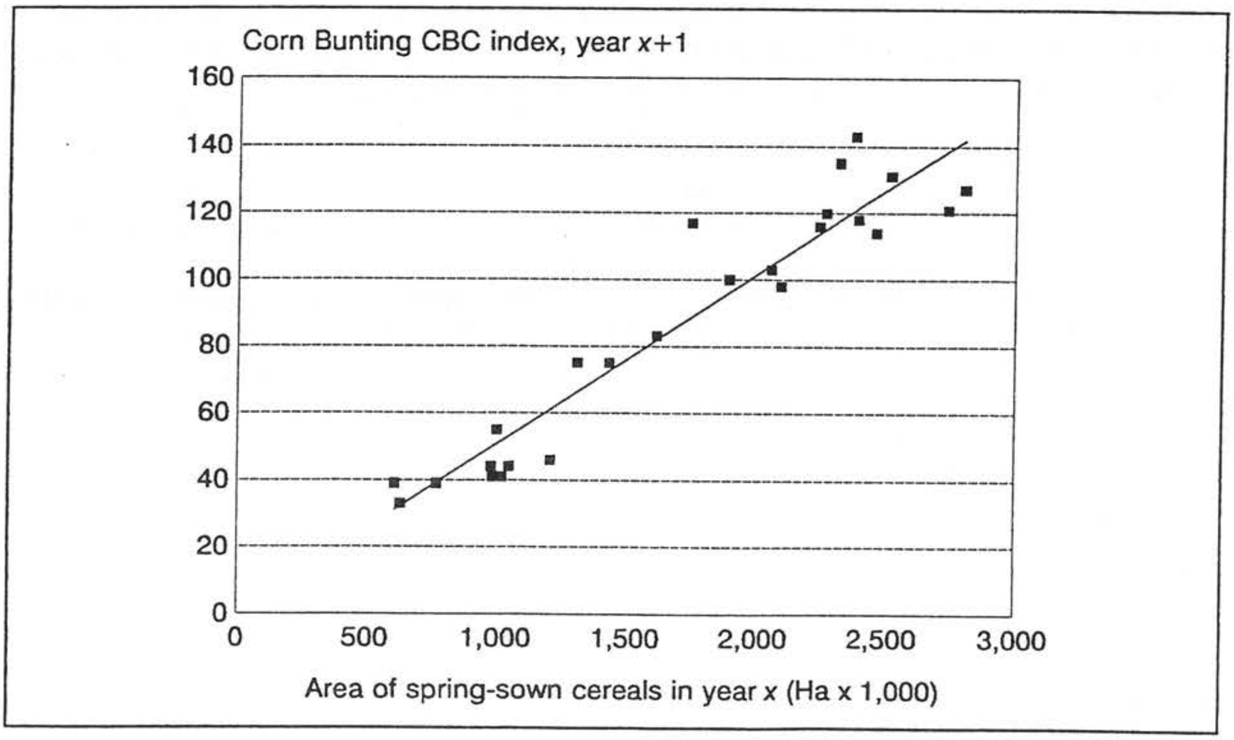

Figure 3.2.2 Correlation between the area of spring-sown cereals in year x and the Corn Bunting CBC index for year $x+1$. The correlation is highly significant ($r_s = 0.90$, df = 29, $P<0.0001$). Both spring cereal area and CBC index are significantly correlated with year. However partial correlation of spring-sown cereal area with CBC index, which takes account of the correlation of each with year also yielded a significant correlation ($r_{xy.year} = 0.62$, df = 28, $P<0.05$).

3.3 Set-aside: can birds benefit? Results of an RSPB pilot study

Andy D. Evans, Royal Society for the Protection of Birds, The Lodge, Sandy, Bedfordshire SG19 2DL.

Background

Detailed ecological studies by the RSPB indicate that loss of over-winter stubbles as a food source probably contributed to the collapse of the British Cirl Bunting *Emberiza cirlus* population. Corn buntings *Miliaria calandra* are in rapid decline and also show a marked preference for weedy stubbles in the winter. It is possible that loss of winter stubble fields through changing farming practice has been detrimental to many of the species of farmland seed-eating passerines which are currently in decline. Set-aside fields with a regenerated cover are, in effect, weedy stubbles and might provide a food source for wintering birds. A pilot study was carried out in the winter of 1992/93 to determine to what extent birds used set-aside fields in south Devon.

Methods

Fifteen set-aside fields were selected for study and each was paired with a nearby (within 1 km) winter cereal field. Each pair was matched as closely as possible for area, shape, boundary type and size, soil type, altitude and aspect. All birds on each of the 15 pairs were counted between five and eight times through the winter (October - March). Both fields of a pair were counted on the same day and the order in which they were counted randomised. Counts were by 'complete area search'. This involved flushing every bird by walking transects 'tractor' fashion to within 50 m of each point on the field. All weeds along a 10 m transect were identified and total coverage (in cm along the transect) measured. Volunteer cereals were excluded from this procedure.

Results

The total number of birds counted on set-aside fields was up to 15 times greater than that on winter cereal fields and the number of species was twice as high. Peak numbers of seed-eaters (finches, buntings and pigeons) were far higher on the set-aside fields (Fig. 3.3.1). Thirteen species were found significantly more often and/or in significantly greater numbers on set-aside than on winter cereal (Table 3.3.1). The number of seed-eaters using a given field tended to increase with weed cover (Spearman rank correlation, $r = 0.502$, $n = 30$, $p < 0.02$).

