Environmental Studies
FACT SHEET
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Birds as Biomonitors

Biomonitoring: use of living organisms sensitive to pollution or habitat change which decline in number or disappear when pollution levels rise or their habitat is altered.

Effective biomonitors: are easily identified; widespread – not confined to one area of the UK or a specific habitat; have a narrow tolerance range to pollution.

Examples: aquatic invertebrates used in TBI/BMWP for water quality monitoring, detritivores in soils, farmland bird species as part of the UK Government's Biodiversity Action Plan.

Background

Monitoring of populations of common bird species in the UK began in the early 1960s with the British Trust for Ornithology's (BTO) government-funded Common Bird Census (CBC). Although it is now clear that many of the now familiar declines in farmland species began in the mid 1970s, the severity of the situation was not realised until much later. The first indications that modern agriculture was to blame came from the Game Conservancy Trust's long-term studies of grey partridge *Perdix perdix*. These identified the damage to the bird's food chain through the indirect effects of herbicides as the primary cause of the decline.

In the late 1980s, the Royal Society for the Protection of Birds (RSPB) began research on three species under severe threat of extinction in the UK; corncrake *Crex crex*, stone curlew *Burhinus oedicnemus* and cirl bunting *Emberiza cirlus*. The research programmes identified changes in farming practice as the primary cause of decline for all three formerly widespread species (Table 1).

Table 1. Species decline

Species	Reason for decline
Corncrakes	Early, faster and more frequent cutting of the long grass they require for breeding, leading to nest destruction. This change was brought about by: • increased efficiency due to mechanisation • improved productivity of grass through application of inorganic fertilisers • switch from hay-making to silage production
Stone Curlew	Loss of semi-natural grassland, increased vegetation height, due to: • a reduction in rabbit grazing after myxomatosis • reduced levels of grazing by livestock • loss of spring tillage.
Cirl Bunting	Loss of weed-rich overwinter stubble fields and extensively managed rough grassland which provide adult and nestling food respectively.

Biomonitoring data has identified five key factors that are likely to have driven farmland bird population declines:

- change from spring to autumn sowing of cereals
- changes in land use diversity at both landscape and farm scale
- increases in artificial fertiliser causing changes in grass and cereal sward structure
- increases in livestock densities
- loss of rough grazing

In 1995, a group of non-governmental wildlife organisations reviewed the information on bird population status and trends in order to agree revised priorities for bird conservation in the UK. Birds were assigned to the top priority or 'Red List' if they had undergone population declines of 50% or more in the previous 25 years or an historical decline between 1800 and 1995. Of the 36 species assigned to this list, no less than 10 were once common and widespread farmland birds. A further 4 had been rare but were nevertheless associated predominantly with lowland farmland habitats. The UK Government's Biodiversity Action Plan (BAP), launched in 1995, also recognised the severity of the problem and action plans were subsequently published for all 14 species

In 1999, the Government formally recognised the importance of biodiversity to the 'quality of life' in the UK by adopting wild bird populations as one of 14 headline indicators of sustainabililty. This included an index based on the composite trends of 20 widespread species which breed predominantly on farmland and which have declined by c. 40% since the mid-1970s.

Population declines of farmland birds in Britain are now considered sufficiently serious that the UK Government is committed to action under the UK BAP. For example, the target is to halt the decline of tree sparrows by the year 2003 with an increase in range by 2008. It is clearly important to establish the causes of these declines if they are to be halted.

Disadvantages of biomonitoring

- the appearance of a predator or inter-specific competitor can affect the population of the biomonitor.
- it does not give specific information about the pollutant present or nature of the habitat change – particularly so for birds towards the top of food chains.
- there is often a time lag between the environmental change or increased pollution and the population change. This makes establishing cause and effect difficult.

Monitoring Data

A range of bird monitoring data exists in the UK, from national monitoring schemes covering a wide range of species (e.g. CBC) to specific monitoring of nationally rare species e.g. cirl bunting (Table 2).

