A RE-EVALUATION OF THE AIMS AND METHODS OF THE COMMON BIRDS CENSUS

edited by R.J. O'CONNOR and R.J. FULLER
on behalf of a Nature Conservancy Council/
British Trust for Ornithology Technical Review
Group.

A report on certain research conducated under
NCC contract HF3/03/192 June 1984.

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CONTENTS

SUMMARY

1. The objectives and methods of the British Trust for Ornithology's Common Birds Census (CBC) conducted under contract to the Nature Conservancy Council were reviewed by a joint BTO/NCC Technical Review Group during 1983. The present document is the formal report on the deliberations and conclusions therefrom.
2. The CBC was started in 1962 to provide a means of annually monitoring population levels of the commoner breeding birds on farmland; in 1964 the project was extended to cover woodland birds. The data are collected using a territory mapping method which is described in Chapter 1. The historical development of the CBC in terms of its habitat coverage and sample sizes are also described in Chapter 1.
3. A comprehensive review of the efficiency and suitability of CBC methods is presented in Chapter 2. Basic assumptions behind the scheme are stated. Census efficiency (relationship of CBC results to the true numbers of bird territories) is assessed from both theoretical and empirical standpoints. Many factors may potentially influence the efficiency of census visits: these are described and assessed in relation to CBC practices. The interpretation of the field data by the process of manual territory analysis is also discussed and the possibility of using automated methods is considered but rejected. The procedure of assessing population change by percentage changes in paired samples of plots from consecutive years is evaluated and the long-term consistency and representativeness of the farmland data are examined: an alternative method of estimating population trends, developed by M.D. Mountford, is described. It is concluded that the methods of data collection and interpretation are broadly satisfactory although certain areas of extra validation work are specified.
4. Chapter 3 outlines the objectives of the CBC as specified in the scientific annexe of the NCC contract with the BTO. The extent to which the CBC meets these objectives and the potential range of applications and developments of CBC data are reviewed.
5. A total of 36 numbered recommendations were made by the Review Group. These recommendations are listed in relation to different aspects of the CBC in the final Chapter.

CHAPTER ONE

BACKGROUND TO THE REVIEW

1.1 INTRODUCTION

The present report reviews the objectives and methods of the Common Birds Census scheme conducted by the British Trust for Ornithology under contract to the Nature Conservancy Council. When the scientific annex to the current contract was prepared in September 1979, the NCC specified therein that a review of the CBC should be conducted in 1983, with a view to systematically re-evaluating the objectives of the CBC as the new contract, with its altered terms of reference, developed. The review was also to consider the results of certain methodological checks on the CBC in progress at the time the contract was renewed.

To conduct this review the BTO and the NCC agreed in 1982 to constitute a CBC Technical Review Group composed of BTO staff and census experts from outside Beech Grove, together with BTO Council representatives. The Group consisted of: Dr. P.R. Evans (Chairman), Dr. C.J. Bibby, J.A. Hardman, Dr. R.J. Hornby, Dr. D.R. Langslow, Dr. D. Moss, M. Shrubb, S.M. Taylor; and the following BTO staff attended: Dr. R.J. O'Connor, R.J. Fuller, D.E. Glue, J.H. Marchant, R.A. Morgan, Dr. K. Taylor, P. Whittington and Mrs. E. Murray (minuting secretary). The Group met on three occasions between January and May 1983 and considered various papers prepared by individual members or groups of members working to meet specific requests from the Review Group. The present document is the formal report on the deliberations and conclusions therefrom.

1.2 HISTORICAL REVIEW

The Common Birds Census began in 1962, after pilot work in 1961. The Scheme is based on the use of a territory mapping method developed in Sweden by Enemar (1959) and modified slightly for use in Britain (Williamson and Homes 1964). The rules developed in this fashion were subsequently accepted, with minor modifications, by the International Bird Census Committee in their "Recommendations for an International standard for a mapping method in bird census work" (Anon. 1969). To ensure maximum year-to-year consistency the rules used as guidelines for fieldwork and interpretation of the CBC have been standardized since 1965. Copies of these rules are attached: Appendix 1 contains the original CBC Instructions which guide the observers as to the fieldwork required; Appendix 2 contains the original Guiding Principles for the analysis of CBC returns, the rules followed by BTO staff in undertaking analysis of the CBC results. Appendix 3 contains the latest version of the CBC Instructions, for both fieldwork and analysis of returns, which were prepared in 1983 and which incorporate the recommendations of the Review Group.

The BTO originally initiated the Common Birds Census Scheme at the request of the then Nature Conservancy, to monitor populations of those species likely to be affected by changes in agricultural practice, with most emphasis being placed at the time on the use of agro-chemicals

(particularly pesticides), and on the loss of hedgerows and marginal land on farmland. To meet this monitoring function the CBC returns have been analysed annually and the results, in the form of tables of the proportional change in population level from the previous year, have been published annually for the various species covered.

The CBC was extended in 1964 to cover woodland birds. In such habitat the census methods differ in detail from that appropriate to farmland (Williamson 1964). Many of the species covered by the woodland CBC index are also covered by the farmland index but a number appear only in the woodland index. In addition, a number of species that are rather scarce have been indexed by combining data from census plots of all types, primarily woodland and farmland plots but including some so-called "special sites", census plots that do not fall definitively into either farmland or woodland categories but which for various reasons (e.g. location on Nature Reserves) have had CBC census work undertaken on them. This Scarce Species Index is susceptible to changes in the balance of habitat representation within the annual samples but nevertheless provides a crude measure of population trends in species that would otherwise go unmonitored by farmland and woodland indices (Batten 1971).

Figures 1 and 2 summarise the development of the CBC Scheme over the period 1962-82, showing the development of the scheme in terms of numbers of census plots covered and of the numbers of species for which monitoring indices have been published.

In 1974 the BTO started the Waterways Bird Survey (WBS). This project aims to monitor riparian bird populations along both natural and man-made watercourses. The WBS is, in effect, a linear CBC. The methods (which are described in the WBS Instructions, Appendix 4) are close to those of CBC. WBS has to contend with a range of methodological problems similar to those of CBC but in general these problems are attenuated due to the comparative simplicity of many riparian habitats.

1.3 OUTLINE OF THE SCHEME AND ITS METHODS

In the Common Birds Census Scheme observers visit a defined census plot between 8 and 12 times through the breeding season. On each visit they record onto a large-scale (1:2500) map the locations of all birds seen or heard. All relevant information is included on the map: thus the sex of birds seen, their behaviour (song, alarm calls, fighting, carrying food), and location of any nests found are recorded. Any movements of birds seen are noted, as are simultaneous registrations (registration of two or more birds that can be definitely identified as separate individuals). A standard notation is used on the map to facilitate analysis by BTO staff. At the end of each breeding season the information from the visit maps is transferred by the observer on to species maps, such that all registrations for a single species appear on that map. Typically these registrations fall into clusters of greater or lesser compactness. These clusters are taken to constitute evidence of a territorial pair. The procedure

followed in interpreting the species maps is laid down in the Guiding Principles (Appendix 2) which are very similar to the international standard (Anon.1969). In interpreting these clusters as territories, particular attention is paid to singing males and to simultaneous registrations, with a view to increasing as far as possible the agreement between cluster total and the real territory total on the plot.

The extent to which the location and the number of clusters can agree with the location and numbers of territories on the census plot depends both on the efficiency of the field-worker and on the behaviour of the birds concerned. Whilst the behaviour of each species is likely to be relatively constant in similar habitats across the country (and thus open to calibration, should this be desired), the behaviour of individual field-workers is not amenable to such calibration. Consequently, from the start of the CBC scheme emphasis was placed on maintaining the consistency of fieldwork by each observer, such that the CBC Index might correctly track any population trends, even though the absolute level of observer census efficiency might vary from one participant to another (see below). The CBC Index is therefore based on the accumulation of estimates of percentage changes from year-to-year. In this way the validity of the Index does not require the observers to be equally efficient in their censusing skills. It is, however, essential that observers do not vary in efficiency from year to year.

The visit maps are analysed in Beech Grove by a team of five (in 1982) staff analysts. These analysts have been trained to ensure that they are consistent and comparable in their

interpretation and application of the CBC analysis guidelines (see below). In this way the element of skill and judgement involved in interpreting species maps (for example, in experience of the size of territories for particular species, in interpreting particular patterns of registrations, and so on) has been standardized to minimise any variation inherent in the analytical process.

