RESEARCH REVIEW No. 46

PESTICIDES AND BIRDS: A REPORT ON THE EVIDENCE FOR CHANGES IN FARMLAND BIRD POPULATIONS AND THE PROPOSALS FOR A PESTICIDE TAX

FEBRUARY 2001

Price £3.50

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by

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This review was carried out in January-February 2001 and was funded by grants of £8,000 from the Home-Grown Cereals Authority (Project No 2478) and £1,000 from the Processors and Growers Research Organisation.

Contents:

Summary

- **The evidence for declines in the populations of some farmland birds is sound and the statistical analyses used are appropriate.**

- **The evidence is clear that some of these declines, and other changes in bird populations, are linked to agricultural practice.**

- **The contention that pesticides alone are a cause of the changes in bird populations is not generally supported by the evidence. However, pesticides have played a role in agricultural changes that have led to changes in bird populations.**

- **Direct effects on birds of correctly used pesticides are minimal. Their most important effect has been in supporting changes in cropping patterns that have altered habitat and food availability.**

- **There is no evidence in support of the hypothesis that a pesticide tax alone would deliver significant benefits to birds.**

- **A pesticide tax hypothecated for agri-environment schemes might generate some benefits for birds but the cost would fall mainly on the arable and horticultural sectors, whereas the increased productivity and stocking rate of grassland, which uses very little pesticide, can have detrimental effects on bird populations.**

- **The proposed design and application of a tax are flawed.**

- **Some biodiversity indicators have improved over the last 10 years and recent bird population changes have generally shown improvements. For no bird species are the recent population trends worse than in earlier analyses.**

- **The role of changes in grassland management on bird populations and survival deserves more attention.**

- **A number of influences on agriculture; organic farming, crop assurance, predation, set-aside, new crops and global warming, and their possible effects on birds are briefly discussed.**

- **The farming industry working with conservation organisations is the most likely way of achieving acceptable solutions to the concerns of each and the targets imposed by HMG policy documents.**

Background and terms of reference

Changes in bird populations have recently become the focus of much of the discussion concerning biodiversity in the UK and have been used to promote the introduction of a pesticide tax. The debate has been polarised between the farmers on whom the burden of a pesticide tax would fall and those organisations and their memberships who would wish to see a tax introduced. This review was commissioned by the Home-Grown Cereals Authority to obtain an independent view of the evidence supporting bird population declines and the role of pesticides in those declines and whether the proposals for a tax are sensible and likely to deliver benefits to birds. There were some specific terms of reference.

1. To comment on the scientific validity of recent studies, and the conclusions drawn from them, concerning the effects of pesticides on bird populations.

2. To review recent literature relating to farmland bird populations in the UK and speak to the main interested parties about their views on the reasons for the changes documented.

3. To review other possible anthropogenic and non-anthropogenic influences on bird populations both within and outside agriculture.

4. To comment on the likely effects of a pesticide tax on farmland bird populations and other indicators of biodiversity.

Introduction

The relative importance of agriculture to the UK and its economy has fluctuated widely. In 1902 the Chairman of the Board of Agriculture, the forerunner of MAFF, stated that "Agriculture in the UK is dead, it is our job to bury it decently". Almost 100 years later there are some who would judge that HMG has much the same view. In the intervening years, however, two wars demonstrated the fragility of the UK's ability to feed itself and for much of the last 50 years it has been Government and then EU policy to support and increase agricultural productivity. More recently, changes in policy have resulted in the implementation of setaside linked to an area payments scheme. The Agenda 2000 proposals also herald further changes, especially in the balance of arable crops grown.

Farmers have responded to these policy decisions and have sought to maximise and maintain their profitability. The use of pesticides has featured largely in the last 50 years, initially with herbicides but with insecticides, nematicides, rodenticides and fungicides now being seen as very important components of current farming practice. The last few years have seen marked fluctuations in the fortunes of farming, and economic survival has become increasingly difficult; the number of people leaving farming has increased, and employment within the whole agricultural industry has declined to historically low levels.

It has often been remarked that, in the UK especially, the intimate relationship between the urban and rural areas has created particular difficulties in reconciling the requirements of both. Approximately 75% of the UK is farmed with much of the remainder occupied by urban areas and infrastructure. Thus changes in farming practice often have effects that are obvious to the non-farming majority of the population. These changes are usually gradual and their effects not immediately obvious, although the introduction of set-aside was possibly the largest single change in area of land use in the UK. However, the consequences of these changes can be large. O'Connor and Shrubb (1986) give the historical background to changes in agriculture in relation to birds. The 1870s were a high-water mark for UK agriculture reflecting changes that had begun 100 years earlier. Thereafter free trade and cheap food initiated a long decline culminating in the depression of the 1930s. In the 1930s the area of tilled land was less than in 1698 and may have been less than at any time since the Black Death when the population was only $1/10^{th}$ of that in 1930. In the 1930s, 81% of the agricultural area was in grass, and by the 1980s the area of arable land was still less than in the 1870s. These changes are profound even without the effects of superimposed changes in management, and have undoubtedly had a large effect on bird populations, although there is usually nothing but anecdotal evidence to support such changes. However, for some species such as the wryneck and grey partridge, there is good evidence of declines over this period. As O'Connor and Shrubb (1986) remark "The widespread distribution of many habitats in farmland *(in the 1930s)*, such as wet grassland or other unimproved pasture and overgrown hedgerows, is the product therefore, not of a traditional agriculture in tune with its environment……but of enforced neglect by an agriculture unable to maintain its capital".