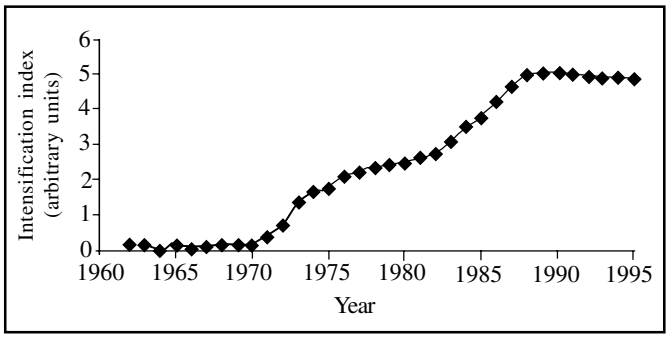
Table 2. Data summary of bird monitoring schemes

Scheme	Sampling unit	Coverage	Method	Data
Breeding Birds Atlas	10-km square	Whole GB and Ireland. Covers two periods, 1968-72 and 1988-91	Timed visits to tetrads within each square to record presence of all birds located.	Presence/absence per 10 km squares
Common Birds Census (CBC)	Variable sized plot (7-313 ha)	GB, but bias towards southern Britain. Approximately 100 farmland plots per year. Annual since 1962.	Territory mapping technique applied to bird registrations collected over several visits. Simple habitat data collected.	Relative annual population change
Breeding Birds Survey (BBS)	1-km square	Randomised sample throughout GB and NI. Approximately 2000 squares per year. Annual since 1994.	Distance sampling techniques applied to bird transects. Simple habitat data collected	Density and percentage population change
Species-specific surveys (widespread species)	Typically 1-km square	Typically randomised sample of squares throughout GB.	Species-specific	Density and estimated population size
Species-specific surveys (scarce species)	Variable	Typically whole species range	Species-specific	Often complete population census

Such schemes have three main purposes: to monitor changes in abundance and distribution over time; to estimate actual population sizes at national or regional scales; and to consider bird-habitat relationships. The design of species-specific surveys can enable a much more accurate assessment of bird-habitat relationships than many national monitoring schemes. Most of the evidence for population declines has come from the CBC, an annual national monitoring scheme for breeding birds. Although the CBC has been a very useful tool in demonstrating population declines, it has one major drawback in that the sites are not evenly distributed in the UK, but are biased towards the south and east. Estimates of population change are therefore only representative of lowland England.

Fig. 1 shows the trend in agricultural intensification in the UK. The graph summarises 32 different factors in order to get an overall view of intensification.

Fig 1. Trend in agricultural intensification



According to Fig 1, the major period of intensification was between 1970 and 1988, with periods of relative stability before and after. The changes have not been country-wide, but have varied regionally, reflecting the fact that arable farmland dominates in the east and grasslands dominate in the north and west.

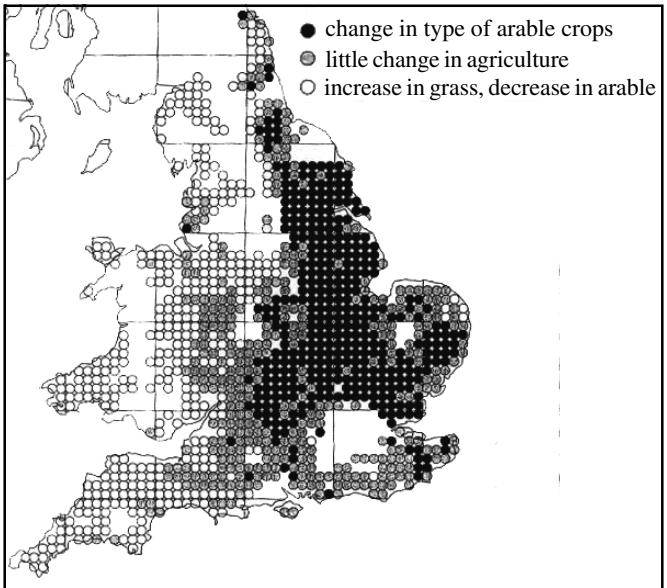
The majority of declining farmland species show a close temporal matching with the index of intensification shown in Fig 1 but in order to gain some insight into specific causes of decline, individual variables need to be considered.