1.4 PREVIOUS REVIEWS OF THE COMMON BIRDS CENSUS

A great deal of attention has been given internationally to the mapping method and its validity, and the relevant studies are reviewed below. Several additional studies have examined the implementation of the mapping method within the CBC scheme (Taylor 1965, Snow 1965, Milner and Hornby 1977, O'Connor and Marchant 1981), the latter two specifically at the request of the NCC. Milner and Hornby were expressly concerned with identifying the possible weaknesses in a CBC scheme based on voluntary fieldwork by professionally unqualified fieldworkers and with recommending what action, if any, might be necessary to attend to any difficulties identified. In most cases their conclusions endorsed the practices of the CBC but they listed a number of areas where further investigation was desirable. In particular, they noted (i) the weakness of the then available experimental evidence as to the extent to which the CBC index tracked changes in bird populations (ii) the high cost of manual processing of the CBC data and the resulting paucity of analyses at national level and (iii) that the continuing

development of the scheme would necessitate continuing statistical scrutiny. They suggested various steps that might be taken to meet some of these difficulties, principally a field investigation of the validity of the CBC index as calculated, the acquisition of computer facilities to allow greater use of the data collected in the field, and various measures that might reduce the staff time expended on the routine processing of the annual intake of CBC returns. Their individual recommendations are considered in greater detail below.

O'Connor and Marchant (1981) report the results of the field experiment suggested by Milner and Hornby. They showed that the statistical design of the annual CBC analysis (Williamson and Homes 1964, Taylor 1965) was such that the principal sources of error in fieldwork were adequately controlled at the computational stage. They also confirmed the finding of Milner and Hornby that the use of professional staff in interpretating the field maps was an important source of standardization. Their findings provided much of the experimental validation of the CBC requested by the earlier review.

1.5 STRUCTURE OF THE PRESENT REVIEW

A major part of the review is an examination of the validity of various assumptions made in the CBC. This is presented in Chapter 2 which details the results of all the methodological checks, some of which were conducted specifically for the Review Group. This chapter also makes some recommendations in relation to the few remaining

sources of unchecked error. Chapter 3 is a statement of the revised objectives of the CBC following the deliberations of the Review Group. Chapter 4 lists in full the detailed recommendations of the Group.

CHAPTER TWO

THE VALIDITY OF CBC METHODS : A REVIEW

This chapter provides an assessment of the efficiency and suitability of the CBC methods. It presents a review of research specifically conducted to assess various aspects of the CBC and other research relevant to CBC methods and their future development. Many of the recommendations of the Technical Review Group were based upon consideration of the results of this research.

2.1 GUIDELINES FOR ASSESSING CENSUS TECHNIQUES

Dawson and Verner (in press) have offered some systematic guidance to the choice of census techniques for particular purposes. These guidelines help to assess the efficiency and suitability of the CBC technique. Dawson and Verner suggest that a total of nine headings address the most important questions concerning census techniques. These headings are listed below and the relevance of each to the CBC is assessed.

1. What question is being asked?

CBC was initially established to monitor annual population levels of commoner bird species. However, the data have increasingly been used in a wide range of habitat and population studies. The objectives of CBC are detailed in chapter 3.

2. What resources are available?

Skilled amateur fieldworkers are the source of the original CBC data and professional input is provided only in the processing of the results centrally. Of particular concern here is the possibility that a very small additional input of professional manpower may return a disproportionately large amount of additional information, for example, about habitat use by birds. The large number of people involved in the CBC raises questions of comparability and consistency of both observers and analysts.

3. What scale of measurement is necessary in answering the question?

Dawson and Verner make the point that the optimum technique is the cheapest method that returns results on the scale of measurement required. That is, a ten-fold increase in precision is undesirable if a cruder assessment already answers the question of interest. On the other hand, it also indicates some caveats to be observed. For example, if what the CBC scheme provides is merely an index of population level for a particular species, with different relationships between index value and true population density for different species, comparisons between species may not be possible.

4. On what geographical scale is the question being asked?

This question is particularly relevant to the interpretation of CBC indices. If a truly national index of population levels is required, then the distribution of CBC sampling

effort, in the form of census plots, must be in some way related to the geographical distribution of birds. If this is not possible, then the CBC index as presently calculated does not constitute a national index and must be either presented as an index for only certain parts of the country, such as lowland England, or must be weighted in some way to compensate for the under-sampling of certain parts of the country.

5. What habitats are to be studied?

The CBC primarily covers woodland and farmland but a variety of "Special plots" is included in the present scheme. If these special plots are not in sufficient numbers to generate population indices for species of these habitats, should these habitats be retained in the scheme? Similarly, the previous question of regional coverage is relevant to indices which are habitat specific.

6. What is the range of subject species?

The CBC as currently practiced expressly excludes certain species: gulls, Heron*, Rook, and some observers do not record Woodpigeon and House Sparrow. In addition, some groups of species (eg. aerial foragers and nocturnal species) are probably under-covered by the census. This incomplete species coverage has implications for certain community studies.

* Scientific names of birds are given in Appendix 7.

7. What are the characteristics of the subject species?

This question is relevant to the CBC in several respects. First, the extent to which CBC coverage can be extended towards the scarcer species. Secondly, the extent to which the CBC practices must be modified to take account of migrancy, since migrant species are present on the census plots for only part of the full CBC fieldwork period. Thirdly, species differ in their conspicuousness and one can ask whether the CBC technique makes adequate allowance for this.

8. What section of the species' population is of interest?

The CBC is ostensibly concerned with breeding bird populations but non-breeders or "floaters" may be difficult or impossible to distinguish from breeding birds.

9. What size of difference is of interest?

For the CBC to serve as a monitoring scheme one wishes to have a clear idea as to the size of the annual (or longer term) differences that one wishes to detect. In addition, this question also raises the problems associated with the practical use of CBC data when a change has been detected on the CBC plots as a whole.

2.2. THE CBC AS A MONITORING TOOL: SOME BASIC ASSUMPTIONS.

In order to assess whether the CBC efficiently meets its objectives it is necessary to give some further background on various assumptions that are central to the scheme.

A bird census method such as the Common Birds Census may be used for two quite distinct purposes (Kendeigh 1944). The first objective, which is generally thought by the public at large to be the general function of a census, is to provide absolute estimates of population density, that is, an estimate of the actual number of pairs breeding in a given area. An alternative objective of a census technique may be to provide comparative measures of relative abundance, usually by the provision of an index which can be repeated from year to year (or from place to place, or whatever).

A relative measure (I) is related to density by some function which ideally is linear. That is, the density of a species on a census plot may be given by some formula of the type

$$D_j = a_j I_j + b_j$$

where D_j is the density of birds on the plot j, I_j is the relative measure of the species' abundance on the jth plot, and a_j and b_j are constants. These constants will be both species-specific and plot-specific, so that comparisons of relative densities by taking the ratio of index values will not, in general, be possible. Dawson and Verner (in press) point out that territory mapping techniques can be used for absolute and for relative measures and that considerable confusion as to objectives and sources of error can therefore arise with these techniques. In the case of the

CBC, changes in density can be correctly indexed even if the values of the coefficients a and b are unknown, provided that census efficiency remains constant from year to year. For absolute densities both coefficients and the measure of relative abundance (I) must be known. In both cases the relationship between D and I must be linear over the full range of densities.

In the CBC scheme the results from a number of census plots are collated to yield an overall index. Since census efficiencies a_j cannot be established for each observer, only proportional changes in index (and therefore density) can be calculated. By summing these over the census plots surveyed in both years a best estimate of population change is obtained, with confidence intervals as given by Bailey (1967). This estimate is independent of the particular census efficiencies a_j of the observers concerned. However, not all observers remain in the scheme each year and, although additional observers on other plots are recruited to maintain the scheme, the number of departing and newly-recruited participants do not always balance. Hence, in the CBC the further assumption is made that, on average, the characteristics of observers and their plots do not change from year to year.

If the CBC data are to be used to estimate absolute densities then some criteria additional to those required in estimating relative change must be met. Ideally the census efficiency coefficients a_j and b_j should be known for each plot. However, if the variation in a_j and b_j between plots is small compared to the variation in bird numbers between plots the former can be neglected. Absolute densities can

then be obtained on the basis of an independent estimate of the average value of a. The following sections consider the extent to which CBC can be used to estimate absolute densities.

The validity of the various assumptions underlying the monitoring function of CBC were examined for farmland by Taylor (1965). By comparing plots first censused in 1963 with those first censused earlier, he showed that observers' standards were adequately consistent from year to year. He also showed that population changes estimated from the two groups were consistent from year to year. Finally, he established that population changes estimated from the two groups were consistent (implying consistency of the average characteristics of the samples) and that the minor adjustments of methods made in the first years of the scheme were unlikely to affect the index in any significant way. Snow (1965) reported a field comparison of CBC results with densities estimated from intensive nest-finding and showed that for most species a census based on eight visits gave good approximations to the population actually present.

Subsequent papers reporting the annual CBC indices have routinely monitored the composition of the plots used in each year, principally with respect to regional and gross habitat composition. Average plot sizes on farmland decreased over the period 1961-80 but their topographical and cropping usage and their regional distribution have not varied significantly over this period (Fuller et al in prep - see below).