The purpose of the above remarks is to stress that there always have been changes in the way the land of the UK is used, that these changes will have effects on all aspects

of wildlife, including birds. There will always be "winners" and "losers", and seeking to maintain a particular population of any particular species may not be compatible with other demands for land use or the requirements of civil society. The varied countryside of the UK has always been praised as one of its attractions but this in itself is a result of policies adopted in the past by governments especially the Enclosure Acts.

The last 50 years have certainly seen large changes in farming in Britain and without doubt these will have had an effect on bird populations. The relative importance of these changes is uncertain but surely prime amongst them must be the increasing use of machinery, the breeding of superior crop varieties capable of utilising increased nutrient resources, the development of chemicals to protect and support the growth of such plants and the substantial changes in the crops grown and their times of sowing or planting. These factors, many promoted by policy changes, have all had effects on birds. And because these changes have been linked and not introduced one at a time, and because changes in varieties and the availability and properties of chemicals are dynamic, it is rarely possible to separate out their different effects. However, there are other changes in society at large that have focussed interest more closely than before on interactions between farming and the more general environment as perceived by a predominantly urban population. Two of these concerns, pesticides and birds, have been linked and are the subject of this review.

Farmland birds

Woodland is the natural landscape of much of the UK. Before agriculture became widespread, woodland and low-lying marshes dominated the landscape with relatively few areas of open country. The marshes have been drained; the woodland reduced to patches of woodland and copses. After enclosure some trees flourished in the hedges established to demarcate ownership and restrict access. These changes have influenced the diversity and abundance of our current bird population. Birds have adapted to the changing environment; some species have been lost partly at least because of these habitat changes while other species have thrived. What were originally "forest" species account for 80% of current farmland birds and open-country species are poorly represented, i.e. partridges, lapwing, skylark, corn bunting and yellow wagtail, and comprise only a small percentage of lowland farmland birds. Thus the diversity of our bird population owes much to the diversity of our landscape. Few "farmland" birds can thrive entirely on one form of farming. They may need cropland for food and grassland/hedgerows for nesting. They often have different food requirements; high-protein invertebrates while breeding and as nestlings, and then seeds and plants for over-winter survival. A recurrent theme in the voluminous literature now available on bird populations and farming is birds' need for diversity of habitat.

The definition of a "farmland bird" is thus subject to discussion. But the review of Campbell et al (1997) considered 40 species dependent entirely or partly on lowland farmland. Using data from the Common Bird Census records (see below), they classified them according to whether they were "declining" or "stable or increasing". Campbell et al (1997) also give details of the estimated populations of these species, their regional distribution in Britain and in Europe, estimates for population changes over the last 100 years and changes in range and population on farmland and in woodland. Ten of the species are summer and 9 winter migrants and thus subject to

effects on their populations outside Britain. The species listed are given in Table 1 according Campbell et al's figures for "declining" or "stable/increasing" and the level of conservation concern (Gibbons et al. 1996). A more recent analysis of changes in farmland-bird populations (Fuller, 2000) between 1987-1996 contains many, but not all, of the same species and considers the changes in populations of 26 species (Table 2). Bailllie, Gregory and Siriwardena (1997) examined population trends for 46 species between 1968 –1995

Table 1. Farmland Bird Species (Campbell et al 1997)

"Declining" species		"Stable/Increasing"	
Grey partridge#	R*	Red-legged partridge	
Stone curlew	R	(Pheasant)	
Lapwing#	A	Quail	R
Turtle dove#	R	Stock dove	A
Barn owl	A	Woodpigeon	
Skylark#	R	Collared dove	
Swallow	A	Pied wagtail	
Sand martin	A	Meadow pipit	
Yellow wagtail		Hobby	
Blackbird	A	House martin	
Song thrush#	R	Robin	
Mistle thrush		Wren	
Dunnock	A	House sparrow	
Spotted flycatcher#	R	Chaffinch	
Red-backed shrike#	R	Greenfinch	
Starling#	A	Goldfinch	A
Tree sparrow#	R		
Linnet#	R		
Bullfinch#	R		
Yellowhammer			
Cirl bunting#	R		
Reed bunting#	R		
Corn bunting#	R		

Declines of >50% between 1969-1994
R Red-listed,
A Amber-listed species of conservation concern

Table 2. Farmland bird populations, 1987-1996 (Fuller, 2000)