Conclusions

Set-aside is used to a large extent by wintering birds and seed-eaters, in particular, appear to prefer it to winter cereal. Note that the vast majority of set-aside fields would have been winter cereal fields but for CAP reform. The RSPB are currently conducting a much larger scale project involving 40 farms; 20 in Devon and 20 in East Anglia to see if the same benefits are afforded by set-aside in very different farming systems.

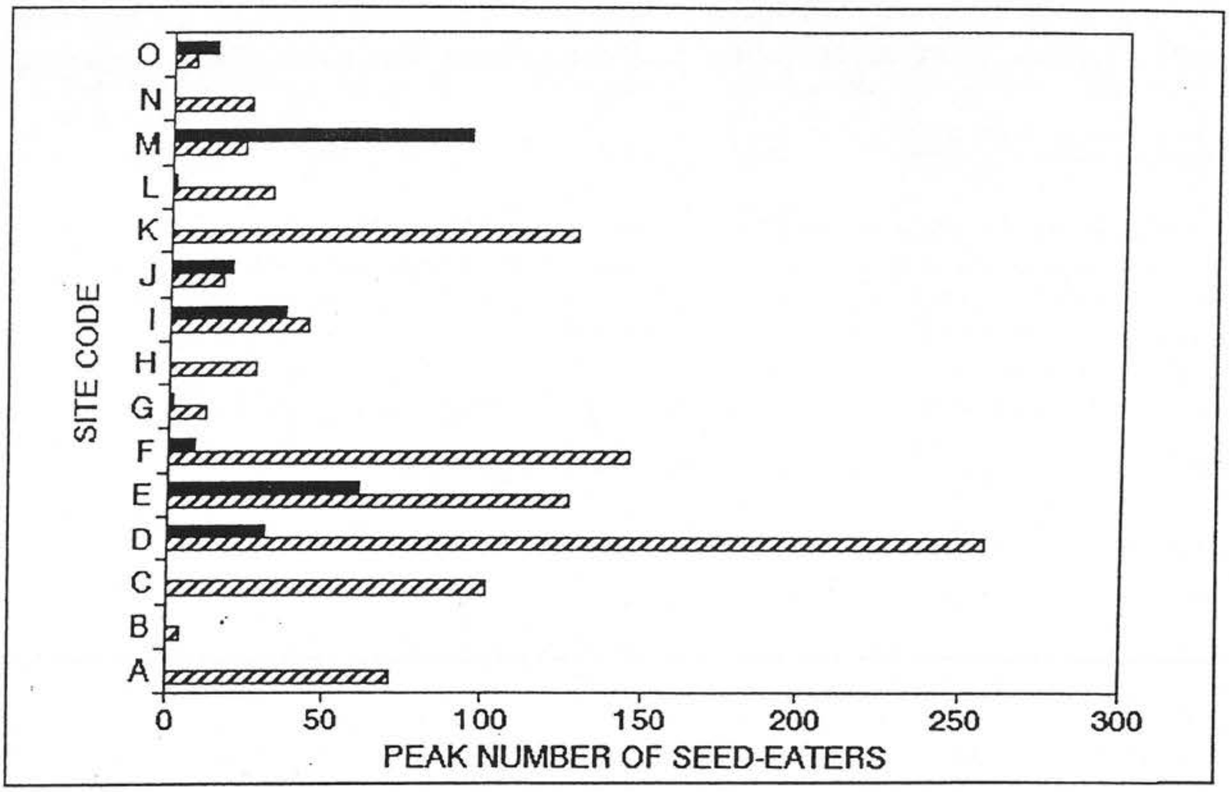

Figure 3.3.1 Peak number of seed-eating birds (finches, buntings & pigeons) across all counts for each pair of fields. Set-aside = dashed bars, winter cereal = solid bars. Wilcoxon Matched Pairs Test, z = 2.582, p = 0.011*

Species	Found more often	Greater numbers
Sparrowhawk	*	*
Pheasant		*
Snipe	*	*
Wood Pigeon	*	*
Carrion Crow	*	*
Blue Tit		*
Skylark	*	*
Meadow Pipit	*	*
Redwing	*	*
Linnet	*	*
Yellowhammer	*	*
Cirl Bunting	*	*
Reed Bunting	*	*

Table 3.3.1 Species which were found significantly more often or in significantly greater numbers on rotational set-aside than cereals in winter (Wilcoxon Matched Pairs Test). Species in italics are on the revised Red Data List.

3.4 Long-term and large scale dynamics of granivorous passerine birds

Simon Gates, Dept. of Zoology, Oxford University, and British Trust for Ornithology.

The proximate factors responsible for the population and distributional changes of granivorous passerine birds in farmland can only be elucidated by detailed ecological work in the field. However, such studies, by their nature, are restricted to short timescales and small geographical areas. By using existing data sets, such as those held by the BTO, covering the whole of Britain and extending back to the early 1960s, hypotheses can be formulated about the causes of population and distributional changes, which can be tested in the field, and lead to an understanding of the relationship between population and geographical changes.

CBC data have been used to identify when declines of various species happened, using a randomisation technique; we asked how likely was a decline as large as that observed to occur if the existing year to year changes had occurred in a random order. This gave a probability for obtaining a separate period of decline as large as that observed in the run of CBC indices. Differences in survival or reproductive success are now being examined between these periods and the preceding periods of stability, using data from the BTO Ringing and Nest Record schemes.