O'Connor and Marchant (1981) reported a field experiment designed to test the assumptions of the CBC scheme regarding year to year consistency of standards. They showed that observers differed in their field standards, principally on account of differences in the time spent on the plot census, but remained adequately consistent on a year to year basis. They also showed that trained analysts were mutually consistent in their interpretation of field maps both within and between years. Aspects of potential observer and analyst related biases are considered further below. O'Connor and Marchant (1981) did not establish the time span over which their results were valid but work by Mountford (1982 in press) shows for several species that this extends to at least five years.

2.3. THE CENSUS EFFICIENCY OF THE CBC

Milner and Hornby (1978) expressed some reservations about the extent to which the CBC results, in terms of clusters per acre, actually represented good estimates of the density of breeding pairs on the census plot. However, Dawson and Verner (in press) point out that much useful work can be done with census techniques that fall well short of the ideal technique. The major criterion to be met is the answering of a biological question, such as monitoring the status of a bird population in Britain on an annual basis, and not some absolute standard which has to be met by the technique used. Nevertheless, it is important to be aware of the absolute efficiency of the CBC and the factors that may cause

variation in efficiency. We have followed the terminology of Svensson (1979) in defining different types of efficiency: (1) apparent visit efficiency is the ratio between the result of a single visit and the final evaluation of the species maps, in terms of clusters; (2) true visit efficiency is the ratio between a single visit and the true number of territories; (3) census efficiency is the ratio between the number of evaluated clusters and the true number of territories. We mainly discuss true visit efficiency which we shall term simply "visit efficiency".

2.3.1 Theoretical background

The reasoning behind the mapping method is that clusters of points identify individual territories. A simple binomial model of census efficiency is usually assumed, so that if a bird has a probability P of being detected on any one visit the probability of detecting it over the course of N visits rises to $1-(1-P)^N$. This simple binomial model is unrealistic but Järvinen and Lokki (1978) found that it fairly accurately predicted variances in the estimates of P. If the number of visits (N) is high enough very few territories are missed. The CBC standard for analysis requires at least three registrations for typical species in plots visited at least nine times; if P is above about 0.5, then 90% or more of the clusters are detected in these circumstances (Svensson 1979). If P is lower than this, too many territories are missed. One can accept fewer than three registrations and

recover some of the territories missed but then chance occurrences of transients or of birds outside their own territories may lead to clusters being assigned which do not in fact correspond to territories (O'Connor and Marchant 1981). Similarly, increasing the number of visits to cope with the less conspicuous species is inefficient since the return per unit effort is rather small: e.g. for 90% identification 16 visits are needed if P is 0.3 and 52 visits are needed if P is 0.1. Moreover, the number of spurious territories increases significantly with the number of visits as shown empirically by O'Connor and Marchant's (1981) analysis of the Aston Rowant experiment. Svensson (1979) recommends trying to increase the visit efficiency (P) rather than increasing the number of visits.

Since these two effects produce errors in opposite directions, one can expect the CBC method to detect the correct absolute number of territories on those plots where the two errors balance out. This will be most likely where a species is more detectable and where few detections are spurious. Dawson and Verner (in press) have considered this effect and find that under the conditions of at least 50% detections per visit and no more than 10% of the registrations contributing to spurious clusters, then 8-14 visits result in the number of clusters being within 20% of the true number of territories. Under these conditions ten visits are optimal, resulting in errors of less than 10% . In addition, this number of visits reduces the extent to which less detectable birds are under-estimated without at the same time producing a great over-estimation of the more conspicuous species. Species that do not conform to these assumptions cannot be realistically censused within this range of visits.

Absolute estimates of visit efficiency are rather rare. Although this has been attempted by a large number of workers (Williamson 1964, Hogstad 1967, Seierstad et al 1970, Slagsvold 1973a, Enemar et al 1979, Svensson 1979, des Granges 1980) they involve a degree of circular reasoning. The various clusters on the census plot are identified and equated with territories and the visit efficiency P is then calculated from the number of registrations in each cluster, divided by the total number of visits. This procedure over-estimates P (Järvinen and Lokki 1978, Svensson 1979), since some territories have by chance too few registrations to be recognised. Dawson and Verner calculated on the basis of a binomial model of detection that a 5% over-estimation occurs if P = 0.4 and 10 visits are made, and this over-estimation worsens rapidly as P decreases. In addition, if some of the territories with a low value of visit efficiency are merged with those of neighbours the over-estimation is compounded. Factors influencing visit efficiency are discussed later.

2.3.2 Attempts to assess census efficiency in territory mapping

A number of studies have attempted to assess the efficiency of CBC-type censusing by reference to the territories established with the very large number of visits (e.g. Snow 1965, Edwards 1977, Witkowski and Ranosezek 1977). However, O'Connor and Marchant (1981) have shown that the extent to which cluster counts obtained from large numbers of visits represents the true number of territories on the plot varies

substantially from species to species and cannot serve as a realistic standard. No statistical treatments of CBC data will, by themselves, yield estimates of census efficiency. The use of territory mapping with known marked individuals is the one satisfactory check available for the calibration of CBC efficiency (Enemar et al 1979, Tomiałojć 1980, De Sante 1981) although for some species such as thrushes, intensive nest searching can be used (Enemar et al 1976). The use of play-back (Falls 1981) can be used to reinforce the detectability of birds and to establish their territory boundaries more accurately. Examples of the joint use of play-back and marked birds include Dhondt (1966) Enemar et al (1979) and Krebs (1971).

Few of these studies have been done with the CBC method but a rather larger number are available based on the very similar international mapping method (Haukioja 1968, Bell et al 1973, Diehl 1974, Jensen 1974, Mannes and Alpers 1975, Mackowicz 1977, Nilsson 1977, Enemar et al 1979, Tomiałojć 1980, Fletcher et al. in press). These studies are largely confined to selected species and their results vary. However, several of the studies suggest that the accuracy of mapping is rather poor. In those studies where the good agreement between mapping and more intensive studies using marked birds and song playback has been achieved, this may be due to chance balancing of errors (Dawson & Verner in press). An example of such a study was that of Enemar et al 1979 on Willow Warblers. In this study two clusters resulted from to a single territory, two edge clusters were wrongly excluded, and one edge cluster was wrongly included: furthermore seven of

the 15 clusters correspond poorly to the territory they were supposed to represent. Tomiałojć (1980) found that in comparisons with three species across five plots his modified mapping method gave estimates averaging 104±1.5% (mean plus standard error) of the number known to be present from colour-marking. Generally, Fletcher et al found fairly good agreement between mapping results and colour-marking of birds, though again with a degree of compensating error.

Despite the possibility of compensating errors, most studies in which territory mapping has been compared with independent assessments of the number of breeding pairs on the study plot have yielded correlations of estimates across species of from 0.69 - 0.97 (O'Connor and Marchant 1981). Dawson and Verner point out that these high correlations result in many species being placed in at least the right order of density, thus making territory mapping the best method for studies requiring estimates of absolute density e.g. studies of inter-specific densities or studies across habitats. On the other hand, mapping should also be regarded as providing an estimate only on a rank scale, not on an absolute scale of density (Svensson 1980, O'Connor 1981b, Dawson and Verner in press). This applies primarily to the use of CBC methods for obtaining absolute densities.

2.4 FACTORS INFLUENCING VISIT EFFICIENCY

It is apparent from the above sections that attainment of a high visit efficiency is essential if mapping censuses are to provide realistic estimates of absolute density. In this section we review the main factors which influence visit efficiency.

2.4.1 Biological factors (species and habitat characteristics)

Territory mapping as used in the CBC is normally suitable for estimating only non-colonial passerines during the breeding season (see review of species-specific problems by Tomiałojć 1980). Furthermore, some species are relatively easy to detect, others are harder to detect, depending on such factors as the numbers and type of sounds they make, their colour, flocking habits, size, vegetation characteristics of preferred habitats, and their response to the observer (Franzreb 1981a, Dawson and Verner in press). For this reason the CBC measures the abundance of each species on a species-specific scale, thus precluding their use for the calculation of species diversity indices.

Intraspecific differences may also contribute to variation in the detectability of a species. A particularly significant source of intraspecific variation is that of breeding status. In some species unmated males sing very much more than do mated males, thereby making themselves more conspicuous (Slagsvold 1973b, Sayre et al. 1978, and references therein). Thus Diehl

(1981) found that several species were less conspicuous after laying than they were before. Should a breeding attempt fail an increase in conspicuousness may follow, as the bird reverts to an earlier phase of its nest cycle and sings more, though this is not always the case (Diehl 1981). Similarly, male passerines that have been experimentally deprived of their mate can be induced to sing to a greater extent than would otherwise be the case (Krebs et al. 1981). Another source of intraspecific variation in detectability lies in the behaviour of some birds as "guest" breeders. Thus Dhondt and Schillemans (1983) found that some pairs of Great Tits successfully bred within the territorial boundaries of another more dominant pair, doing so by virtue of being relatively secretive, without overt territorial behaviour, at least initially. In addition Eyckerman (1974) and Smith (1978) have described the presence of sedentary non-breeding individuals of Great Tits and Rufous-collared Sparrows (respectively) resident in territories held by displaying pairs.

