DEVELOPMENT OF BREEDING BIRD MONITORING IN THE UNITED KINGDOM AND ADOPTING ITS PRINCIPLES ELSEWHERE

Richard D. Gregory

ABSTRACT

Gregory R. D. 2000. *Development of breeding bird monitoring in the United Kingdom and adopting its principles elsewhere.* Ring 22, 2: 35-44.

The development of common landbird monitoring in the United Kingdom (UK) over the last thirty years provides a useful case study of how breeding bird monitoring has changed and how it is likely to develop in the future. Survey design in the UK has advanced considerably from a system of territory mapping with free choice of census plots to line transects based on a formalised, random sampling strategy. This process has extended monitoring from a few hundred census plots to many thousands and adequate coverage from around fifty to over one hundred species. The single most important message to emerge from this experience is that the sampling strategy is crucial to the success of any new monitoring scheme – the survey method, while important, should be viewed as a secondary consideration.

R. D. Gregory, RSPB, The Lodge, Sandy, Bedfordshire SG19 2DL, United Kingdom, E-mail: richard.gregory@rspb.org.uk

Key words: breeding bird monitoring, sampling strategy, survey method, survey design, randomisation

INTRODUCTION

In this paper, I describe the development of common landbird monitoring in the United Kingdom (UK) over the last thirty years. One of the first distinctions that needs to be made is between the sampling strategy (which defines how the survey plots are chosen) and the survey method (which defines how the data are collected in the field). Together, these define the survey design. In discussing the UK experience, I also draw out some general issues that are applicable to many areas of survey work, particularly when setting up new, or modifying existing, common breeding bird monitoring schemes.

COMMON BIRDS CENSUS AND BEYOND

The first co-ordinated, large-scale survey work on widespread landbirds in the United Kingdom began in the 1960s at the instigation of the Nature Conservancy (now the Joint Nature Conservation Committee – JNCC) and the British Trust for Ornithology (BTO). The motivation for the survey came from fears about habitat degradation on farmland and, in particular, the deleterious impact of pesticides (Marchant *et al.* 1990). Hence the Common Birds Census (CBC) was born and by the mid-sixties a range of habitats were being censused using a standardised territory mapping method based on the techniques developed by Enemar (1959). The method is based on a series of census visits made by volunteers to a pre-chosen survey plot through the breeding season (usually around ten visits) from which clusters of bird registrations, which are taken to represent bird territories, can be identified. The latter process is carried out by specialist staff at BTO so that subjectivity is minimised and there is consistency in the standard of territory mapping through time. There are at present around two hundred plots counted each year and they focus on farm and woodland habitats. The scheme covers around fifty common species with a reasonable degree of precision out of over 200 breeding bird species in the UK.The primary objective of the CBC in its early years was to assess the potential environmental impacts of toxic chemicals in agriculture. It was only as the time series accumulated that the relevance and importance of the data to wide-scale, common bird monitoring became apparent. In recent years, the CBC has been the cornerstone of major revisions to the list of birds of conservation concern in the UK (Gibbons *et al.* 1996) and in identifying the worrying plight of many lowland farmland birds (Fuller *et al.* 1992, Siriwardena 1998).Despite these undoubted achievements, however, the ultimate use of the data has been compromised by survey design in a number of ways. First, because plot selection has been based on free choice it remains arguable as to how representative the bird trends are of the wider countryside. In fact, plots are concentrated in the south and east of England and while they might provide reasonable coverage of that area, they cannot be viewed as representative of the UK. Second, and related to the point above, the high demands of the fieldwork effort from volunteers and associated analytical time at BTO headquarters have limited the numerical and geographical expansion of the scheme. Third, habitat coverage is limited to farms and woods and there has been rather limited habitat recording through time.Against this background, the BTO, in collaboration with other conservation organisations, began to explore alternative survey designs for common bird monitoring in the UK (Baillie and Marchant 1992, Greenwood *et al.* 1995). This involved a series of both field- and desk-based studies. These included comparisons of point count and territory mapping results (Gregory *et al.* 1994), line and point count transects (Gregory and Baillie in press.) and differing sampling strategies (Gregory and Baillie 1994, Gregory and Baillie in press). This work was guided by an independent technical panel of ornithologists and stat-

isticians from a range of organisations. The input of this group was considerable and highly beneficial to the project. The key findings were as follows:

1. A comparison of standard CBC territory mapping with point counts carried out on the same plots showed that between-year changes from the two methods correlated moderately well. Changes from territory mapping were twice as precise as those from point counts, but importantly, the total time required to carry out and analyse mapping data was seven times greater.
2. An extensive pilot study in 1992 and 1993 compared line transects and a combined method of point counts linked by transect sections in randomly selected one kilometre squares of the National Grid. These two methods provided similar measures of between-year change with similar levels of precision. The line transect method was favoured because (a) it was preferred by volunteers, (b) required less time per visit, (c) recorded more birds per unit time, (d) was slightly more precise at measuring change, and (e) could be applied in a wider range of habitats than point counts. These trials showed the practicability of volunteers carrying out bird counts in randomly chosen squares through a network of volunteer organisers.
3. A desk-based study was used to assess the suitability of four separate sampling strategies to monitor widespread species. The starting point for each stratification was the distribution of volunteers since this is something that cannot be altered. Each strategy chose more squares where there were more potential volunteers. Hence, the sampling strategy is able to cope with unevenly distributed volunteers without introducing bias. Squares were selected (a) according to observer density, (b) according to observer density but on a regular grid, (c) according to observer density with proportional numbers of squares per land class and (d) according to observer density with a constant number of squares per land class. Stratification by habitat type in (c) selects squares in relation to their commonness, providing good representation and (d) oversamples rare habitats and thus rarer species in these habitats. Simulations were also used to assess the relative benefits of adding in extra fieldwork effort in more remote regions, and in reality, this could only be achieved through using professionals. The results from the four sampling strategies were surprisingly similar in terms of the predicted species coverage and its precision. The grid based stratification performed worst, while simple random sampling (a) provided monitoring that was comparable with the more complicated stratification by habitat. As you might expect, professional input was most valuable in increasing species coverage in those areas with the lowest observer density. In conclusion, simple random square selection with the numbers of squares in each region weighted by observer density was considered the most appropriate design for a new UK-wide monitoring scheme.

BREEDING BIRD SURVEY

The evaluation work culminated in the introduction of the Breeding Bird Survey (BBS) in the UK in 1994 (Gregory *et al.* in press). The scheme is financed and run

by a partnership of BTO, JNCC and The Royal Society for the Protection of Birds. The basic features of the survey follow the pilot work. Its strategic aims were to improve the geographical representation of monitoring, to improve the habitat representation of monitoring and to increase species' coverage across the UK. In order to achieve these aims it was imperative that the new survey was based on a formal randomised sampling strategy. The BBS aimed to provide precise information on year-to-year and longer-term changes in population levels of a spectrum of common/widespread species across a range of habitats in the UK.

Survey squares (1 × 1 km squares of the National Grid) were selected as a random sample stratified by observer density from within 83 regions across the UK. At a local level squares were allocated to volunteers through a network of voluntary BTO regional organisers. Each organiser received a list of target squares for their region to be allocated to volunteers in strict order from the top downwards. This was essential in maintaining the random design. The same squares would be surveyed year after year and new volunteers would be found if the original one dropped out. Fieldwork involves three visits to a square per year; the first is used to record details of the habitat and to mark the survey route, the second and third visits to count birds using a line transect method. The ideal survey route comprises two parallel lines each 1 km in length. Each of these lines is divided into five sections (each 200 m in length), and birds and habitats are recorded within these units. Habitat type and land use are recorded annually on a habitat form using a standard system (see Crick 1994). The parallel recording of land use and habitat change on the same plots would facilitate a better understanding of the factors responsible for population changes, and this will be particularly important for populations in decline.

Count visits are timed, so that the first is in the early part of the breeding season (April to mid May) and the second in the late part (mid May to the end of June). Visits should be at least four weeks apart. Volunteers are asked to begin their counts between 6 *a.m.* and 7 *a.m.* They record all the birds they see or hear as they walk along their transect routes and are encouraged to pause, listen and scan for birds. Birds are noted in three distance categories (within 25 m, between 25-100 m, or over 100 m either side of the line) measured at right angles to the transect line, or as in flight. Recording birds in distance bands provides a measure of bird detectability in different habitats and allows population density to be estimated (Bibby *et al.* 1992, Buckland *et al.* 1993). The average visit time is around 90 minutes.

All the survey forms are designed so that the data can be readily computerised. Beyond a careful check once the forms are received at BTO headquarters, no time is required in interpretation.

The analysis of population change between years is based upon a TRIM-type model (loglinear poisson regression – ter Braak *et al.* 1994; Panneoek and van Strien 1996) although it is carried out in a statistical package (SAS 1989). Observations are weighted by the area of the sampling region they come from and by the

number of squares surveyed within that region. Larger regions get higher weight but increasing the number of squares within a region reduces the weighting. In this way population change figures are unbiased by observer distribution.