The structure of the population of each species provides the link between population changes and changes in distribution. Metapopulation theory has been developed to describe the dynamics of spatially structured populations (e.g. Hanski & Gilpin 1991), and such models may be applicable to distributions over large areas. Across a species' distribution, the expectation is for there to be geographical variation in the productivity of sites; the most favourable sites, where productivity is highest, should be found near the centre of a species' range, with those at the edge being less productive (Brown 1984). The periphery of the range may form a sink, which persists only because of immigration from more productive areas (Lawton *et al.* 1994). I suggest that these ideas may be important for conservation of farmland birds, for three reasons. First, they provide a way of making testable predictions about the patterns and population trends that would be expected. Second, source populations are the key to successful conservation; there is no point in trying to conserve a species in sink habitat alone (Newton 1991). Third, the fate of local populations may be connected more with environmental changes in other habitats or locations than with local changes.

It has not yet been determined whether these processes operate for any species, but there are several suggestions that they might apply to farmland birds:

1. The BTO *New Atlas of Breeding Birds* has revealed that there is great variation in abundance throughout the ranges even of common birds.
2. Population trends differ between different areas and habitats (Marchant & Gregory 1994; Marchant *et al.* 1990).
3. Birds are very mobile and are capable of dispersing over large distances.
4. Simple environmental changes have not yet been shown to correlate well with distributional changes (Gibbons & Gates in press).

References

Brown, J.H. (1984). On the relationship between abundance and distribution of species. *American Naturalist* 124: 255-279.

Gibbons, D.W. & Gates, S. (in press). Hypothesis testing with ornithological atlas data: two case studies. *Proceedings of the 12th International Conference of IBCC and EOAC.* The Netherlands.

Hanski, I.K. & Gilpin, M. (1991). Metapopulation dynamics: brief history and conceptual domain. *Biological Journal of the Linnean Society* 42: 3-16.

Lawton. J.H., Nee, S., Letcher, A.J. & Harvey, P.H. (1994). Animal distributions: patterns and processes. In: *Large Scale Ecology and Conservation Biology* (35th Symposium of the British Ecological Society), eds P.J. Edwards, R.M. May and N.R. Webb.

Marchant, J.H. & Gregory, R.D. (in press). Recent population changes among seed-eating passerines in the United Kingdom. *Proceedings of the 12th International Conference of IBCC and EOAC*. The Netherlands.

Marchant, J.H., Hudson, R., Carter, S.P. & Whittington, P. (1990). *Population Trends in British Breeding Birds*. British Trust for Ornithology, Tring.

Newton, I. (1991). Habitat variation and population regulation of sparrowhawks. *Ibis* 133(suppl.1): 76-88.

3.5 Long-term trends in food-resource availability in Sussex

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In 1968, Dick Potts started the Partridge Survival Project on a 62-km^2 area of the South Downs in Sussex. The aim was to investigate the causes of the decline of the Grey Partridge *Perdix perdix* which even then was giving cause for concern. It rapidly became apparent that chick survival was closely linked to the availability of invertebrate food in cereal crops. The preferred prey items were caterpillars (sawfly and Lepidoptera), ground and leaf beetles, weevils, plant bugs and leaf hoppers. As a result, from 1970 onwards, around 100 cereal fields within the Sussex study area have been sampled annually for invertebrates by D-vac in the third week of June (the week of peak partridge hatch). At the same time, crop type, weed species and disease levels were recorded. The observed changes in cropping pattern, namely the widespread abandonment of mixed farming and a shift from spring to autumn crops, mirror nationwide trends and suggest that the study area is typical of much of southern Britain.

From 1970 to 1989, the total number of invertebrates sampled in Sussex approximately halved. Bearing in mind that the Sussex study began well after the introduction of herbicides in the late 1950s, which was thought to have already reduced invertebrate numbers by half, this implies a 75% drop in cereal invertebrates over the last 40 years. The groups most affected were the aphids and their predators, the sawflies and various small beetles (Table 3.5.1).

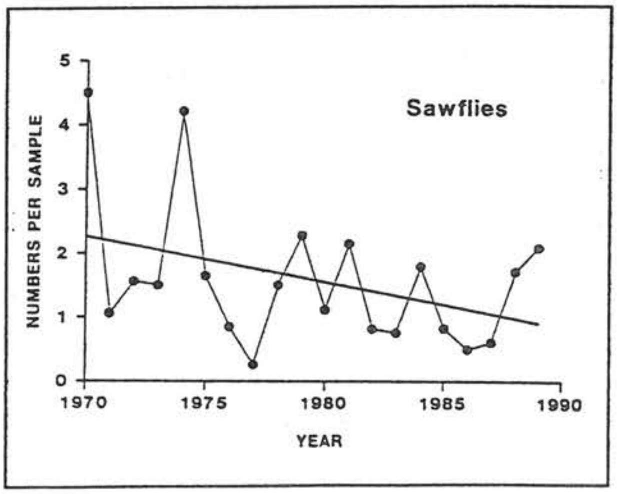
Numbers of sawflies, one of the preferred chick-food items, had dropped by half on average since 1970 (Fig. 3.5.1). Time-series modelling found that their density was related, with a one-year lag, to the proportion of cereal fields that were undersown and to summer weather. In 1989, when 7 km^2 were treated with a broad-spectrum summer insecticide, sawfly density was under a tenth of that predicted by the model in the treated area, but within the predicted range outside it. The model forecast that recovery on the treated area would take about four years.