Several biological factors contribute to incorrect estimation of visit efficiency (Enemar 1959), including temporary visitors, double counting, counting of females as males, and regular visitors from outside the study plot. Some birds may enter or leave the territorial population over the period of the study or they may change the location of their territory. Birds may also change the size of configuration of their territory, may defend more than one territory or may even share a territory (Enemar 1959, Blondel 1969, Eyckerman 1974, Berthold 1976, Parr 1979, Eagles 1981). O'Connor and Marchant (1981) have shown that whilst these problems can be

reduced by concentrating all the visits to the census plot into a short time period the different species to be censused each have their own optimal period (see "seasonal variations" below).

The conspicuousness of a species may be affected by properties of its habitat. The physical density of the vegetation will affect the ease with which birds, especially those which seldom vocalize, can be detected. The vegetation may also influence the behaviour of a species, making it more obvious in some habitats than others. Thus, it cannot be assumed that counts of a species obtained in one habitat will be directly comparable with those made in another.

2.4.2 Time of day

A number of studies have shown that the detectability of breeding birds varies with the time of day. This has been assessed by a number of studies which have examined the total number of individuals seen at different times of day but this procedure is misleading because different species contributing to these totals may peak in detectability at different times. Those studies that have examined the problem on a species basis have shown that whilst many species peak in detectability around dawn this is followed by a very rapid rate of change of detectability, so the small changes in the timing of a census lead to quite large differences in detectability (Shields 1977, 1979, Robbins 1981a, Skirven 1981). Other species show relatively little variation with the time of day (Marion et al 1981).

In principle it is possible to calculate corrections for variations in time of day but as the pattern of diurnal variation alters seasonally at least for some species (Shields 1979, Robbins 1981a) considerable calibration would be needed. Consequently, normal CBC practice has been to confine the fieldwork to a period of high detectability, principally in the morning, though evening counts are also accepted. An important point not always appreciated is the impact of the sharp fall-off in detectability on census results if the census period is varied by small amounts around the immediate post-dawn period.

2.4.3 Seasonal variations

Dawson and Verner (in press) review the evidence for seasonal changes in the detectability of birds. Some evidence exists to indicate marked seasonality of detectability and Slagsvold (1973b) has shown that some species, such as the Song Thrush, have very short singing periods which may differ in timing between years. He has therefore argued that the timing of census work should be varied on a year to year basis in response to changes in the general phenology of events. However, this argument is most strong in areas with very short and well-synchronised breeding seasons, as in the Arctic, and is therefore less critical for British and Irish conditions (O'Connor and Marchant 1981). Perhaps the most marked changes in seasonal detectability in British birds occur amongst certain "early" residents (eg. Great Spotted Woodpecker and Nuthatch) which abruptly cease singing in the early spring and amongst some migrants which have short periods of intense

song activity. Examples of the latter are certain Sylvia warblers and Sedge Warbler (Bell et al 1973).

2.4.4 Weather

Bad weather during the course of a census is likely to affect the efficiency of the observer as well as the behaviour of the birds and the two effects have not been disentangled in the studies conducted to date. Dawson (1981a) found that high winds and precipitation had detrimental effects of numbers of birds counted in New Zealands forests. For the Common Birds Census O'Connor and Hicks (1980) have shown that the major effects on the number of birds detected in CBC work are season, temperature and rainfall, though temperature and date were correlated to provide a seasonal effect. Spring temperatures determining the rates at which females could divert energy to egg formation were limiting amongst early breeders (Perrins 1970, Dunn 1976). As this could result in differences in the date of breeding between years it could potentially influence seasonal detectability. However, O'Connor and Hicks (1980) also found a more immediate effect of temperature on detectability, for after removal of seasonal trend with temperature most species were detected more frequently on warm days than on cold days. Although the range of rainfall experienced in the course of the study was rather small, a slight depression of detectability of most species was found on rainy days.

Robbins (1981b) similarly found that counts recorded for many species in the Breeding Birds Survey (a method using point counts) were correlated with temperature. He also found that detectability was greatest when ambient temperatures were most

akin to those prevailing in the centre of a species range. He found that counts of species near the northern edge of the range were most often positively correlated with temperature whilst for counts of species nearest the southern limit of the range such correlations were negative. He also found that rainfall tended to despress detectability, as did strong winds.

These observations suggest that the normal CBC practice of avoiding censusing in adverse weather conditions such as rain and strong winds are well-founded. Temperature effects are, however, relatively unimportant other than on a seasonal basis.

2.4.5 Differences between observers

A variety of factors contribute to differences in census efficiency between different CBC observers, including expectations, judgement, acurity of vision and hearing, knowledge, motivation and experience. In tropical forests identification can be a problem, regardless of the obeerver's skill (Karr 1981, Oelke 1981) but in Britain and Ireland identification of birds by sight or sound is a problem primarily only for less experienced observers in dense woodland. In some species song repertoires have evolved so as to mislead conspecifics into thinking that more than one singer is present (Krebs 1977, Yasukawa 1981) and this may mislead human observers into double counting as well. Problems arise particularly amongst species with similar habitats and calls, particularly where observers are inexperienced or where they have become careless with discomfort or fatigue

(Robbins and Stallcup 1981).

Of particular concern to the CBC is the question of hearing ability, since many of the longer running (up to 20 years) CBC plots are conducted by increasingly older observers. Emlen and De Jong (1981) found that observers with even mild to moderate loss of high frequency ranges could detect various species only at short distances (25-90% of the distances achieved by normal observers). Ramsey and Scott (1981a) conducted a survey of 274 people and concluded that differences in hearing ability could lead to ten-fold differences in the areas surveyed by observers. Whilst the CBC with its fixed plot boundaries is not directly affected in this way, the sensitivity to hearing can be expected to influence overall census efficiency.

Several studies have shown that the speed at which the observer conducts a mapping method census has major influences on the overall registrations achieved. In particular, O'Connor and Marchant (1981)found that bird densities assessed by several different observers censusing a plot independently appeared to be related to the time spent in the field, with more experienced observers choosing to work more slowly.

Variations between CBC observers in their census efficiencies are eliminated for monitoring purposes by basing the CBC index only on estimates of population change obtained from the same census plot in the years concerned. This procedure ensures that even if CBC observers collectively underwent a long-term drift in their average census efficiency, such as might be brought about by new participants working to improved standards of bird recognition or other fieldwork, the CBC index itself

is unaffected. No particular efforts are made to maintain a constant average standard of census efficiency on the part of observers, other than to monitor the general competence of observers and to eliminate from CBC calculations observers whose results are obviously sub-standard. For the index purpose this consistency brought about by plot pairing is all that is needed. It is nevertheless of interest to know the extent to which estimates of absolute density calculated from CBC results might be taken to be independent of the long-term turnover of observers. (It is emphasised here that this question is independent of absolute census efficiency, but depends on the constant of proportionality between the number of clusters identified for a species on a census plot and the true number of pairs breeding there). These comments concerning variations between CBC observers also apply to the WBS.

2.4.6 Saturation of observers at high bird density

When many birds are detected in a short time an observer may fail to record some of them because of inability to concentrate on them all at once. This effect, referred to as "saturation", can happen either interspecifically or intra-specifically (Dawson and Verner in press). Interspecific saturation or swamping (van Riper 1981) can be particularly important at the dawn chorus, with more cues being missed where the observer is busy recording a large number of birds. Direct evidence for this comes from Scott and Ramsey (1981b) who found that in Hawaiian forests observers who concentrated on only a few species were able to detect more of them than were those who were trying to count everything. They suggested

that as many as 30% of the commoner species were missed, but rare species were not so readily missed.

Intraspecific saturation results in there being an upper limit to the number of any single species that can be distinguished when many conspecifics are present together (Enemar 1959, 1962, Erskine 1980, Bystrak 1981, Dawson 1981a). Virtually no calibration studies for this effect have been conducted on CBC plots, though O'Connor and Marchant (1981) found only minor differences in the species tallies of observers differing greatly in the numbers of individual birds they detected. Diehl (1981) found that Red-backed Shrikes censused with the mapping method were more detectable on a low density plot than in a high density plot.

Another way in which a similar effect can be induced as a biological, not observer, artefact is the varying territorial activity of birds at different densities (Järvinen and Lokki 1978). For example, calling rates may be lower at low densities than at higher density, as evidenced in studies of Ring-necked Pheasants (Gates 1966), Ruffed Grouse (Rodgers 1981) and Long-billed Marsh Wren (Verner in Dawson and Verner in press).