With the BBS now in its fifth year, it is proving a tremendous success. The number of squares counted has gone up from 1569 in 1994 to 2297 in 1998 – well above expectations and providing excellent coverage across the UK. The scheme monitors over a hundred common species with good to reasonable precision. The first five years show 33 species to be increasing significantly and 20 to be declining significantly (Noble *et al.* 1999). While the time-series is too short to draw firm conclusions, the scope of the monitoring is impressive. Significant declines among birds such as Cuckoo (*Cuculus canorus*), Swift (*Apus apus*), Skylark (*Alauda arvensis*), Spotted Flycatcher (*Musciapa striata*), Starling (*Sturnus vulgaris*), House Sparrow (*Passer domesticus*), Linnet (*Carduelis cannabina*), Bullfinch (*Pyrrhula pyrrhula*), Yellowhammer (*Emberiza citrinella*) and Corn Bunting (*Milaria calandra*) give pause for thought. The scale of monitoring also allows country-based trends to be assessed, for example, for Wales and Scotland, and this has already pointed out heterogeneity in some bird trends.

The BBS will soon be taking over the main monitoring role for common and widespread birds in the UK and it is planned for the CBC to be discontinued. Recent studies have also used the data to examine broad scale bird-habitat relationships (Gregory and Baillie 1998, Chamberlain and Gregory 1999, Gregory in press) and to test theoretical explanations of commonness and rarity (Gregory and Gaston in press).

ADOPTING THE PRINCIPLES ELSEWHERE

A number of general messages emerge from the experience in the UK and from elsewhere in Europe. They can be reduced to a series of questions or points that are basic considerations when embarking on a new monitoring scheme:

What are the objectives of the monitoring?

It is imperative that the objectives of the monitoring are defined at the outset. The objectives must then be matched to the sampling strategy and the fieldwork method. One needs to decide on the species and sites/areas/regions to be covered. Consideration should also be given to the level of precision required, even if this is in broad terms. One should probably resist specific/topical issues if the main purpose of the scheme is to measure long-term change. The broader the base of the monitoring the more likely it is to pick up environmental problems, some of which would not have been predicted.

What resources are available?

By resources, I mean both skilled amateur and professional ornithologists and the finances to support a monitoring scheme. Basic know-how, such as knowledge

of bird identification and a tradition of volunteer involvement in organised survey work, is a considerable advantage. The potential number of volunteers and their spatial distribution is also crucial to the survey design. In terms of financial resources, one needs to bear in mind the long-term nature of the survey work. It is advantageous to build partnerships of non-governmental organisations and governmental agencies so that the costs of running the project are shared and they then share ownership of the results.

What is the sampling strategy?

The sampling strategy is all-important to the ultimate success of the monitoring. With a growing need for detailed information on population trends we need to ensure that the data collected are properly representative of the countryside and reasonably precise. This requires a formal sampling strategy, which should ideally incorporate random sampling and stratification. The latter process is usually used to increase precision by defining strata, in which the variance within strata is smaller than the variance across strata (broad habitats are the most obvious strata if we feel population changes will differ among them). However, in the UK example it is actually used to accommodate differences in the distribution of volunteers without biasing the results. Since volunteers are almost always concentrated in particular areas this procedure could be usefully adopted elsewhere. The key questions will be the optimum number of sample plots and their distribution. These issues can be assessed by reference to existing data in simulation studies or by carrying out carefully designed pilot studies.

What is the survey method?

As the survey method needs careful thought, and should be matched to the manpower and the habitats of a particular region or country, there is no single best method (Bibby *et al.* 1992, Bibby *et al.* 1998). There are three main fieldwork methods, line and point transects and spot or territory mapping (and there are various combinations). Each of the methods has both strengths and weaknesses (Table 1) and individual studies should be tailored to their specific needs. In general, territory mapping is probably the most inefficient method because it is demanding of much time in the field and in analysis (greater time also implies being more expensive to run). Line and point count transects compare moderately well with each other and the choice between them may come down to local conditions and even volunteer preferences. In a sense, the survey method does not matter if it is carried out to a high standard, it complements the sampling strategy, it provides adequate precision, is practical and popular, and thus meets the objectives of the survey. As the methods become more complex and intensive (*i.e.* more site visits per season for longer periods), the level of collected details increases but at some point the amount of new information collected per visit will decline. Hence, you need to consider whether this extra information is necessary for the purpose of the survey. The alternative, which is usually preferable, is to have less intensive fieldwork from

a large number of plots because this increases representation. It may be useful to identify the potential sources of bias and how they might be avoided or minimised. One particular issue is bird detectability, which should be considered carefully for line and point count transects.