Aphid predators are insects of agricultural interest, and many of them have declined (Table 3.5.1). The abundance of Staphylinidae, and of the genus *Tachyporus* especially, has dropped by over 80% in 20 years. The rate of decline is similar across age groups, across species and across farms. *Tachyporus* are fungus feeders as well as being polyphagous predators. The use of foliar fungicides in the Sussex study area has risen from no crops treated in 1970 to nearly 100% treatment by 1990, while the levels of mildew and rusts in the crops have collapsed. The connection may be coincidental, but two other groups of mycophagous beetles, the Cryptophagidae and Lathridiidae, have also shown sharp declines in abundance since 1970.

Such changes relate not just to Grey Partridges, but to all declining farmland birds whose young require insect food. Judicious use of Conservation Headlands, Beetle Banks and set-aside provides ways of restoring this food resource and of helping the birds that depend on it.

Taxon	% in samples (by number)	Trend	Annual rate of change (%)
Total	**100.0**	**Down**	**−5.3**
Aphididae	**37.2**	**Down**	**−8.4**
Parasitoid wasps	**15.0**	**Down**	**−4.7**
Aphid-specific predators	**0.5**	**None**	**-**
Coccinellidae	0.3	None	-
Others	0.2	None	-
Polyphagous predators	**13.6**	**Down**	**−3.8**
Carabidae	0.5	None	-
Staphylinidae	6.5	Down	−7.7
Arachnida	3.0	Down	−4.1
Predatory Diptera	3.6	None	-
Others	<0.1	None	-
Chick-food items	**3.0**	**None**	**-**
Symphyta, Lepidoptera	0.5	Down	−4.5
Hemiptera (not aphids)	2.2	None	-
Chrysomelidae, Curculionidae	0.3	None	-
Miscellaneous	**21.1**	**Down**	**−6.9**
Cryptophagidae	4.9	Down	−6.7
Lathridiidae	2.4	Down	−12.7
Cecidomyiidae	8.2	None	-
Lonchopteridae	2.4	Down	−5.4
Drosophilidae	3.2	None	-

Table 3.5.1 Summary of long-term trends among a range of invertebrate taxa sampled in Sussex cereal fields over the 20 years 1970-1989. The miscellaneous category represents taxa that do not belong to other categories but are numerically important in the samples.



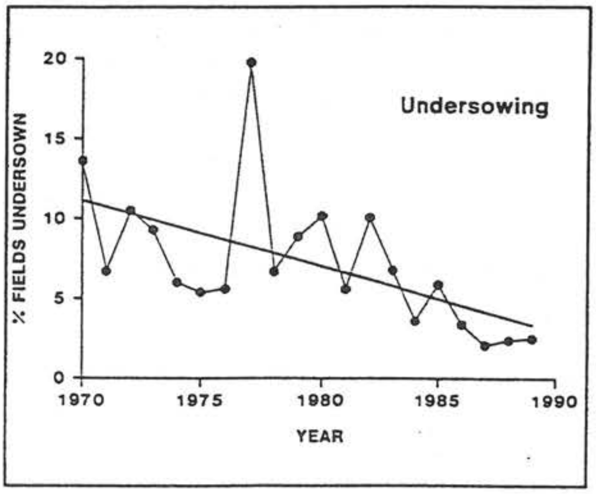


Figure 3.5.1 Average annual density of sawflies (Symphyta: Hymenoptera) per sample on the Sussex study area from 1970 to 1989 (left), and annual proportion of fields that were undersown during the same period (right).

3.6 The role of pesticides in declines of seed-eating passerines

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Pesticides have been widely quoted as contributing towards the observed declines in seed-eating birds of farmland (Marchant *et al.* 1990), and indirect effects of pesticides, operating chiefly via declines in food availability, are often thought to be a contributory mechanism. In fact, much of the evidence is circumstantial, with studies on the Grey Partridge providing the most well-founded example of the adverse indirect effects of herbicides and insecticides contributing significantly to reduced survival, and hence population declines, in farmland birds. In that example, although increased pesticide use is only one of three factors which have led to a decline (the others being increased predation and shortage of nesting cover) manipulating that factor alone has led to significantly improved survival of young birds, most notably where pesticide use has been restricted in 'conservation headlands'.

Whatever factors may have led to declines in other farmland birds, therefore, manipulation of pesticide uses alone or as part of wider changes to farming practice could be a powerful means of reversing trends. Moreover, through mechanisms for pesticides, the means already exist through which necessary changes might be implemented, if those mechanisms are correctly targeted.

The 'pesticide specialists' at English Nature are interested in establishing whether pesticide use has in fact contributed to the decline of these species and, if so, in promoting mechanisms to help reverse those declines. It is important that research effort should be well-directed and although we have contributed to support for the work by The Game Conservancy Trust on the Corn Bunting in 1994 that species was selected for opportunistic reasons rather than because there is particular evidence that pesticides have played a role in the recent population decline in that species.