2.4.7 Use of tape recorders

A common technique used by birdwatchers is to use squeaking or pishing sounds to attempt to get birds closer for identification (Smith 1975). This is particularly useful in the mapping method of the CBC when pursuing individual contacts with unidentified birds and where standardisation of procedure is perhaps less critical than in transect and point count work

(Connor and Dickson 1980). The logical extension of this procedure is to use tape recordings of the territorial calls of the bird so as to identify its territorial boundaries and thereby map the territory (Falls 1981). Dawson and Verner (in press) have reviewed the disadvantages of this technique. Although they enable difficult species to be studied more readily and may be less sensitive than other censusing procedures to daily and seasonal effects (Falls 1981, Marion et al 1981) they have some defects (Johnson et al 1981). These include the habituation of the birds to the sound (Verner and Milligan 1971, Patterson and Petrinovich 1978), the response may depend on the dialect of the recording (Verner and Milligan 1971, Searcy et al 1981), birds may be attracted beyond their normal territory boundaries (Falls 1981) and there may be differential response to neighbour and non-neighbour song (Weedon and Falls 1959, Searcy et al 1981). In addition, excessive provocation of birds by using tape recorders may result in inadequate attendance at the nests.

2.5 INTERPRETATION OF SPECIES MAPS

The previous section outlined potential sources of error and variation which may influence the efficiency of a single field visit. With the mapping method a second class of potential error must be considered: the problems involved in interpreting the field registrations in terms of clusters.

2.5.1 Differences between analysts

The number of clusters identified on any particular map depends to a significant extent upon subjective judgements as to the strength of evidence required to delineate a distinct territory. A measure of standardization on this point was introduced by the acceptance of International Bird Census Guidelines as to map interpretation (Anon 1969) although the CBC guidelines for analysis (Marchant 1983) are more elaborate. Even so, problems of interpretation may persist in the absence of adequate practical experience. Svensson (1974) and Best (1975) found considerable variation between the results obtained from different analysts interpreting species maps in accordance with the international guidelines. For territorial passerines the coefficients of variation obtained in these studies ranged from 15-36%. A variety of factors accounted for this large range, including a lack of knowledge of the habitat of the area, paucity of contemporary records of song and territorial defence (ie. poor fieldwork), and perhaps inadequate records of movements of individual birds. The problems of analysis reported in these studies may be largely due to inadequate experience on the part of the analysts. This seems

likely because comparison of three trained analysts of varied experience (O'Connor 1981a, O'Connor and Marchant 1981) revealed considerable agreement between analysts as to the number of clusters identified. Taylor (1983) came to a similar conclusion for analysis of WBS species maps. The CBC analytical procedures are highly standardised (Williamson et al 1976) and the staff analysts are extensively trained before undertaking independent interpretation of CBC returns. The findings of O'Connor and Marchant (1981) confirm the view of Milner and Hornby (1978) and indicates that the CBC analytical procedures are adequately consistent for index purposes.

2.5.2 Interpretation of maps and absolute densities

2.5.2.1 Biological factors

A variety of biological factors make it difficult to interpret defined clusters in terms of real territories. Those problems which manifest themselves at the fieldwork stage have already been dealt with but the analytical procedure itself introduces a separate suite of potential problems (eg. species which feed outside their defined territories). Fuller and Marchant (1984) ranked species in order of ease of analysis. This exercise was based on the collective experience of five CBC analysts and it showed that there were considerable analysis difficulties, involving subjective judgements, for more than half of the 60 species considered. Some very common species (eg. Blackbird and Blue Tit) can be difficult to analyse. A

major cause of analysis difficulty was identified as the absence of any natural clustering in the registrations; such species were termed wide-ranging. Under such circumstances there is likely to be considerable variation in the ways that cluster boundaries could be drawn. Another problem has been identified by Zach and Fall (1979) who found a degree of overlap of song posts amongst Ovenbirds , even though most records clustered well. In addition, foraging ranges overlapped territorial boundaries extensively. Similarly, Ferry et al (1981) found that the home ranges of five forest species were 2-12 times the area of their territories as determined by mapping. Svensson (1980) gives examples of cases where different song posts of birds with large peripherally defended territories were interpreted as separate territories.

It should be noted that although the above problems can make it difficult to relate clusters to real territories this does not undermine use of the CBC mapping method for the purposes for which it has been developed. Assessments of the absolute efficiency of such techniques were considered under Section 3.2.

2.5.2.2. Sampling problems: edge territories

The allocation of edge territories is a particular problem in relating CBC results to absolute densities. Marchant (1981) has analysed the errors involved when the IBCC guidelines for including boundary territories were followed. He found that between 10 and 25% of the edge territories were wrongly included in the plot, thus generating over-estimates of density. He suggested that this was probably due to observers working more

thoroughly within the boundaries of the plot and to a tendency towards registering birds seen just outside as inside. He also found that the location of boundaries along bird-rich areas such as hedgerows or wooded canal banks tended to increase the error in density estimation. Verner (1981) found a relatively larger edge effect error on a series of smaller plots in Californian oak woods: he found that as plot size reduced from 13 to 3.2 ha. the estimated densities increased by a factor of 2.7. However, it is possible that the smaller plots in his study actually contained higher densities, so the effect may not be entirely error.

Dawson and Verner (in press) have extended the simple model of Marchant (1981) to show that the over-estimation of density (expressed as a percentage of real density) decreases with increasing plot size and with increasing detectability of a species whilst it increases with the average territory size of the species. The effect would be particularly important in comparisons between plots in different habitats if the plot size varies with habitats (cf. the large difference between farmland and woodland plots used in CBC). Plot size also influences interspecific comparisons of absolute densities estimated from CBC results, since the edge error will vary in relative magnitude depending on the average territory size of the species. In practice this is likely to be a serious problem only for the larger species (eg. most non-passerines and corvids).

2.6 INTERPRETATION OF LONG-TERM TRENDS

2.6.1. "Randon walk" effects in the CBC

Geissler and Noon (1981) have drawn attention to the risk that an index obtained by pro-rating successive estimates of percentage changes onto previous index values is liable to undergo a so-called "random walk", due to the compounding of errors in successive estimates of population change. This effect is clearly subject to sample size: the larger the sample is, the narrower are the confidence intervals derived therefrom and the lower is the probability that successive estimates of population change should be in the same direction to a significant extent. Moss (1984) examined this possibility for the Common Birds Census by use of computer simulation methods. He modelled a situation in which 100 CBC plots were present in the annual sample, with one-eighth of the sample being lost each year and replaced by an equivalent number. These numbers are fairly typical of the CBC situation. He introduced random population changes drawn from between -50% and +50%, computing the index and confidence limits as described by Bailey (1967). The index deviated from the expected value of 100 but remained within the range 90-115 for ten runs of 19 years each. This variation is thus much smaller than reported by Geissler and Noon, probably due to a larger sample size in CBC. Moss pointed out that random fluctuations within this range would probably be smaller than the annual population changes recorded for the majority of CBC species.

Moss also considered the situation in which CBC plots were abandoned by their observers either because the habitat had deteriorated or because the observer has lost enthusiasm (and therefore efficiency) for the scheme. He modelled these two effects by introducing a 20% decrease in the number of territories recorded in each plot in the final year before it was lost from the scheme. Over a 19 year period this resulted in a decrease in the index value from its initial level of 100 to between 51 and 67. This situation is unlikely to occur with the CBC because careful checks are made to ensure that sampling effort (number of hours in the field, number of field visits and seasonal spread of visits) are consistent for each pair of years in which a plot is included in the index.

Moss did describe one situation under which spurious trends in the CBC might be possible. He calculated density estimates for a number of species and compared the behaviour of these density estimates against the behaviour of the CBC index over the same time period. Since species might be absent from particular census plots because the habitat there was unsuitable (e.g. aquatic birds are likely to be absent from farms with no water present), he estimated his densities both on the basis of all farms surveyed and on the basis of only those farms that held the species concerned in that year. CBC results in a given year contribute to the index twice, first (except in the case of new plots) to the estimation of population change in the preceding year and secondly to the estimation of population change in the following twelve months (except for plots leaving the scheme). For each year Moss calculated two densities: one for plots censused in the previous year and one for those plots

censused in the following year. The two densities thus derived for any year would not be equal if there were differences in average density between those plots censused for the first or last time in that year. For each year these densities were then plotted against the CBC index for several species (Table 1). As one would hope, the results show that in most cases there was a statistically significant correlation between the two trend lines. However, for one species, Spotted Flycatcher, there was no relationship between index and density. In fact the Spotted Flycatcher index gradually drifted downwards while density tended to increase. Moss considered this to be a result of new plots entering the CBC holding on average more Flycatchers than those dropping out; the index does not allow for such disparity. Moss suggested that prior to calculation of long-term trends using CBC data the relationship between density and index values should be checked. Alternatively Mountford's (1982) method might be employed to produce minimum-variance estimates of population change within samples mutually consistent across years in respect of densities of the individual species under investigation (see section 8 below).