Table 1
A comparison of census techniques for common land-birds

	Time in field and analysis	Efficiency	Level of detail	Habitat suitability	Species suitability	Detectability a problem?	Density estimates	Strengths and weaknesses
Territory mapping	High	Low	Fine grained	All habitats - but impractical at large scales	Suits territorial species. Not suited to non-territorial species, semi-colonial birds, birds that sing for brief periods, and non-standard mating systems	No	Obtained directly Good precision - edge territories create problems	Regarded as the most accurate method but this is debatable. Provides a map of bird distribution which allows detailed studies of bird-habitat relations
Line transects	Low-high	Very high	Coarse grained	Extensive, open and uniform habitats	Suits mobile, conspicuous species and those that flush	Yes	Obtained by distance sampling -Reasonable precision	Able to cover large areas quickly and record many birds. Good access is required. Not suited to difficult terrain. Double counting a minor issue
Point transects	Low-high	High	Fine grained	Dense habits - scrub-woodland Can be used in extensive habitats	More suited to cryptic and skulking species than line transects. Not suited to birds that flee from the observer	Yes	Obtained by distance sampling -moderate precision, possibility of overestimation	Allows time to identify difficult and cryptic birds. Bird-habitat relations easily assessed. Suits areas where access is difficult. However, time is 'lost' moving between points. Double counting is a problem - avoid counts over 10 minutes

A general point is that it is usually advantageous to trial the survey methods (and the sampling strategy) prior to the launch of a new scheme. This might even mean discarding early years of data and modifying methods considerably but such measures may be necessary for the long-term success of the project.

How should data be collected?

Careful thought needs to be given to form design, data handling, computerisation and data analysis at an early stage. Coded information is highly desirable be-

cause it is readily and quite cheaply computerised and requires relatively little checking. A method that requires considerable interpretation and extraction of data once returned to the organising institution is likely to be expensive and inefficient. Survey forms should be simplified as much as possible and all data should be coded, *i.e.* bird names, observer name, site codes, dates, weather conditions and so forth. The process of computerisation should also consider methods of analysis and the packages available to assist in doing this.

Should habitat be recorded?

While ornithologists may be reluctant to assess habitat type and land use, experience shows that if this information is not collected, it may be very difficult to interpret and understand population change. Any pointers that can be gleaned from the monitoring data may be useful in diagnosing the cause of population declines and may thus inform conservation action. This is not to say that broad scale monitoring of birds and habitats will provide all the answers but it may provide useful clues as to the causes. It is impractical to expect ornithologists to collect highly detailed botanical/cropping data but they should still be able to collect broad scale data, particularly from a simple coded, hierarchical system.

Running volunteer surveys

In the UK, there is a tradition of surveys being run through networks of volunteer organisers and counters. This is clearly a very efficient way of collecting data and engaging people in conservation. Our experience suggests that you should be ambitious from the outset and with appropriate promotion and training, it is possible to mobilise large number of volunteers. In order to do this one should allow a good preparation period. If a network is established, and this is strongly recommended, it is important to clarify the responsibilities of the organisers, promote good practice and provide them with training and support. Likewise for the volunteer counters, one should provide adequate training, development and support; and listen to their concerns. It is extremely important to provide feedback (in talks, workshops, newsletters, personal letters *etc.*) and to thank volunteers for their efforts.

CONCLUSIONS

There is no single best survey design (sampling strategy or survey method) for common bird monitoring. There are however a number of general principles in survey design that should be adhered to closely. Consideration of the sampling strategy is the single most important factor to emerge from recent work and experience. There is much to be learned from the UK experience and much to recommend the BBS-model when considering monitoring projects elsewhere.

ACKNOWLEDGEMENTS

The biggest thanks have to go to the many volunteer birdwatchers in the UK without whom common bird monitoring schemes would not be possible. Thanks also to Richard Bashford, John Marchant and Stephen Baillie, who have been instrumental in the introduction and success of the BBS, to the BBS Steering Group, and the members of the BTO's Integrated Population Monitoring Group for their help and advice. I thank David Gibbons for constructive comments on the manuscript.

REFERENCES

Baillie S. R., Marchant J. H. 1992. *The use of breeding bird censuses to monitor common birds in Britain and Ireland – current practice and future prospects.* Vogelwelt 113: 172-182.