Declining	No change	Increasing
Grey partridge	Kestrel	Wren
Lapwing	Stock dove	Robin
Turtle dove	Yellow wagtail	Whitethroat
Skylark	Dunnock	Great Tit
Blackbird	Song thrush	Goldfinch
Lesser whitethroat	Blue tit	Linnet
Starling	Jackdaw	
Tree sparrow	Chaffinch	
Yellowhammer	Greenfinch	
Corn bunting	Reed bunting	

Of the species appearing in both Tables 1 and 2, four (dunnock, bullfinch, reed bunting, song thrush) moved from declining in Table 1 to stable in Table 2, and one (linnet), moved from declining to increasing. No species moved from stable/increasing to declining. The report of the Breeding Birds Survey (see below) for 1999 (Noble, Bashford and Baillie, 2000) provides greater national and regional breakdown for populations and covers more species. In England between 1994-99, 24 species declined and 28 increased significantly but the farmland species, linnet, bullfinch, yellowhammer and skylark appeared to be declining in all regions.

For a variety of reasons, including their "popularity", their visibility, the enthusiastic collection of data by many hundreds of amateurs, and the ability of those interested to identify them readily by appearance and sound, birds have gained a pre-eminent position as indicators of environmental change or biodiversity. Whether they are "good" indicators or not can be discussed (see page 15), but birds have been accepted by government as appropriate indicators. Populations of key farmland birds have been made one of the quality of life indicators by MAFF and 26 species, 13 of which (Table 3) are thought to be characteristic of farmland, have Biodiversity Action Plans which seek to stabilise declines or increase populations over a given timescale.

Table 3. Biodiversity Action Plan species characteristic of Farmland.

Grey partridge	Corncrake
Stone curlew	Turtle dove
Skylark	Song thrush
Spotted flycatcher	Tree sparrow
Linnet	Bullfinch
Cirl bunting	Reed bunting
Corn bunting	

Some of the rarer of these species (stone curlew, cirl bunting, and corncrake) though still uncommon are recovering strongly but populations of the commoner farmland species still appear to be declining (Gregory et al, 2000). Thus birds are firmly embedded in government policy and the farming community needs to respond positively. Attempting to undermine or reject the use of birds as indicators is likely to be counter productive.

Basis for the evidence for changes in bird populations

Game Conservancy Trust (GCT)

The longest and most detailed data set relating largely to a single species is that relating to the grey partridge (Potts, 1986). This comes from early game-bag records and the work of the last 60-70 years of the GCT. The decline of the grey partridge appears to have begun at the end of the 19th century and coincided with a period of decline in agriculture and game-bird management (Marchant et al 1990). Since the last war the decline appears to have accelerated. The early declines would thus appear to be linked to habitat change as pesticides were little used. Though the data are sound, it has to be recognised that grey partridge are not especially representative of farmland species as a whole. This is partly because they are game birds, but also because the young leave the nest early and, in consequence, foraging distances are restricted compared to other species in which the nestlings remain in the nest and the parents forage, possibly over large distances if food sources are sparse near the nest. Recent work at GCT on another declining species the corn bunting, which has similar food requirements to partridge but rather different behaviour, links the population declines with agricultural activity. Nest survival seems to be poorest where chick food is least abundant. This is apparently because the longer absences from the nest of foraging parents leads to increased predation.

Common Birds Census

The principal source of information on changes in bird populations is the Common Birds Census (CBC). This was started in 1962 and its aim was to monitor bird populations, mainly on farmland, and its initiation was at least partly driven by obvious changes in the landscape, such as hedgerow removal, and the increasing use of pesticides, especially herbicides. Woodlands were included from 1964. The recording is mainly done by amateurs and to protocols laid down by the British Trust for Ornithology (BTO) who co-ordinate and analyse the results. The BTO also offers training and guidance for observers. All observers have to undergo a probationary period of two years and only when the BTO are satisfied with the quality of the data are they used in analyses. The areas to be monitored are selected by the observers but using criteria laid down by BTO who have the final say on the acceptability of an area. The monitored area should be at least 60ha. The CBC method is based on mapping and requires 10 complete mapping visits between mid-March to late June each year. Records are also made of bird activity and the habitat. The maps generated by the observers are then used by BTO professionals to produce territory maps using standard international methods. The most public output of the CBC work are indices of population change. The index for any species is a measure of its change in abundance relative to a datum year for which the index was set at 100. For most species this year is 1966.

There are some deficiencies in the CBC (Greenwood et al 1995). The number of plots monitored by CBC is relatively small, about 240, although there are small fluctuations in number. The plots are also more representative of lowland farming areas, where most observers live, than perhaps more sparsely populated areas. Inevitably there are changes in plots and observers, although in many ways there is remarkable continuity for a voluntary scheme, and though there are checks on how representative the plots are they are not randomly chosen and may thus be biased towards more "interesting" and perhaps, in consequence, more diverse sites. These drawbacks do not detract from the value of the information or from the importance of the conclusions that have been drawn from the results. A wide range of statistical techniques has been used to help interpret the data and much of this information has been published in Scientific Journals of high repute and standards. Though it is the more populist publications that receive the most attention and perhaps provoke most indignation, the sometimes narrow focus is backed by sound science. However, there are inevitably, but not necessarily defensibly, occasions when the complex interactions that are clear from the scientific studies are simplified to make a particular point or emphasise a particular message.