An alternative to the pair-wise modeling on a binomial basis used by Bailey (1967) is to use a non-binomial model such as provided by Upton and Lampitt (1981). However, this merely reduces the size of the "random walk" problem. An alternative procedure is to predict the missing values in an analysis of variance (Geisler and Noon 1981), a technique which will be effective wherever the number of missing plots is not too large a proportion of the total. Against this, the CBC plots have rather a large turnover, approaching 20 per cent each year.

Robbins et al (1980) and Geisler and Noon (1981) offer yet another way of analysing CBC data where this sampling base alters from year-to-year. They tried various ways of fitting trend lines to the individual estimates from each area sampled, assuming a constant average rate of change within each year and correcting (by weighting) for the number and dispersion of samples within each region. A similar technique could be used based on curvilinear regression or on analysis of variance. However, it is rare (and is certainly not true of the CBC) to find only a small proportion of plots lost from the long-running survey. Hence the annual means method of Robbins et al 1980 and of Järvinen and Väisanen (1977b, 1978) might be more appropriate. Here, emphasis is placed on maintaining a very large number of replicates within particular strata (in CBC terms, within farmland and within woodland habitats), such that the average is unlikely to drift because habitats remain represented in constant manner.

For the CBC such checks on habitat composition of the sample are usually employed on a year-to-year basis, thus providing a rough check that no major changes are occurring. Over a longer (approaching a decade) timescale such annual checks are inefficient and long-term trend studies are desirable. These have not been carried out to date for woodland although the studies of Fuller et al (in prep) have gone some way towards showing that the farmland samples have remained relatively constant with respect to land type and agricultural practice over the duration of the CBC scheme (see 2.6.2).

2.6.2 Long-term consistency and representativeness of CBC farmland samples

One of the problems associated with the interpretation of the CBC scheme results is the extent to which the census plots actually reflect the composition of farmland in their surroundings. CBC plots are self-selected by the observers concerned and in principle these observers might select plots for censusing that are particularly rich in birds or are managed by farmers who are particularly sympathetic to conservation. In such circumstances the trends shown by the CBC census plot samples would be buffered against changes occurring in the general agricultural environment, and would thus underestimate any population decreases that might be brought about by agricultural practices. This effect could also operate if the observers normally abandoned census plots subjected to significant habitat modification.

The first of these problems has been investigated by Fuller et al (in prep). They considered three questions: 1) could any long-term trends that are recorded in the CBC indices be the result of changes in respect of regions or habitats sampled or in relation to the area of the census plots surveyed? 2) To what extent are the farmland plots representative of the ecological land types present in Britain, and 3) to what extent are the CBC farmland plots representative of regional agricultural practices? They examined these questions in samples of CBC plots used in computing population changes for the years 1965-66, 1970-71, 1975-76 and 1980-81. From each of these samples they drew a random

subset of 50 plots for detailed examination. In this way they obtained temporal and spatial samples of the CBC plots for examination with respect to land use patterns. They compared their samples against national statistics on land use drawn from two sources: 1) the ITE system of land classification, developed by Bunce et al (1981), a classification system which can be used to classify any 1-km square in Britain as one of 32 land classes. Key attributes are measured for each square, many from 1:50000 Ordnance Survey maps. The attributes are of four types: (i) climatic, (ii) topographical and positional (iii) geological, (iv) human artefacts. Each land class can be characteristic in terms of key topographical, landscape, land-use and vegetational features. 2) The MAFF/DAFS annual agricultural statistics which provide national statistics on land under different types of crops.

Fuller et al (in prep) found that the CBC census plots have been adequately consistent in respect of the numbers of plots and the area sampled in different land classes across Britain. The regional distribution of plots had also been consistent since the start of the scheme. They also showed that the average area of a farmland plot has declined considerably over the period of the CBC (Figure 3), thus raising the possibility of errors due to edge effects if the data are used to estimate absolute densities (see above). The CBC farmland plots were not representative of British farmland as a whole but did adequately reflect land classification patterns within an area of England roughly south of the River Humber and east of the River Severn (Figure 4). The CBC under-represented several land classes in

north and west Britain, in particular several upland types and cereal/mixed farmland in east Scotland and north-east England. This largely reflects the geographical spread of CBC plots, which are concentrated into the areas of highest human population density in central and south-eastern England (Figure 4). Within the main area surveyed, intensive arable agriculture was well represented within the CBC which suggests that CBC observers are not generally selecting the richest habitats for birds.

The comparison of cropping statistics compiled from the annual cropping plans returned by participants with the statistics compiled by MAFF showed that throughout England the Common Birds Census sampled major farmland types (cereals/other arable crops/grassland) in very similar proportions to that recorded in the Ministry's statistics. In Wales and Scotland, however, grassland was under-sampled. The two major cereal crops - wheat and barley - were also generally represented in proportion to the Ministry's statistics.

The overall conclusions to be drawn from the work by Fuller et al. is that long term changes in the CBC sample composition for farmland that have occurred are too small to be a significant source of bias in the CBC index. Moreover, the CBC index published annually by the BTO must not be taken as a national index of bird populations on farmland, since the CBC plots are not representative of farmland as a whole. An index confined to England, particularly to the south, east and central regions, would however constitute an adequate measure of trends on farmland in that region.

BTO staff have also examined the possibility that observers abandon plots should they deteriorate through habitat change. Table 2 was compiled by examining a sample of letters recording the reasons for particular CBC plots being abandoned and shows that in the majority of cases it was due to the death or illness of the observer or to his having to change address. Only 7% of the reports involved habitat change. Thus it seems unlikely that habitat deterioration plays a significant role in explaining changes in the CBC indices.

2.7 AUTOMATED DATA ANALYSIS

Although manual analysis of CBC species maps gives considerable consistency an alternative is to use an objective algorithm as suggested by North (1977). The basic idea of his approach was that one could record the x and y co-ordinates of each registration on the CBC map and then examine these to test what registrations were significantly spatially clustered and thus constitute a territory. In principle this could lead to considerable savings of analytical time and might additionally save some time through being able to work with visit maps rather than with species maps. The relative merits and demerits of this approach depends on two factors: 1) the relative time spent processing CBC results with the current manual method and 2) the availability of suitable algorithms for performing the clustering in the manner consistent with current practice for all species.

In 1980 a pilot study was performed by R. Hicks to assess the advantages and disadvantages of using a digitizer to routinely input CBC registrations from species maps onto

computer files. The results of the study are held as an unpublished report by the BTO. This approach would potentially permit automated cluster analysis and it could facilitate analyses such as relationships between registrations or clusters and habitat features. Also, data storage problems could be reduced. However, the main conclusion drawn from Hicks's test was that these advantages were outweighed by the excessive amount of time taken to process the data. Annual samples of 300 CBC plots would take 2-3 man-years of digitizing effort, though this might be reduced to approximately 1-2 man-years with practice. These figures are comparable with the time spent on manual analyses at present and thus warrant consideration of the technical suitability of the available algorithms.

North (1977) offered a procedure based on the amalgamation of adjacent points on the map, with new points being added to each cluster until some suitable level of clustering had been obtained. The principal difficulty of this procedure is that all clustering analysis will proceed if unchecked to yield a single giant cluster incorporating all the registrations on the map. To cope with this problem North introduced the idea of a "defining distance" against which the amalgamation of clusters was tested. Clusters could not be merged if they exceeded this defining distance. This distance was chosen empirically by trying a variety of values and choosing that one that gave the optimal fit to the number of clusters throughout by using analysis. North's procedure has a number of significant disadvantages. First, although North emphasises the objectivity of the computerised algorithm, the dependence of his method upon the

choice of the defining distance chosen to match the "subjective" assessments by analysts in effect continues the subjectivity that the algorithm is supposed to remove. More importantly, the method uses only the spatial occasions of the registrations, thus discarding the additional information contained in the CBC registrations for different types, notably those pertaining to contemporaneous registrations upon which Tomiałojć (1980) places much emphasis. BTO analysts also rely heavily upon contemporaneous registrations for their interpretations and find most difficulty with maps containing only diffuse registrations (Fuller and Marchant 1984). A further drawback of North's original method was that it made no use of the temporal ordering of the data contained therein. North (1978, 1979) subsequently modified this procedure to introduce time as a further variable to be integrated to the clustering procedure. In effect, the algorithm was altered such that links between points were made to the nearest other point from an earlier visit, with this procedure continuing until the predefined minimum number of registrations (normally three) had been achieved and a cluster could be delineated. However, this resulted in a further problem associated with variation in territory size of a species in different habitats, for in rich habitats containing small bird territories, the chosen defining distance was too small for the census plot concerned, whilst in poor habitats supporting larger territories of the same species, the average defining distance was too large. Hence, in processing data from poor habitats the process of linkage of registrations was ended prematurely by average

distances exceeding the defining limit, before all the points that a BTO analyst would have assigned to that territory had in fact been joined. North (1979) therefore modified the scheme to allow a rather larger defining distance whilst blocking the merging of small territories in rich habitat by requiring that two previously identified territory clusters could not be fused together.