For these reasons, we welcome the opportunity at the 'seed-eating farmland birds' research workshop, on discussing the effects of pesticides on these species, in order to help prioritise our own work. Below are listed examples of a range of issues relating to the impact of pesticides which we believe should be considered:

i. Which of the seed-eating species should be priorities for our studies in relation to indirect effects of pesticides?

   - What is the basis for supposing a pesticide effect on such species? Are there likely known <u>mechanisms</u> for an effect?

   - What is the available information for such species? How extensive is <u>evidence</u> for an effect?

ii. What additional background work might be necessary in order to determine which species should be the subject of further studies.

   - Is the species 'typical', or in other ways likely to be particularly influential to policy makers?

   - Is there any more recent evidence emerging from surveys on 'less-intensive' production systems, including ESAs, set-aside, conservation headlands etc?

   - Is there evidence for declines abroad, and what does this add to our knowledge about possible mechanisms?

iii. How might work planned, or in train, on the impact of other farming activities on selected species, contribute to an understanding of possible pesticide effects, or be adapted to deliver relevant information?

- Is autecological information needed for most of these species? For which ones are such studies being undertaken or planned?

- Are population models being developed/have been developed for any of these species?

- Is further analysis planned of existing information (breeding success, range or distribution changes)?

- Are more detailed monitoring or large-scale manipulative studies planned or in progress (c.f. the BTO's Organic Farming and Birds project)?

References

Marchant, J.H., Hudson, R., Carter, S.P. & Whittington, P. (1990). *Population Trends in British Breeding Birds*. British Trust for Ornithology, Tring.

3.7 The ecology of Skylarks *Alauda arvensis* on lowland farmland

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The Skylark is one of Britain's most abundant breeding birds; the *New Atlas of Breeding Birds* estimates 2 million breeding pairs, with 1.35 million of these on farmland. Farmland Common Birds Census (CBC) data, however, reveal a 54% decline between 1968 and 1991 which implies that British farmland lost approximately 1.6 million breeding pairs of Skylarks in this time. In terms of absolute numbers, this decline is far greater than that of any other British breeding bird over the same period.

This study aimed i) to quantify variation in population density and breeding success of Skylarks across crop types and between organically and conventionally managed farms on study areas totalling over 1,000 ha in Suffolk and Oxfordshire during the 1993 and 1994 breeding seasons, and ii) to extrapolate these data to the national scale using land-use statistics and literature estimates of annual survival rates of adult and first-year Skylarks, to investigate whether the population trend recorded by the CBC can be explained by agricultural land-use change.

On all study areas, occupied breeding territories were mapped weekly from mid-March to mid-July. All nests reaching the nestling stage were found, and the number of chicks fledging from those nests recorded. The following results pertain to territory density and fledging success from different land-use types. Concurrent studies of nestling condition, diet and parental provisioning behaviour are not considered here.

Territory densities were consistently lower on conventionally managed cereals than on organic cereals. Many territories on conventional winter cereals were abandoned without successful breeding, but it remains uncertain whether low food abundance or the rapid growth rate and eventually prohibitive height and density of the crop was the main cause of these abandonments. Of conventional cereals, only spring-sown barley supported a fledging success likely to balance subsequent mortality losses, whereas several organic cereal types were net 'exporters' of Skylarks. Of other arable crops, only sugar beet supported any successfully breeding Skylarks. Set-aside, whether grass-sown and managed by cutting, or with a naturally regenerated green cover managed by herbicide-spraying, and silage fields, supported high densities of Skylarks which had high fledging success. On individual silage fields, however, breeding success depended critically upon the timing of cutting relative to the stage of the nesting cycle of the breeding pairs. See Table 3.7.1 for a summary of these results.

When these data are extrapolated to the national scale, using land-use data for 1978, 1984 and 1990 from the *Countryside Survey 1990*, the predicted population density on farmland is lower than that estimated by the *New Atlas* for all three years, but the predicted annual percentage population changes match well those estimated from CBC data (Fig. 3.7.1). The predicted effect on rate of population change in the unlikely event that all British cereal management became organic is also illustrated. Although it represents an unrealistic scenario, the potential of extensification of cereal husbandry to improve breeding conditions for Skylarks in cereal-growing areas is apparent. By 1990, our extrapolation predicts that set-aside and other fallow land may have hosted 34.7% of Skylarks fledged from British farmland, despite representing only 5.5% of the land cover. In contrast, winter cereals occupied 25.6% of the agricultural land cover but supported only 6.5% of the fledged Skylarks.

Conclusions

1. The decline of farmland breeding Skylarks in Britain may be explained largely by changes in cropping - notably the loss of crop types favoured for nesting (e.g. spring-sown cereals and young leys), and the intensification of cereal husbandry.

2. Set-aside is now a very important breeding habitat for Skylarks. Management of set-aside and rotational ley grassland that is sensitive to the needs of ground-nesting birds is essential to prevent acceleration of the present decline.

3. Extensification of cereal agriculture has great potential to reverse the population decline. A revival of spring-sowing and ley-based crop rotation would be beneficial. Experimental work is needed to assess the relative merits of reducing pesticide/fertilizer inputs, and reducing the density and growth rate of winter cereal crops as ways of improving conditions for breeding Skylarks.

Acknowledgements

Our thanks to Jon King and Stephen Browne whose fieldwork contributions were essential to the success of the study. This work was funded by the Ministry of Agriculture, Fisheries & Food, the World Wide Fund for Nature UK and the Biotechnology and Biological Sciences Research Council.