Breeding Birds Survey

Despite the value and success of the CBC it was felt by the organisations concerned with birds in the UK that a rather more extensive and random selection of survey areas was desirable. This resulted in the Breeding Birds Survey (BBS) which began in 1994 after pilot work. The BBS has now taken over from the CBC for which funding ended in 2000. The BBS (Noble et al, 2000) is based on 1km x 1km-squares of the National Grid. Squares are chosen on the basis of a stratified, random-sampling design. The same squares are surveyed each year. Each square is visited three times and, in 1999, 2379 squares were recorded. The aim is to have 2-3000 squares recorded each year. The labour is largely from volunteers but again follows a strict protocol. The counting is based on predetermined transects, each divided into 5 equal sections. As well as bird records, habitats and any mammals seen are also recorded. The CBC and BBS were run in parallel for 7 years and comparisons made of population trends resulting from each. The agreement between the two systems was close, adding confidence to the results of the much longer runs of data from the CBC (Noble et al, 2000, H. Crick pers. comm.).

Thus, though the extent and quality of the evidence in support of the changes in populations of birds will always be a compromise between what is desirable and what is practicable, there is little doubt that all the evidence gathered supports the conclusions drawn about changes in bird populations and that, over the period 1960s to 1990s, populations of more bird species have declined than remained stable or increased and that this is especially so of species that depend on farmland and associated habitats, either completely or in part, for their survival. The various analyses that have been done are rigorous and appropriate as far as can be judged in the time available.

Why have many species declined?

The argument has focussed on agricultural intensification as the primary cause and analyses have been done on changes in bird populations and changes in agriculture (Chamberlain et al 2000, Donald, Green & Heath, 2001) for England and Wales and for Europe. The period 1970-1988 saw most intensification characterised by increases in the area of oilseed rape, autumn-sown cereals and the use of pesticides and inorganic fertilisers. Over the same period there were declines in the areas of spring-sown cereals, bare fallow and root crops. The analyses linked changes in agriculture and changes in bird populations but there was usually a lag in the response of bird populations. The conclusion of Chamberlain et al (2000) was that large shifts in agricultural management are a plausible explanation for the declines in farmland-bird populations. They developed a model linking critical amounts of high-quality habitat or food resources that may explain the lag in the response of birds. Presumably such a lag may also be seen when habitat and food resources improve. They also conclude that "Identifying individual factors responsible for bird declines is not possible without detailed experimental work because many components of intensification are interdependent. Birds may be responding to a suite of interacting factors rather than individual aspects of farm management". These conclusions reinforce those of Chamberlain et al 1999 (BTO report 209) which looked very widely at the effects of agricultural management on both range and populations of farmland birds. The ranges of grey partridge, lapwing, turtle dove, yellow wagtail, tree sparrow, corn bunting, and reed bunting all declined by more than 5% between 1969 and 1988 and these declines were much greater in non-arable areas in which species richness also declined most. It was also shown that different species showed difference responses to agricultural change in different regions; studies have shown that for species that have declined the patterns have been different (Siriwardena et al 1998, Fewster et al. 2000), suggesting that each species responds in different ways to these changes. Chamberlain et al (1999) also found correlations between birds and decreases in spring barley or increases in winter barley, or to winter cereals as a whole. For 21 bird species, mixed and arable farms held more diverse assemblages than grassland farms. However, arable farms showed larger changes (usually decreases) in density than mixed or grassland farms. In their analyses they could find little evidence of strong links between pesticide application or application rates and species abundance although for skylark. blackbird, greenfinch and yellowhammer fertiliser use did have a negative effect on abundance, possibly through changes in grassland management. They caution against seeking insights concerning specific agricultural changes on birds but suggest two areas worthy of detailed study; the time of sowing (autumn v. spring) of cereals and the effects of grassland management. They also observe that there were conspicuously few associations with pesticide use.

Why pesticides?

Pesticides received a large amount of bad publicity as a result of the consequences of the use of the very persistent organochlorine materials. The legacy of this is still widespread even though such materials are now banned and the most obvious effects on the birds at the top of the food chain have been reversed with the increase in numbers of sparrowhawks and buzzards and the successful introduction and spread of red kites. Nevertheless, even though most direct effects of correctly used pesticides have disappeared (Burn 2000), because pesticides are specifically used to kill

potential bird food, plant or invertebrate, they will always be seen as prime suspects when attempting to apportion blame for population declines. The evidence for an indirect effect of pesticides on the survival of the grey partridge is well documented (Rands, 1985, 1986), and data in support of the contention that corn bunting survival is also linked to a decrease in chick food as a result of herbicide and pesticide use is also strong (Brickle et al. 2000). However, evidence for such close links between pesticide use and most of the bird species for which declines have been recorded is not available (Fuller, 2000). This does not mean that they are not involved but any effects cannot be separated from the many other changes involving agriculture.