Wragg (1982) has subsequently re-examined North's algorithm. He showed that the temporal ordering of data involved in North's algorithm (whereby registrations were linked only to registrations from earlier visits) was undesirable because it constrained the nature of the clusters eventually formed. For example, when he reversed the temporal sequencing of data under test, so that data from visit 10 was labelled as data from visit 1, and so on, quite different clusters were obtained. Since a desirable property of any clustering procedure used for CBC data is that the spatial information should be dominant, with temporal ordering merely present as a modifier, this indicates a major defect in North's algorithm. Wragg also found that the number of territories determined was independent of variations in registration location and suggested that the answer provided by the algorithm was simply a function of the number of registrations, perhaps modified to some extent by the relative frequency of registrations from the different visits. However, Milner and Hornby (1978) previously examined the possibility that the numbers of territories determined by CBC analysis might be replaced by simple counts of registrations and concluded that the latter were not good predictors of the eventual number of territories (as one might expect a priori from the spatial integration over visits provided by the CBC method).

Wragg's findings suggest that automated cluster analysis has serious defects. The most likely shortcoming lies in the failure to recognise the quality of the various registrations, a point acknowledged by Wragg. Although his algorithm expressly took into account simultaneous registrations, precluding merging of such sightings and integrating information on distance moved by known individual birds, it paid little attention to other characteristics of the registrations. For example, the finding of a nest or the location of a singing bird received exactly the same weight as a single diffuse registration of a bird.

One further consideration is necessary here. All the algorithms considered by North and by Wragg involve substantial computing power, with their various models run on main frame machines and utilising standard graphics (and mathematical packages available thereon). In principle, these packages could be replaced by equivalent packages of purpose-written software to be commissioned for running on the much smaller machine available to the BTO or the BTO machine could be up-graded to provide the necessary computing power and the appropriate software licences could be purchased for the use of these packages on the improved machine. These hidden costs need to be taken into account in assessing the cost effectiveness of automated analysis.

It is worth noting that some advantages would accrue were the CBC data to be routinely processed by computer. The principal of these would be that the CBC registrations would be routinely available for matching with habitat and with data from previous years, so that one could examine such points as the consistency of spatial location of territories on long-running plots and

their correlates with habitat elements. This would undoubtedly be a useful gain but it is questionable whether all the CBC data need be available on the machine for effective use of such procedures: it is more likely that use of a well chosen sample of the material would be more cost effective. That is, digitized registration data from a small number of long running plots would be a more effective use of digitizer time than would digitizing all the plots received in any particular year.

Summarising, automated data processing is unlikely to be cost effective because there would be little net saving of manpower needs, though less qualified staff might be employed on this operation rather than on manual CBC analysis; the algorithms available are as yet unsatisfactory and require much larger computing facilities than are available presently at the BTO; and the additional benefits of having the CBC registration data computerized en masse do not offer enough additional advantages to warrant a change on those grounds.

2.8 ADEQUACY OF THE PRESENT CBC SAMPLE

How many CBC plots are necessary? One limit is set by plot turnover, which currently runs at about 20 per cent for farmland and woodland plots. A second limit is set by the question being asked. Where the CBC scheme is used solely for indexing purposes, the presence of bias - that is, a systematic difference between the number of birds assessed per plot and the number of birds actually present there - does not matter, provided the bias is present equally in all samples to be compared. However, the precision of the estimates made is important from the point of

view of detecting changes in index value. O'Connor and Marchant (1981) compared the results obtained with four different observers carrying out independent CBC's in the course of the same season on a single plot of mixed habitat at Aston Rowant NNR. Results from this study suggest that absolute precision is closely related to the average density of each species present on the plot (Dawson and Verner in press). The most abundant species have coefficients of variation close to that expected on the basis of a Poisson distribution and the less abundant species had rather lower coefficients than expected. These results help clarify the suggestion made by Dawson (1981b) that CBC techniques might be more precise in forests than on farmland, on the basis of comparison of earlier studies by Snow (1965) working on farmland and studies by Frochot et al (1977), Enemar et al (1978) and Eagles and Tobias (1978), working with small passerines in forest and scrub. In the farmland study some species such as the Blackbird had means which were much less than the variance between observers, though other species, such as the Great Tit, showed the opposite. In the woodland studies, however, means were almost always greater than the variances between observers. Dawson (1981b), reviewing these various studies, suggested that four replicate mapping censuses (ranging from about 80 to about 240 hrs. of fieldwork) would give standard errors of between 6 and 20% of the mean. Applying similar calculations to the data obtained by O'Connor and Marchant (1981), Dawson and Verner estimated that standard errors for common species (those with 10 or more clusters on the plot) were between 9 and 15% of the mean, although individual plotted points

ranged from 4 to 23%. These differences give some idea of the precision of individual annual estimates that may be obtained from CBC but they do not take into account the greater efficiency that can be obtained by the CBC practice of pairing plots across years. O'Connor and Marchant (1981) found that variations between observers in the percentage differences they assessed for various species between two successive years on the same plot was much smaller than the differences associated with observers in density estimates within any one year. Dawson and Verner have estimated the average coefficient of variation in percentage assessments at 10^{+} 3%.

2.8.1 A method of improving precision of the CBC index

Mountford (1982, in press) has recently devised a model which improves the estimation of population trend obtained from serially correlated, unbalanced data of annual population counts such as obtain with the Common Birds Census Scheme. In normal CBC practice population indices are computed by applying the most recently obtained population estimate to the CBC index computed to the previous year. Thus, if r_{56} is the population change estimated between year 5 and year 6 and I_5 is the population index available in year 5, then the index for year 6 is obtained as

$$I_6 = r_{56}I_5$$

Thus over a series of years the population index in any year n is obtained as

$$I_n = I_o r_{12} r_{23} r_{34} \cdots r_{n-1,n}$$

where I_o is the arbitrarily set value of the index at the start.

(Alternatively, I_o can be chosen to correspond to some arbitrarily set value at some point within the run of years covered by the scheme). This procedure thus is based entirely on year to year comparisons, yet in a scheme such as the CBC many of the census plots surveyed in year n+1 were also censused in year n-1, so that it is possible in principle to make use of the comparison across the two year interval (n-1, n+1) without violation of the observer pairing principle. Were all census plots surveyed by the same observer in every year, such comparisons would provide no additional information to the pair-wise calculations. However, with the considerable turnover of plots in the CBC scheme the data are considerably unbalanced and the direct and indirect estimates of population change do not coincide.

To develop a suitable statistical model for the indirect estimation of population trends Mountford (1982) examined Skylark data for the years 1963-76. He showed that all plots showed consistent estimates of the population change recorded within any pairing of years. The average value of this change varied annually, of course, and the plots showed more scatter the larger the gap between the two years. He therefore chose a linear model of territorial occupancy of the type

$$y_{ij} + p_i g_j + e_{ij}$$

where y_{ij} is the estimated number of territories in sample plot i in year j with an expected value $p_i g_j$, and p_i is the ith

plot effect and g_j is the jth year effect. The residual error variable e_{ij} has zero mean and variance proportional to the expected value $p_i g_j$. He derived large sample, minimum variance, estimates of the compound estimate of index for annual population size based on this model. Then, provided the data are connected (i.e. some plots continue for more years than a single pair), any increase in the number of sample plots brought about by extending the length of the CBC series provides extra information and improves the precision of the estimates of annual population size. For Skylark, Mountford showed that on comparing a five-year period (1963-67) and a 14-year period (1963-76) the latter produced estimates that were, on average, twice as precise as the former.

Mountford points out that this precision is obtained at the cost of an increasing likelihood that the assumptions of the model would be violated with the passage of time, for example due to change in the ecological characteristics of each sample plot. He therefore provides a test for the linearity of the model presented above where the data are unbalanced. He showed in the case of Skylark data that the improved method of estimating the yearly changes extended for nine years from the 1963 start. Over a nine-year timespan, therefore, it is possible to use his method to give a single unified picture of the population changes over those years, where the currently used sequential method analyses only the change between successive years. Over a period of eight years the gains in relative efficiency (as estimated by the ratio of variances for sequential and overall method) were as much as six-fold in the case of Skylark.

Mountford's analysis can be used for other years by taking different starting points and going forward or backward in time, thus identifying those years over which the sequence of CBC data are adequately linear for this method to be applied.