Bibby C. J., Burgess N. D., Hill D. A. 1992. *Bird Census Techniques.* Academic Press, London.

Bibby C. J., Jones J., Marsden S. 1998. *Expedition Field Techniques: Bird Surveys.* Royal Geographic Society, London.

Buckland S. T., Anderson D. R., Burnham K. P., Laake J. L. 1993. *Distance sampling: estimating abundance of biological populations.* Chapman and Hall, London.

Chamberlain D. E., Gregory R. D. 1999. *Coarse and fine scale habitat associations of breeding Skylarks Alauda arvensis in the UK.* Bird Study 46: 34-47.

Crick H. Q. P. 1992. *A bird-habitat coding system for use in Britain and Ireland incorporating aspects of land-management and human activity.* Bird Study 39: 1-12.

Fuller R. J., Gregory R. D., Gibbons D. W., Marchant J. H., Wilson J. D., Baillie S. R., Carter N. 1995. *Population declines and range contractions among lowland farmland birds in Britain.* Conserv. Biol. 9: 1425-1441.

Gibbons D., Avery M., Baillie S., Gregory R., Kirby J., Porter R., Tucker G., Williams G. 1996. *Bird species of conservation concern in the United Kingdom, Channel Islands and Isle of Man: revising the Red Data List.* RSPB Conservation Review 10: 7-18.

Greenwood J. J. D., Baillie S. R., Gregory R. D., Peach W. J. 1995. *Some new approaches to conservation monitoring of British birds.* Ibis 137, Suppl.: 16-28.

Gregory R. D. in press. *Broad-scale habitat use of sparrows, finches and buntings in Britain.* Vogelwelt.

Gregory R. D., Baillie S. R. 1994. *Evaluation of sampling strategies for 1-km squares for inclusion in the Breeding Bird Survey.* BTO Research Report No. 139. Thetford.

Gregory R. D., Baillie S. R. 1998. *Large-scale habitat use of some declining British birds.* J. Appl. Ecol. 35: 785-799.

Gregory R. D., Baillie S. R. in press. *Survey design and sampling strategies for breeding bird monitoring.* Proceedings of Bird Numbers 1995. Estonia.

Gregory R. D., Baillie S. R., Bashford R. I. in press. *Monitoring Breeding Birds in the United Kingdom.* Proceedings of Bird Numbers 1995. Estonia.

Gregory R. D., Gaston K. J. in press. *Explanations of commonness and rarity in British breeding birds.* Oikos.

Gregory R. D., Marchant J. H., Baillie S. R., Greenwood J. J. D. 1994. *A comparison of population changes among British breeding birds using territory mapping and point-count data.* In: Hagemeijer E. J. M., Verstrael T. J. (Eds). *Bird Numbers 1992: Distribution, monitoring and ecological aspects.* Proc. 12th Int. Conf. IBCC and EOAC, Noordwijkerhout, The Netherlands. Statistics Netherlands, Voorburg/Heerlen & SOVON, Beek-Ubbergen: pp. 503-512.

Marchant J. H., Hudson R., Carter S. P., Whittington P. 1990. *Population trends in British breeding birds.* British Trust for Ornithology, Tring.

Noble D. G., Bashford R. I., Marchant J. H., Baillie S. R., Gregory R. D. 1999. *The Breeding Bird Survey 1998.* BTO Research Report No 225, Thetford.

Panneoek J., van Strien A. J. 1996. *TRIM (Trends and Indices for Monitoring data). Users manual.* Statistics Netherlands.

SAS Institute. 1996. *SAS/STAT software changes and enhancements through release 6.11.* SAS Institute Inc. Cary.

Siriwardena G. M., Baillie S. R., Buckland S. T., Fewster R. M., Marchant J. H., Wilson J. D. 1998. *Trends in the abundance of farmland birds: quantitative comparison of smoothed Common Birds Census indices.* J. Appl. Ecol. 85: 24-43.

ter Braak C. F. J, van Strien A. J., Meijer R., Verstrael T. J. 1994. *Analysis of monitoring data with many missing values: which method?* In: Hagemeijer E. J. M., Verstrael T. J. (Eds). *Bird Numbers 1992: Distribution, monitoring and ecological aspects.* Proc. 12th Int. Conf. of IBCC and EOAC, Noordwijkerhout, The Netherlands. Statistics Netherlands, Voorburg/Heerlen & SOVON, Beek-Ubbergen: pp. 663-673.