In consequence it is impossible to predict what benefits to birds might accrue from any unilateral change in their use such as that which might result from a pesticide tax. However, there is an element of 'guilty until proved innocent' about some reports, the authors of which seem reluctant to accept that no effects, either direct or indirect, can be directly attributable to pesticides alone. Following the precautionary principle is perfectly acceptable provided it is not taken to the point of dictating policy when there is no evidence of any benefits from that policy. However, for some there is a broader perspective to pesticide use and consequences to the environment in general, especially concerning the so-called "external" costs of agriculture. Pretty et al (2001) estimated annual capital and running costs for the removal of pesticides, originating from agriculture, from drinking water to be c£120 million, and one view is that this is pollution and that the polluter should pay. It is beyond the scope of this report to comment on such issues. Government policy is also directed towards a decrease in pesticide use, although without compromising crop protection.

Since 1962 when the CBC began, there has clearly been a very large increase in the use of pesticides (pesticide usage surveys), not necessarily in the total active ingredient applied but certainly in the area treated. Cereal crops are often sprayed more than once with herbicides and fungicides and other arable crops show a similar pattern, with herbicides usually the most frequently used materials (Pesticide Usage Surveys). Within agriculture the majority of the pesticide used is applied to arable crops but grassland is still the predominant ground cover in the UK and only very small amounts of pesticide are applied to this crop, often to help in establishment or remove persistent toxic weeds (Pesticide Usage Survey data). Thus, if a pesticide tax was introduced, and if its introduction decreased pesticide use by the 8-20% of active ingredient indicated in the ECOTEC report (2000), the effect and costs would largely fall on arable crops. But, given that most bird species need a variety of habitats for their survival and that grassland management has been implicated in bird decline and identified as a target for further research (Chamberlain et al, 1999), the effects of a decline in pesticide use on bird populations are uncertain at best and could be minimal. Whereas the costs to the arable farmer would be large (the ECOTEC report estimates 1-2000 job losses resulting from the introduction of a 30% tax and net profitability declining by around 10% across the sector).

Studies, mainly by the GCT, have indicated that narrow-spectrum pesticides are less "harmful" to bird food items than broad-spectrum materials, especially insecticides, but the general trend, especially for fungicides and herbicides, has been to broader-spectrum products. This may be of little consequence for the use of fungicides, which would seem to have the potential for only a small indirect effect on birds as a result of killing the food source of some fungivorous invertebrates, but at present few

herbicides are targeted at single species even though there may be one principal target of the application. This is unlikely to change unless threshold values for weed control can be reliably established and herbicides specific for target weed species are available. And this has to be seen in the context of the economics for the pesticide manufacturers in that narrow-spectrum products will have smaller markets than broad-spectrum ones, which is becoming an important factor given the increasing costs of developing a new pesticide.

Few would claim that many birds are currently affected directly by pesticides (Burn, 2000). The main source of information on direct effects is the Wildlife Incidents Investigation Scheme which the Pesticides Forum, Outcomes and Indicators Subgroup (report) has recommended should be strengthened. However, as knowledge of bird food items has improved, and how these change during the year, the potential role of insecticides and herbicides has become clearer (Potts, 1986; Sotherton & Self, 2000; Vickery et al 1999). Such knowledge is essential if schemes are to be initiated that are sympathetic to birds but do not compromise the farming operation.

Some specific issues relating to interactions between agriculture and birds have been raised both in discussions and in the literature and are considered briefly below.

Organic versus conventional farming

Making comparisons between organic and conventional farms is fraught with difficulties because of the different approaches adopted. However, many claims have been made for the benefits of organic farming to biodiversity, including birds. When comparisons have been made (Chamberlain, Wilson & Fuller, 1999; Wilson et al 1997), the results were equivocal. Only in one, out of three, breeding seasons was there a difference in species diversity favouring the organic farm (Chamberlain et al 1999) and some species showed greater densities on organic field boundaries in at least one season/year, mainly in the autumn. There were more breeding skylarks on the organic farm in one breeding season. The differences were not directly linked to differences in pesticide use but seemed to relate mainly to aspects of habitat management, especially of hedges (Chamberlain & Wilson, 2000). In the work of Wilson et al (1997) where some of the habitat variables were taken into account, skylark densities were greater on organically cropped fields or set-aside than conventional fields. This difference was associated with the change of habitat associated with conventional farming and the denser, faster-growing crops in conventional agriculture that discourage nesting.