The CBC index for 11 farmland passerines was analysed in relation to 18 agricultural statistics, nitrogen application being the most commonly selected variable.

Winter or spring sown barley was selected in 6 granivorous passerines (greenfinch, goldfinch , linnet , bullfinch, corn bunting and reed bunting. Declines were associated either with an increase in winter barley or a decrease in spring barley.

Such species, including grey partridge, lapwing ,turtle dove, tree sparrow, corn bunting and reed bunting have tended to show a marked contraction in range towards the south and east. Losses in all of these species have shown similar geographical patterns to the pattern of intensification shown in Fig 2.

Fig 2. Intensification in lowland England and Wales 1970 - 1988



10 km squares defined according to 18 spatial agriculutural variables (changes in type of arable crops decreases in fodder roots and spring cereals and increases in winter wheat and oilseed rape).

Monitoring data used in conjunction with habitat data can give a general idea of patterns of decline, but in order to identify more firmly likely factors underlying population declines, species-specific surveys tend to be more valuable. This is for two main reasons. Firstly, the survey can be designed to eliminate geographical or methodological biases that may exist in broad-scale monitoring schemes. Secondly, the collection of habitat data can be more targeted and specific hypotheses can be tested.

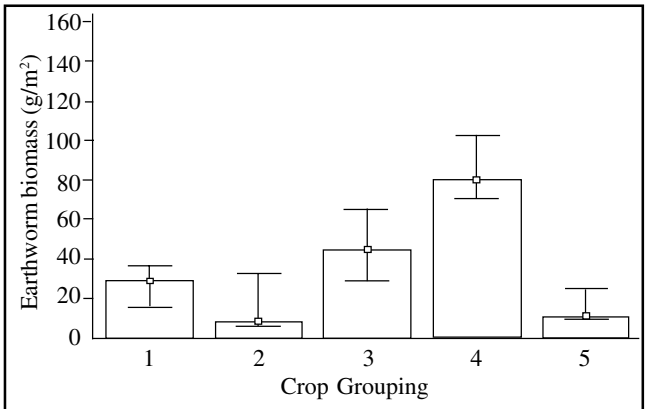
Lapwings

A national breeding survey of lapwings in 1998 revealed almost a 50% decline in just 11 years. On arable or mixed farmland, the highest densities of breeding lapwings were found on spring cereals. In common with the skylark, the vegetation characteristics of spring cereals are probably most preferred by nesting lapwing, but there is also evidence that spring cereals are more productive. The highest densities of all occurred in spring cereals that were adjacent to grass fields. This is likely to be due to the foraging requirements of the fledglings as grass fields seem to be a favourite feeding habitat. Therefore both declines in spring cereals and the fact that arable farms are now less likely to have adjacent grass fields than in the 1960s may have affected the population. On pastoral farmland, lapwings prefer to breed on rough unimproved grassland and avoid silage and heavily grazed grassland. Conversion of rough to 'improved' grassland (e.g. by drainage and re-seeding) and the increase in livestock densities is likely to have had negative impacts on lapwing populations.

A study was conducted over the breeding season March to May 2000, within the Arable Stewardship Pilot Scheme area in the West Midlands. Soil samples were taken using a soil corer with 10 cm diameter and 10 cm depth. Ten samples were taken from random positions within the central area of fields. Faecal samples were collected from chicks and crop specific soil moisture deficit (SMD) was determined.

There were differences in earthworm biomass between crop types with the highest biomass recorded on pasture fields (Fig 3). Cultivations and high SMD had a negative effect on earthworm biomass. Earthworm chaetae were present in 94% of chick faecal samples and they were more common in faeces from older chicks. This suggests that to maximise the benefits of agri-environment schemes for lapwings, land management that promotes earthworm biomass should be considered.