Crop Type	Territories/ha	Fledged young/pair
Organic Winter Wheat	0.25	**1.30**
Organic Winter Oats	0.22	0.43
Organic Spring Wheat	0.24	**1.68**
Organic Spring Barley	0.63	**2.04**
Organic Spring Oats	0.73	0.84
Conventional Winter Wheat	0.05	0.26
Conventional Winter Barley	0.10	0.29
Conventional Winter Oats	0.25	0.65
Conventional Spring Barley	0.05	**1.39**
Silage	0.22	**1.52**
Grazed Pasture	0.01	0
Grass Set-aside (cut)	0.33	**1.25**
Nat. regen. Set-aside (sprayed)	0.36	**1.67**
Sugar Beet	0.12	**1.19**
Peas/Beans	0.10	0
Oilseed Rape	0.05	0
Linseed	0.10	0
Maize	0.07	0

Table 3.7.1 Mean territory density and fledging success of Skylarks breeding on various agricultural land-use types. Values in bold indicate fledging rates high enough to replace likely annual mortality losses (see Delius, J.D. 1965. *Ibis* 107: 466-492 for the only published data on annual adult and first-year mortality rates).

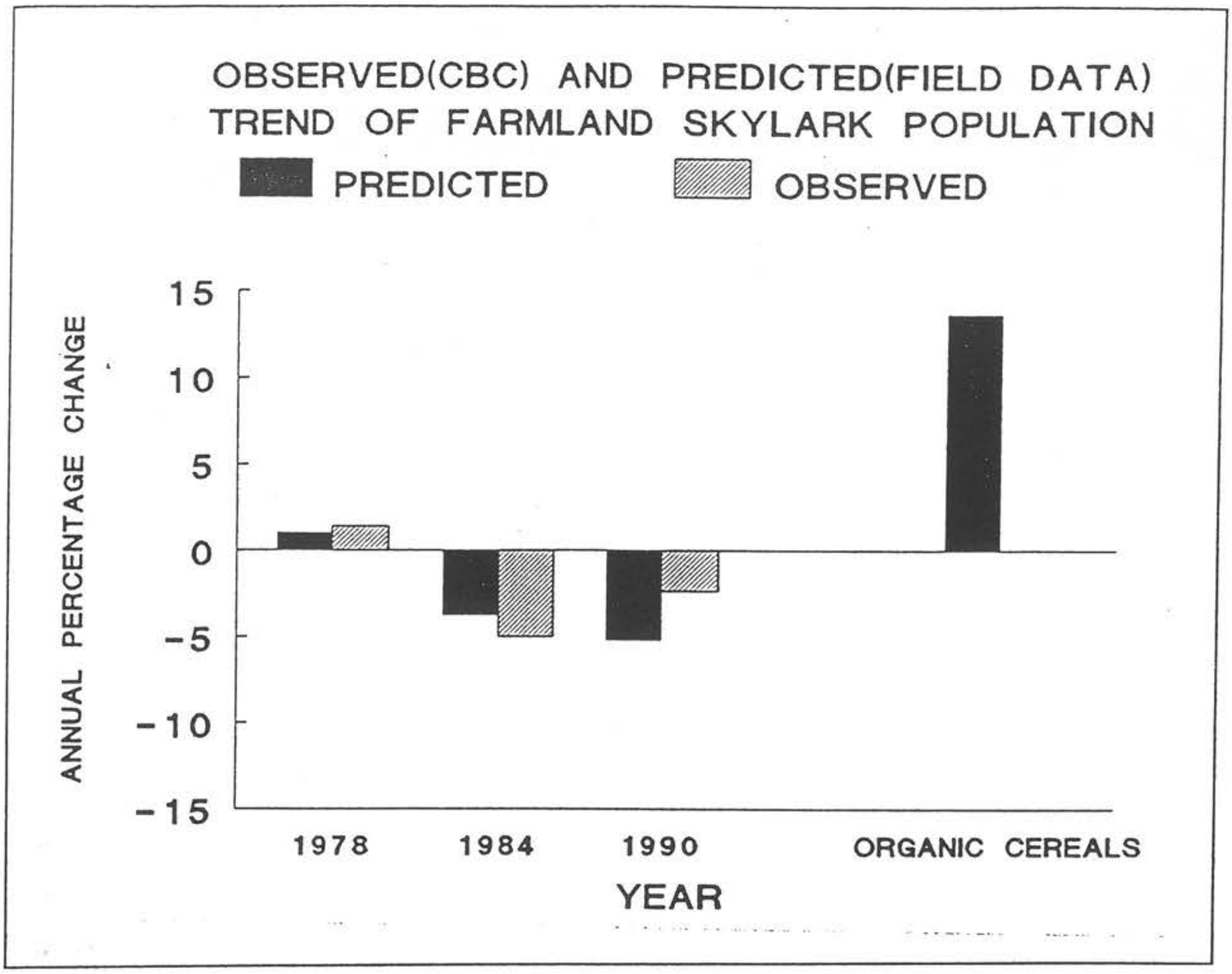

Figure 3.7.1 Annual percentage changes in the British farmland Skylark population at three time points predicted by extrapolation of field data to the national scale (see text), and observed from CBC data. The latter set of changes were estimated from the slope of a linear, least-squares regression fit through the series of seven CBC Mountford index values centred on the focal year. The figure also shows the outcome of the extrapolation technique when it is used to predict rate of population change under a scenario in which all current cereal acreage was managed organically.