Even with the difficulties of making comparisons, and thus drawing conclusions, about bird populations on organically or conventionally grown crops, the crops and rotations dictated by the organic approach are more likely to provide the diverse habitat which seems to favour birds (Fuller 1997). The conclusion that organic farming is the best way forward for birds does not directly follow, as modifications to habitat and management (e.g. Stewardship schemes) within a conventional system would seem equally capable of delivering benefits to birds. Thus, though maintaining or increasing diversity currently plays a greater role in the organic than the conventional farmer's approach to production, there is often an assumption that the conventional system seeks to eliminate completely competitors of the crop. This is rarely attempted and even more rarely achieved, especially for weeds. The concept of

forecasting and modelling competitive interactions, especially for weeds, would enable more targeted treatments in this crucial area.

Agri-environment schemes

There is an increasing number of schemes designed to favour wildlife and habitat features within conventional farming systems. The pilot Arable Stewardship Scheme is one of the most recent and the results from the Allerton Trusts's farm at Loddington indicate that there are beneficial features for birds, especially the increase in overwintering stubbles. The RSPB has recently purchased Hope Farm, which will be managed to favour birds, and it will be interesting to see the future results from such work both for birds and the financial viability of the farm enterprise. However, at present these schemes are rather small areas surrounded by much larger areas not subject to the same conditions. The wide foraging range and the movement of some birds makes it difficult to interpret the specific effects from such changes in management. Indeed it is possible that birds directly benefit from a mosaic of management practices and the widespread introduction of some apparently favourable new schemes might not deliver the anticipated benefits. These possible consequences should be investigated (Baillie et al. 2000). The role of pesticides in such schemes could be crucial in maintaining the desired conditions.

Crop assurance schemes

Crop assurance schemes are a recent feature of UK farming and seek to ensure the quality of production, storage and the traceability of crops. One result is that access to grain stores is largely prevented for birds and rodents, thus removing a potential food source both directly and indirectly. Tidy farms are not the best environment for birds, many of which have come to rely on tail corn and access to food sources round farm buildings. How much assurance schemes may have contributed to declines in bird numbers is uncertain but they generally make life harder for farmland birds.

Predation by birds

With the recovery of many raptors, especially the sparrowhawk, following the withdrawal of the organochlorine materials and the very obvious and well documented (Marchant et al. 1990; Noble et al, 2000) increases in predatory species such as the corvids (magpies, jackdaws), there has developed a belief that predation is having a significant and detrimental effect on bird populations. There is evidence to support this (Stoate & Thomson, 2000) but analyses of data from the CBC do not suggest that predation has had a significant effect on the populations of songbirds in general, although it was recognised that predation could have had an effect on some species in some localities (Thomson et al, 1998). However, predation is a significant influence on gamebird populations (Newton, 1993, Tapper, S. C., Potts, G. R. & Brockless, M. H. (1996) and can be important for other species in particular circumstances (Brickle et. al 2000). There are features of current farming practice that do increase the risk of predation for some species. For example skylarks do not favour dense tall cereal crops as nesting sites and the increase in winter cereals has created unfavourable conditions within the crop. In consequence, nests are now often made close to the open space provided by tramlines which gives easier access to predators (Donald & Vickery, 2000)

Set-aside

Set-aside was introduced as a production control measure not an agri-environment scheme and, though the future of set-aside under the Agenda 2000 proposals is uncertain, its introduction to UK agriculture in 1992 was certainly one of the largest single land-use changes experienced by the UK. Because of the decline over the last 30 years of winter stubbles, with the switch from spring- to autumn-sown cereals, set-aside has been investigated to see if its presence can replace that lost resource (Evans, 1997). The RSPB's preferred management for set-aside is rotational set-aside with a green cover established by natural regeneration rather than by sowing. Analyses of bird preferences between set-aside, winter cereals or grassland were compared in summer (Henderson & Evans, 2000; Henderson et al, 2000). All birds were more abundant on set-aside than on winter cereals, and numbers were largest on rotational set-aside, with the exception of crows that preferred grass. Except for crows, winter cereals and grassland were the least-preferred habitat. Set-aside seems mainly utilised by birds for food but its value is very influenced by its management. Set-aside is also a preferred foraging habitat in winter (Buckingham et al. 1999). It is not known if such preferences reflect an increase or redistribution of populations on farmland. In consequence it is difficult to predict what effect the withdrawal of set-aside would have on bird populations as a whole.

CS 2000

The recent publication of the Countryside 2000 survey (Haines-Young et al., 2000) suggests that some of the measures of diversity in the Enclosed Farmland Habitat have stabilised or even increased while some continue to decline. There is evidence of increasing plant diversity in the Arable Broad Habitat especially in the boundaries of fields, in some areas by 38%, although in improved grassland plant diversity has declined. There were no significant differences between 1990 and 1998 in the length of hedgerow and some evidence that losses have been reversed. However, the quality and diversity of recently planted hedges will take many years to match that of those long-established. Areas of semi-natural 'acid' and 'calcareous' grasslands fell but the number of lowland ponds increased. These changes will have differing effects on birds and there is likely to be a lag before there is any evident change in populations. CS 2000 also sets the BAP target of 15000 ha of cereal field margin managed to maintain, improve and restore biodiversity. A real concern is the loss of grassland types to direct improvement by fertilising and cutting frequently and the inadvertent changes by eutrophication from neighbouring areas.