Fig 3. Median earthworm biomass by crop grouping



1 = overwintered cereal/linseed stubbles followed by spring/summer fallow
2 = winter cultivation 3 = rotational set-aside
4 = pasture 5 = spring cultivation

RSPB's Operation Lapwing

Aims to help farmers bring lapwings back by offering free advice on management and helping them to enter agricultural schemes that provide money for such work. Nesting lapwings need sparse vegetation and plenty of earthworms and insects so farmers should :

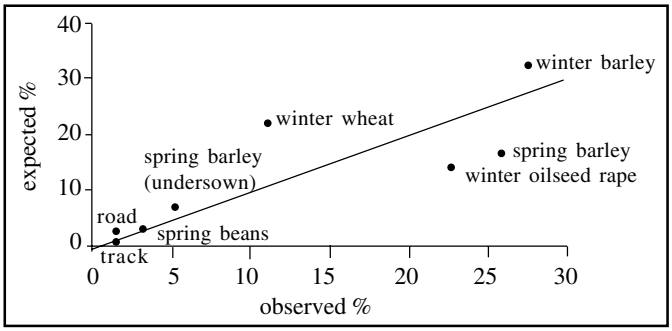
- grow spring cereals or root crops
- carry out all machinery operations by end of March
- mark lapwing nests to avoid destroying them with machines
- create wet or boggy areas, grassy pasture or set-aside where chicks can feed
- on livestock farms a large open field away from mature hedgerows or woodland is best
- fields with boggy corners, wet flushes, shallow ditches or waterlogged soils are best
- use cattle to provide the 'bumpy' grass sward lapwings love
- tight grazing through late summer and autumn creates ideal nesting habitat the following spring so long as livestock is removed before then.

Chick food for farmland birds

The development of more efficient pesticides and an increase in the proportion of farmland which is sprayed has led to a reduction in the availability of invertebrates and plant food produced within the crop. For many farmland birds, invertebrates are an essential dietary component but especially so for chicks, which require a high protein diet. Poor availability of invertebrate chick food has been implicated in the decline of the grey partridge, skylark and corn bunting. Poorly fed chicks have lower resistance to adverse weather conditions while slower growth rates increase the time spent in the nest and the risk of predation. Predation may also increase because hungry broods beg more loudly and for longer and lower insect abundance increases the time the adults are away from the nest foraging.

Invertebrates were sampled during the summer of 1999 and 2000 from 12 1km sq blocks of arable farmland. The populations of invertebrates important in the diet of yellowhammers and the grey partridge were investigated between the crops and for the edge and mid-field positions. Most invertebrates were found at the edge compared to in the field centre and differences were always found between crops. Break crops (oilseed rape, beans) often supported the most invertebrates and root crops (potatoes and sugar beet) the least (Fig 4).

Fig 4. Proportions of different habitats of yellowhammer nests



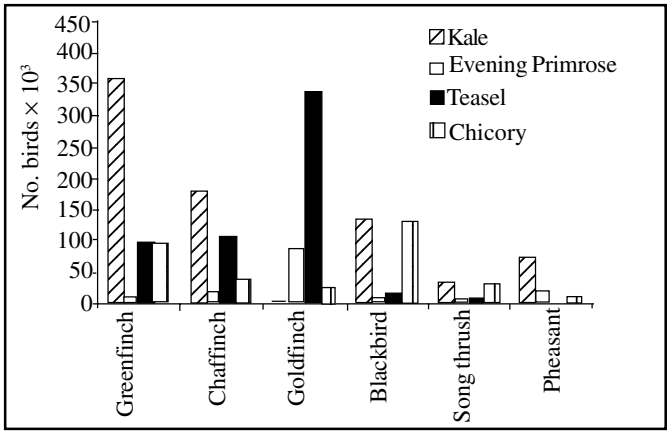
Winter food crops for seed-eating farmland birds

Overwinter survival may be an important factor influencing declines of seed-eating farmland bird species, and evidence suggests that seed availability on farms over the winter period has been reduced. The provision of food resources by growing crops on set-aside or under agri-environment schemes may help bird populations when natural seed supplies are low.

In 1998 a three-year project was begun to assess the value of crops grown to feed birds as a food source during the winter.

Bird species differed in the crops they used. Most species used a variety of crops, but yellowhammers used mainly cereals and greenfinches were largely restricted to borage, sunflowers, and later in the season, mustard. Crops used by several bird species included kale, quinoa, fat hen and linseed. Buckwheat was little used and few birds other than greenfinches fed on borage and sunflower (Fig 5).