3.8 The winter feeding ecology of farmland passerines

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Populations of many of Britain's farmland birds have declined, some by as much as 75%, over the last 15 years. Most studies of the ecology of these species have concentrated on the breeding season (e.g. Wilson & Evans (this volume), Green 1978) mainly for practical reasons. However, the non-breeding period is arguably as important for these birds, especially with recent changes in agricultural practices (O'Connor & Shrubb 1986). This research aims to look at the behavioural patterns of foraging ecology of seed-eating passerines and to integrate this with theoretical work on habitat use. In this paper we outline the approach being taken and present some very preliminary results.

The fundamental concept behind our approach is the 'Ideal Free Distribution' (Fretwell & Lucas 1970), which has been used with success in understanding, for example, the consequences of population increase in Brent Goose *Branta bernicla* and the effects of habitat loss on migratory species (Sutherland 1995). This divides the habitat into a series of patches which differ in quality, with individuals initially using the best patch. However, these birds will cause the patch to decline in quality, both through depletion as food items are removed and through interference between the individuals on the patch. As intake rate declines (below a threshold intake rate the birds ignore a patch), so will the probability of starvation increase, leading to density dependent mortality. Eventually the quality of this best patch (in terms of the probability of surviving) will be reduced to that of the next best patch, which the birds will then use, as the chance of surviving (that day) will be equal in both. As a consequence of this, an ever increasing proportion of the available habitat is used and intake rates are equalized across patches. Using this model we can vary initial food levels and determine the resultant mortality. This can be used, together with an estimate of breeding success, to predict equilibrium population size - the number of individuals the habitat can support. The model shows winter food levels (and how variable the patches are) can affect this equilibrium size quite markedly and that this pattern is affected by density independent winter mortality such as predation by raptors. For example, decreasing food levels leads to an increase in predation, as the birds have to feed in more predation-prone patches to find enough food and increasing predation risk decreases the proportion starving as bird densities are lower later in the winter.

Fieldwork has so far concentrated on characterising habitat use. These observations show, for example, that hedges are important in determining where in a field a bird forages, as for American granivorous passerines, e.g. the White-throated Sparrow *Zonotrichia albicollis* (Schneider 1984). In our North Norfolk study area the Chaffinch *Fringilla coelebs* and Tree Sparrow *Passer montanus* feed very close to the hedge (< 10 m from it), the Corn Bunting *Miliaria calandra* and Yellowhammer *Emberiza citrinella* feed further out (30 - 40 m) and the Skylark *Alauda arvensis* feeds in the middle of fields (mean = 78 m). This will have a number of consequences: the risk of being predated is higher further from the hedge, there are also suggestions that intake rate and hence patterns of depletion, could vary depending on location. This also suggests that hedgerow removal, a major source of agricultural change, will have species-specific effects. In addition, feeding appeared to be affected by foraging neighbours, Tree Sparrows experienced a significant reduction in intake rate when foraging in the presence of the Corn Buntings and Yellowhammers which are much larger. No such effect was observed between the two bunting species which are much more similar in size.

Current work will examine these patterns further by experimentally manipulating food supply in order to ask for each species how important is interference, both direct and indirect, and how do intake rates and vigilance behaviour vary with seed density, distance from cover and flock size. We are also examining distribution of birds across fields in relation to crop type, habitat structure and food supply. In addition, the use of exclosures will enable us to look at how much and where depletion is occurring. By combining this empirical work with the theoretical modelling described above we should learn much about the wintering ecology of these birds. Such an understanding is clearly important in determining why these species are declining.

References

Green, R.E. (1978). Factors affecting the diet of farmland skylarks, *Alauda arvensis*. *Journal of Animal Ecology* 47: 913-928.

Fretwell, S.D. & Lucas Jr., H.J. (1970). On territorial behaviour and other factors influencing habitat distribution in birds. *Acta biotheoretica* 19: 16-36.

O'Connor, R.J. & Shrubb, M. (1986). *Farming and Birds*. University Press, Cambridge.

Schneider, K.J. (1984). Dominance, predation, and optimal foraging in white-throated sparrow flocks. *Ecology* 65: 1820-1827.

Sutherland, W.J. (1995). *From Individual Behaviour to Population Ecology*. University Press, Oxford.

4. NEEDS FOR FUTURE RESEARCH

This section is a record of the main points that emerged from the general discussion at the end of the workshop. It is essential both to determine the causes of the declines in farmland birds and to improve our knowledge of the ecology of the species concerned. Unless this is done it will be difficult to devise valid recommendations aimed at halting and reversing the declines.

4.1 The research approach

There have been two broad approaches to understanding the causes of population changes among farmland birds. The first is essentially a correlative approach in which links are sought between patterns of distribution, abundance and demography and patterns of environmental variation (e.g. agricultural land-use). Such *pattern-based* studies are usually carried out at large spatial or temporal scales and can be used to generate hypotheses concerning the ecological processes causing population change. Furthermore, substantial long-term data sets exist for many of the species that are currently declining and analyses of these could help focus intensive studies on those factors most likely to be important. A good example of a pattern-based study is the BTO's Corn Bunting survey which has identified a number of hypotheses of the processes underlying the distribution of this species. Hypotheses derived from pattern-based work should, wherever possible, be tested by intensive field studies at smaller scales. The second approach is *process-based* which involves intensive work on the ecology of a species in relatively small study areas, perhaps including experimental manipulations. This approach seeks to identify the processes through which agricultural changes lead to changes in demographic rates and, ultimately, in abundance and distribution. Examples of this approach are the work on Grey Partridges, Skylarks and Cirl Buntings. Its advantage is that it focuses directly on those data that must be collected in order to identify mechanisms linking agricultural change to population change. The processes discovered cannot necessarily, however, be generalised to larger spatial scales to explain trends in distribution and abundance throughout the range of the species.