Range changes

Not only are the populations of many bird species decreasing on areas where they are still comparatively common but for many their ranges are also decreasing. For many farmland species there is a retreat from the western and north-western, mainly pastoral regions. One consequence is that bird diversity on arable farmland is often greater than elsewhere. The reasons for this loss of range are not clear and could be due to declining arable populations failing to replenish more marginal areas. Chamberlain & Fuller (1999) found that extinctions were more frequent where crop type, but not necessarily management, had changed least e.g. grassland areas.

"Good pesticides and crops"

If only for the rarity of their reporting it is worth mentioning that some new crops, and the appropriate use of pesticides, can benefit birds. Oilseed rape, a relatively new crop to UK agriculture, has become increasingly used by birds for nesting and for food. Linnets and reed buntings especially seem to find the unripe grain a suitable food item for adults and young and recent suggestions that the declines in populations of linnets have slowed may be, at least in part, due to the utilisation of oilseed rape (Moorcroft, Bradbury & Wilson , 1997; Moorcroft & Wilson, 2000)). Many other species, including woodpigeons, feed on young rape plants and the invertebrates that feed on it (Burton et al, 1999). Several birds do nest in oilseed rape including species of conservation concern such as skylarks, reed buntings, corn buntings and yellowhammers. Nests of reed buntings within oilseed rape desiccated before harvest were unaffected by the spray whereas all nests were destroyed by swathing. These were thought to be second broods and rape a preferred feeding and food collection area for reed buntings. It was estimated that up to 50% of second broods would be lost as a result of swathing but that most would survive desiccation. On set-aside the use of desiccants rather than mowing prior to cultivation allowed more birds and their nests to survive and the chicks to fledge. Selective use of pesticides can also be important in maintaining desired vegetation in some areas (Varney et al, 1995).

Global warming

There is now general acceptance of an anthropogenically driven change in the world and UK climate. Evidence in support of these changes has come from measures of the length of the growing season for plants in northern latitudes (Myneni et al. 1997) and from the nest record scheme of the BTO. Since 1939 this scheme has gathered data on the breeding performance of UK birds. An analysis of some of these data from 1971 - 1995 (Crick et al. 1997) found significant trends towards earlier egg laying for many species including farmland species and corvids. The mean laying date was almost 9 days earlier in 1995 than in 1971 and ranged from 4 –17 days earlier. The consequences for bird populations are uncertain. Overwinter survival might be improved if the juveniles are older but conversely if they become out of phase with their food supply fewer from the early nesting attempts may survive. Certainly early nesting would create a greater risk from late cold periods and the disappearance of invertebrate food supplies.

A pesticide tax

If a pesticide tax were to be implemented, the basis on which it is operated needs to be defined. Several different options are considered in the report to the DETR, the preferred one being to differentiate between pesticides to reflect relative risk and to apply a per kilogram tax to drive down overall pesticide usage.

However, it is difficult to define relative risks, especially given the different use patterns for a pesticide. Five of the six proposed criteria are simple indicators of hazard, such as LD_{50} values in mammals or LC_{50} values in water for fish. It should be noted that the words hazard and risk are used interchangeably within this report, but in pesticide-appraisal schemes they have very different and well-defined meanings. Hazard is the intrinsic toxicity posed by a chemical (e.g. mammalian LD_{50}) whereas

risk is the potential harm caused by a hazardous chemical where usually the hazard is mitigated by methods to limit exposure. In looking to achieve environmental benefits, ideally one should classify by risk and not by intrinsic hazard, though of course the latter is much easier to do in a paper exercise especially as the risks may vary in different use situations.

Will the 'banded per kilogram' pesticide tax achieve the desired benefits? In terms of reducing overall weight of pesticides used, it may well do and this may be of benefit for example to the water industry which has to clean up contaminated surface waters (albeit only to meet arbitrary EU standards for drinking water). However in terms of reducing risk to the environment, it seems highly unlikely that this will be a successful instrument, for the hazard criteria primarily used in the banding scheme are too over-simplistic leading to many anomalies.

Some examples of these difficulties are now considered. In general, insecticides carry the highest banding penalty followed by fungicides and then herbicides. However, the effects of fungicides on any macroindicator of biodiversity, for example bird, insect or hedgerow plant communities, will be negligible; thus the farmers will be paying a substantial tax for no environmental benefit. With regard to farmland birds, it is probably the use of herbicides (together with and confounded by tremendous changes in agricultural practices and loss of natural habitats) that has most impact, but these are subject only to a low tax banding. Herbicides comprise about 50% of pesticide use in the U.K. and indeed worldwide. And the use of a per kilogram tax brings in further difficulties: phenylurea herbicides such as isoproturon are used at 1500 g ha^{-1} whereas a sulfonylurea such as metsulfuron-methyl is used at 15 g ha^{-1}. Since the hazard-based bandings are similar for the two, then a weight-based tax will have no impact on the cost of low-dose herbicide although this herbicide would no doubt control weeds perfectly well and so potentially deplete the food supply for certain farmland birds.