Fig 5. Use of biennial crops by six bird species



Conclusion

In the last decade there have been huge declines in widespread and common species associated with farmland habitats. Such declines have been linked to the process of agricultural intensification which tend to turn ecosystems into monocultures. Farmland covers 75% of the UK land area.

In response to the 1986 Agriculture Act, the Government introduced five Environmentally Sensitive Areas (ESAs), to safeguard areas of countryside where the landscape, wildlife or historic interest is of national importance. By definition, ESAs were designed to target specific, local problems, not widespread common birds, so none of the original designations included provision for lowland farmland birds. Nevertheless, when prescriptions were reviewed in the late 1990s, overwinter stubbles were included in some ESAs in the South Downs, Breckland, Cotswolds and West Penrith.

In 1997 a group consisting of RSPB, the Game Conservancy Trust and English Nature developed the 'Arable Incentive Scheme'.

The success of the pilot was assessed over three years. At the whole-farm scale, wintering granivorous passerines showed some benefit, as did thrushes and wagtails. Breeding populations of lapwing, reed bunting, greenfinch, house sparrow, starling and yellow wagtail increased.

In the spring of 1997, a large mixed farm of 282 hectares was selected to demonstrate an advanced, ecologically aware, economically viable farming system. The farm (Titley Court, north-west Herefordshire) comprises 166 hectares of arable, 14 hectares of woodland and 102 hectares of grassland. The object was to implement management based on a sustainable whole-farm integrated system according to the principles stated by the Institute of Biological Control. To understand the ecology of the site, detailed surveys were conducted on the soils, the hedgerows, field margins, the water courses, the 'in-field' flora and the summer nesting and over-wintering bird populations.

Cropping, grassland management, hedgerow and field margin management have been integrated with environmental management. The objective was to increase biodiversity and encourage the establishment of flora at the field edge, to support populations of beneficial invertebrates and increase bird numbers. Monitoring procedures were put in place to quantify the effects of the changes in farm management on the biodiversity of the site.

During the four year recording period, a total of 96 different species of birds were recorded on the farm. Seven of the bird species recorded were on the Birds of Conservation Concern Red List and eight were on the Amber List (Table 3).

Table 3. Percentage change in bird numbers at Titley Court Farm

	Titley Farm 1997 to 1999	Regional 1997 to 1999	National 1994 to 1998
Blackbird	+132	+17	+3
Chaffinch	+64	+26	+4
Song Thrush	+200	+40	−1
Mistle Thrush	+100	+40	−6
Yellowhammer	+83	+6	−16
Skylark	+21	+23	−5
Tree Sparrow	+600	nil	−8

There has been a large increase in bird breeding territories over the period of the project with seed-eating birds appearing to benefit the most.

The overall conclusion seems inescapable: the biomonitoring of farmland birds must remain central to the Government's UK BAP and that IFM will lead to environmental recovery if encouraged through the European Union's Common Agricultural Policy.

Practice Questions

1. Describe the trends and correlations shown in Fig 1, 2, 4 and 5.
2. Which statistical test could be used to interrogate the data in Table 3? Justify your choice.
3. What are the limitations of using farmland bird species as biomonitors?
4. Plan an investigation into declining farmland bird species in your area.

References to specification:
10.1 and 14.4 feedback mechanisms
10.2 global climate change
12.3 food chains and webs, changes in ecosystems
12.4 populations
12.5 wildlife conservation
13.3 environmental impacts (of agricultural production systems)
14.1 introduction to pollution
14.3 water conservation and pollution.

Synoptic links:
12.3 changes in ecosystems
13.3 environmental impacts of agriculture
12.5 wildlife conservation
14.3 indicator species
12.4 populations
12.3 food chains and webs
10.1 feedback mechanisms, introduction to pollution.

Useful sources of information
www.rspb.org.uk = general data and Hope Farm.
www.ukbap.org.uk/ = UK Government's Biodiversity Action Plan.
www.sustainable-development.gov.uk/indicators = UK Government's BAP targets.

Acknowledgments: This Factsheet was researched and written by Tony Corscadden
Curriculum Press, Unit 305b, 120 Vyse Street, Birmingham. B18 6NF

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