In conclusion, both approaches are complementary and necessary. Neither approach, in isolation, is sufficient to understand the causation of population and range changes. Future research should combine intensive and extensive elements.

4.2 Priority research areas

The workshop was an opportunity to identify research priorities for seed-eating farmland birds. Several potentially valuable lines of work were identified and these are described under the five headings below.

4.2.1 Analysis of historical trends

There is a need to relate population trends as shown by the Common Birds Census, to agricultural changes as shown by agricultural statistics. This should be done at a regional level.

There may also be opportunities for collecting further data on farming practices as potential correlates of population trends on extant or lapsed bird census plots. Specifically, an attempt could be made to collect retrospective data on factors such as time of sowing and chemical inputs on long-running farmland CBC plots. Even where good bird census data do not exist, it could be worth approaching farms known to record their farming practices in a systematic manner. This would help to gain a more exact picture of changes in those farming practices that are not readily discerned from the agricultural statistics. The former Experimental Husbandry Farms would be especially helpful in this respect because they were set up to be representative of agricultural practices in their regions.

Analyses of environmental correlates of long-term trends in breeding success using Nest Record Card data would be valuable, though the resolution of historical habitat data may be inadequate to relate breeding performance to farmland type (see below).

4.2.2 Breeding season ecology

Autecological work on all the declining species is highly desirable because mechanisms underlying the declines probably differ from one species to another. Such studies should strongly emphasise the food requirements of the birds.

National extensive data sets have the potential to be developed in ways that might give useful insights. The Nest Record Scheme, for example, could be developed to provide more detailed habitat information (e.g. crop type) to accompany individual nest histories. It could also be extended on a volunteer study group basis to undertake relatively intensive studies of breeding biology, breeding performance and nestling food of selected species within defined areas on a long-term basis. There is considerable scope for studies based on samples of individual long-term CBC plots; for example to analyse patterns of territory distribution of selected species in relation to changes in cropping.

4.2.3 Winter ecology

This may be the main limiting season for many seed-eating birds but there is a severe dearth of basic information about abundance, distribution and habitat requirements of most farmland birds in winter. Better knowledge is needed of dispersal and movement patterns. For example, what is the distributional relationship between breeding and wintering populations? Many seed-eating birds feed in flocks in winter but very little is known about flock ranges and the capacity of species to exploit extremely patchily distributed food supplies. A systematic study of ringing recoveries would be a useful first step, but more detailed work involving mark-recapture-resighting studies is also needed. Further Winter Atlas work, or winter surveys of the Breeding Bird Survey squares, could also provide a means of adding to our knowledge.

4.2.4 Factors influencing the food supply of birds on farmland

Many of the population declines of farmland birds are probably underpinned by changes in food supply. There is a clear need to understand how farming practices affect, and have affected, food resources for birds through changes in cropping practices, pesticide inputs and fertiliser inputs.

There are three major types of problem in studying the effects of farming on food resources. First, knowledge of the diets of most farmland birds is totally inadequate. It is, therefore, difficult to establish experimental work to assess effects of, for example, pesticides on these food resources. Ideally seasonal, geographical and habitat-based variation in avian diet should be assessed. There is some potential for collecting more dietary data through nest recorders and ringers. For the foreseeable future, information on diet is most likely to accumulate through autecological studies. Second, it may be difficult to isolate the effects of chemicals from those of cropping practices. Third, several studies have shown that there is often huge variation in the distribution of available food (both seeds and insects) both within and between fields. This can lead to severe problems of sampling food availability in ways that can be meaningfully related to bird distribution. To some extent the birds themselves could be used to 'sample' food resources by comparing the availability of food items at locations where birds are feeding with that at randomly selected locations.

To date, the effects of intensification of grassland management, especially increased use of inorganic fertilisers, have been largely ignored. More work is needed on the implications for grassland invertebrates such as grasshoppers which form important food supplies for several species of farmland birds. For example, the decline of the Red-backed Shrike may have a basis in the collapse of grassland invertebrate populations through changes in grassland management.

4.2.5 Population dynamics

There is a need for population processes to be examined on different scales. Autecological work will lead to a better understanding of processes on a local scale. It might be particularly revealing to compare a declining and a stable population of the same species. The development of population models based on historical extensive data (CBC, Nest Records and Ringing) will also be extremely valuable in identifying likely 'pressure points' in the past dynamics of populations of seed-eating birds. These types of analyses should help to identify whether the critical problems lie mainly in the breeding season or winter. In this context, comparisons of declining and non-declining species could give useful insights. The possible existence of large scale processes should not be ignored. For example, is it possible that declines at the edge of the range in some species may essentially be driven by problems in the core of the range? Could population levels of some British farmland birds be dependent on immigration from Continental Europe as suggested for the Tree Sparrow?