Although one of the driving forces for trying to reduce pesticide use is the perceived reduction in numbers of farmland birds, the point has to be made that bird populations, though sensitive to environmental change, are actually a very poor indicator of biodiversity. Birds are highly mobile, can rapidly recolonise any area once conditions are changed for the better (e.g. Minsmere Reserve in Suffolk was rough grazing until flooded during the Second World War) and furthermore rely predominantly on only a few species for food. In contrast, many herbaceous plants in hedgerows and their assorted invertebrate fauna will be relics of former woodland and once destroyed, whether by agricultural intensification or careless use of herbicides, then recolonisation would be very slow if at all given the now very fragmented nature of these relict habitats.

The way forward?

The evidence for the decline in the populations of some farmland birds is clear. It is also clear that the main contributory cause is the way that farmland and the landscape in general is managed. Policy changes that influence management have not, in the past, specifically addressed the issue of bird populations. However, decisions to encourage agricultural production brought with them a wide range of consequent actions, usually now pejoratively described as intensification, which have certainly

contributed to changes in the relative populations of birds. However, other actions, directed essentially at environmental targets, on perhaps a smaller scale, have probably also had effects. The control of rabbits by myxomatosis changed vegetation structure and affected birds, and the straw-burning ban almost certainly had an effect by encouraging the early cultivation of cereal stubbles.

If society wishes to retain a diverse bird population, and few would disagree with the view that birds enhance the pleasure and enjoyment of the countryside, then measures to achieve that end need to be based on good evidence that their implementation will achieve the desired result. While setting targets is a popular recent activity, biological systems do not lend themselves readily to such man-made approaches. Target setting has brought benefits to birds, notably those that are very rare and for which specific, often localised, measures are achievable.

Stabilising or reversing the declines in more common farmland species seems very unlikely to be achieved by the imposition of a pesticide tax. The anomalies and difficulties associated with devising a tax in the first place, the unpredictability of the farming communities' response to a banded tax and the lack of any evidence that pesticides alone are a significant cause of the declines reported indicates that the **only** predictable outcome of the imposition of a tax would be a further charge on an already hard-pressed industry fuelling the decline of profitability across the sector as a whole and the loss of several thousand jobs.

There are already indications that, in arable areas at least, some of the biodiversity parameters are improving (CS 2000). There is a range of Stewardship Schemes either in existence or at the Pilot stage and the effective use and introduction of such measures seems a much more effective way of retaining a viable agricultural industry and a diverse wildlife associated with it. As a result of the concerns about bird populations there is an enormous increase in the information available about the specific requirements of bird species throughout their lives and this should be utilised when introducing new and modifying existing schemes. Most of these schemes have concentrated on arable areas and there would seem to be a need to address issues relating to grassland management which have been neglected in the past. The specialisation of farming in recent years and the consequent loss of mixed farming has been detrimental to birds, but even in mixed farming areas and certainly in largely pastoral regions, how grass is managed is critical to bird survival and diversity.

Agri-environment schemes cost money and some see a pesticide tax as a way of financing such schemes. As outlined above, the cost of any tax would largely fall on the arable sector whereas much of the evidence suggests that it is the pastoral sector where some of the problems lie. Thus for most arable farmers the tax would not be cost neutral even if the agri-environment schemes funded by the tax were suitable for their farms, which in many cases they would not. Even those advocating a tax do not see it as a stand-alone measure, although that impression is sometimes conveyed. The RSPB (internal document via Dr Armstrong–Brown) make many of the arguments outlined above such as the polluter pays principle and the requirement for a range of "pesticide stewardship" approaches funded through the hypothecated pesticide tax. But they do recognise that pesticides are only part of the farming v. bird diversity discussion and would support alternatives to the tax provided they delivered

equivalent environmental benefits. The problem with this approach is that it is impossible to quantify the benefits that would result from a tax.

Documents and proposals concerning voluntary schemes for pesticide stewardship have been submitted to HMG by the CPA/NFU and are being considered. We are not aware of the current position but suggest that a co-operative approach is much more likely to satisfy the requirements of all interested parties than one of confrontation. A recognition, by the farming community of the consequences of their actions, by the conservation organisations of the needs of a viable agricultural sector, and by HMG that whatever methods are used they should be based on sound science and evidence that they are likely to deliver the desired results, seems the best way forward. We are aware that many discussions are already underway and it is beyond the scope of this report to comment on the financing of any actions. However, for the reasons given and discussed above we see no readily definable benefits to farmland birds as a group resulting from the imposition of a pesticide tax but much scope for agri-environment schemes with well-defined scientifically sound approaches.

Acknowledgements. Many people spent time talking to us and providing supporting documents. We are most grateful for their help. In the time available it was not possible to contact everyone with an interest in this area but we are especially grateful to the staff of the RSPB, BTO, GCT and NFU.

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The views expressed in this report are those of the authors alone.