Mountford's technique may have considerable applications with the CBC data: it may prove possible to use it to detect ecological changes on particular plots or between plots on a regional basis. At present many of the regional samples are fairly small and the method may be valuable in improving precision of regional estimates of population change and thus allowing differences to be detected with higher precision than are at present possible. Fuller et al (in prep) have suggested that regional monitoring should be pursued as a preferable alternative to the national index calculated at present. It should be noted, however, that use of Mountford's method with each year's data involves re-estimation of the previously published CBC indices, so that the entire set of annual data would have to be redescribed each year if publication of indices continues on an annual basis.

2.8.2 Sampling patterns

Dawson and Verner (in press) point out that sensible use of replication can considerably assist in optimising observer estimates. In particular, they draw attention to the possibility of replication at more than one level. They point out that such planning can be of great benefit to large-scale studies such as that of the Breeding Birds Survey of North America and that of the CBC in Britain. Thus, if one wishes to index the population

of some species in England, where the density of the bird is known to vary across the country, one uses a pilot survey to determine the relative contribution of within-region and between-region contributions to the overall variance in density estimates. One can then use the simultaneous solution of non-linear equations (Cochran 1977, Gates 1981) to obtain the number of plots per region and the number of regions to be surveyed to provide minimum variation through any given cost (such as might be determined by, say, manpower limitations at Beech Grove). Dawson and Verner point out that the procedure is mathematically complex but can save a lot of effort, although it has not been applied to counting birds other than by Gates et al. (1975). Järvinen and Väisanen (1981) discuss aspects of methodology for sampling large regions using other techniques. Their study was directed at transect/point count procedures and provides useful insight into the complexities of replacing the current mapping method CBC in Britain by a national scheme of transect or point counts. Amongst their recommendations are standardization, checks of observers against each other, each observer counting more than one area, each area being counted by more than one observer, coverage of habitats in proportion to area, and maximum dispersal of the counts over regions.

Application of sampling theory to the control of the regional distribution of CBC plots could be particularly helpful in optimising the precision of CBC indices obtained. Where various regions are known (for example, from historical CBC data) to differ in population density of the species under study, a general rule is to sample each stratum with an intensity proportional to the standard deviation of the counts expected

there. Caughley (1977) points out that even coarse stratification enormously increases the efficiency of overall effort.

The size of the annual CBC sample has an effect on the extent of the confidence limits currently computed for the annual population change but these do not appear to decrease much once the sample available is about 40 or so. However, the confidence limits thus calculated are not likely to be used in the detailed analysis of CBC proposed elsewhere in this Report, the method devised by Mountford (1982 and in press) providing better sensitivity. Preliminary analysis of the farmland data in various ways - for study of simple regional variation, for examination of densities in relation to land-class, and for investigation of the effects of farming practice on birds (Fuller et al in prep.) - suggests that, even with the present computations of confidence intervals, quite small samples may suffice if the regional effects on birds are large or are sustained over time. Hence one can conclude that samples of perhaps 15-20 plots might be adequate within any one homogenous region or sub-habitat and that five or six such regions would give an adequate statistical basis for studying geographical variation in population trends.

2.9 ALTERNATIVES TO THE CBC FOR MONITORING

In considering how well the CBC scheme meets its goals in the light of the above review we can consider alternatives for the primary goal of population monitoring. Although monitoring indices are available from nest record cards and from ringing, particularly for nestlings, the available evidence indicates that the problems of measuring variation in observer effort are such that the CBC gives a more reliable index of population change in those habitats for which it is appropriate.

In terms of general surveys, point counts or transects may be considerably more useful than CBC in identifying important areas for birds. As a supplement to mapping, these techniques are unnecessary in the area for which mapping is available in the first instance. Techniques such as point counts are most applicable in situations where a limited number of observers are to cover a large number of areas. Use of such techniques, for a national scheme operating through an organisation such as the BTO, may require training of observers to ensure consistent standards. Furthermore, mapping, unlike point counts or transects, provides much information on the detailed distribution of birds within plots which is of great value in studying habitat relationships and in making impact studies.

Tabulation of the number of registrations on each CBC map for each species would be less time-consuming than the present system of cluster analysis. However, the indices thus derived would be very much less reliable because this procedure would be no allowance for the variable numbers of registrations per cluster.

An alternative index might be one based on the relative frequency of occurrence on the census plots but this works only in limited circumstances, where the species of interest is uncommon and present in only a proportion of the plots censused. It would thus be unsuitable for use with the common species that are the main target of the present scheme.

The Review Group concluded that there was no realistic alternative to the mapping method as the basis of the CBC. A major consideration was the fact that a change at this advanced stage would require much redevelopment work and a prolonged trial period of overlap with the present methods would probably be needed. Nevertheless, in special habitat studies, not conducted on the long-running CBC plots, there may be merit in adopting techniques other than the CBC-style territory mapping . Expeditionary studies are such a case in point.

CHAPTER THREE

OBJECTIVES OF THE COMMON BIRDS CENSUS

As noted in Chapter One, the original objectives of the CBC were concerned with the impact of agricultural practice on bird populations, particularly in relation to organochlorine use and to hedgerow loss on farmland. Following a re-assessment in 1979 of the needs of the NCC, the scientific annexe to their contract with the BTO specified the objectives of the CBC as follows: maintenance of the CBC index and its annual reporting, analysis to relate bird population levels to habitat variables, the study of the consequences of habitat changes for bird populations, and the formulation of management advice in relation to avian habitat, particularly for woodland. These stated objectives were to be reviewed within the remit of the present report. This chapter considers the main ways in which CBC data can be used under four headings:

(a) monitoring

(b) examining community structure

(c) habitat loss and modification and related subjects

(d) population studies

A final concluding section considers the implications of these discussions for the objectives of the CBC as stated in the scientific annexe of the NCC contract.

3.1 MONITORING SPECIES BY USE OF CBC

Long-term changes in the level of bird populations provide one indicator of general changes in habitat quality (Järvinen and Väisänen 1979, Haila *et al* 1980). Similarly long-term climatic change and shorter-term fluctuations associated with weather catastrophes can also be identified (Williamson 1975, Järvinen and Väisänen 1977a, 1977b, 1978, 1979. Territory

mapping is particularly useful in such monitoring because changes in habitat quality can, at least in principle, be monitored in parallel with the bird. That is, changes in bird numbers recorded in the fieldwork can be partitioned between known habitat alterations on the census plot and those other factors whose effects it is desired to follow. The disadvantage of the mapping method is that, per unit effort, the confidence limits to each year-on-year change are wider than with other census methods (though in the case of the BTO Common Birds Census this is offset by the availability of large numbers of volunteer fieldworkers (Dawson and Verner in press).

Although the original principal objective of the CBC was to monitor farmland (and subsequently woodland) bird populations, the scheme itself involves an enormous field effort on the part of the volunteer participants, supported by a considerable staff effort in administration and map interpretation. In 1982, for example, the CBC scheme handled approximately 14000 species maps from about 360 participants who between them spent an estimated 13000 hours in fieldwork and a further 6000 hours preparing species maps. Given this investment of time and effort, the mere construction of CBC indices cannot be regarded as an adequate return by way of results and other uses of the CBC data are discussed below.

In practice the CBC indices have never been used for biological monitoring as such, though the indices and their trends have been used to establish the status or changes in status of various species. Thus O'Connor and Mead (1980) used the CBC index trend for Stock Dove in tracing the changing fortunes of that species in Britain, and Winstanley et al (1974)

used the indices for Whitethroat to define the consequences of the Sahelian drought for the winter survival of these bird populations. For migrant species in general this function of the CBC scheme may be particularly valuable, given the difficulties of otherwise tracing the fortunes of these species in remote wintering grounds. Similarly, the very abundance of the common species on which the CBC focusses makes the index results valuable, since these species are an integral part of a wide variety of habitats, and not just of the semi-natural habitats on which most conservation work in Britain necessarily focusses. Thus O'Connor and Shrubb (in prep) have used the farmland CBC indices to trace the declines in various common farmland birds brought about by modern agricultural practices.

In practice, the annual publication of CBC indices adopted by the BTO is not intended to serve a monitoring function but rather to provide feedback to the participants whose interest and enthusiasm for the next season's fieldwork is thereby sustained. This is a particularly important role for the prompt publication of each year's results because the high level of commitment asked of participants inevitably results in a considerable proportion dropping out of the scheme each year. This role could, however, be filled by annual reports in the Trust's newsletter, BTO News, where formal statistical treatment of the results would be less essential and where greater emphasis could be given to the "interesting" aspects of the results.

One difficulty which arises with the annual publication of index values in Bird Study is that the variety of consistency checks which need reporting in the formal report for the year

are limited by journal space and by the inevitably low level of BTO membership interest in these methodological checks and/in the caveats appropriate to the results presented. This has made it difficult to delineate clearly the domain of validity of the indices and a habit has spread of regarding the results thus reported as though they were of national trends equally applicable to all parts of Britain. Such mis-use of the scheme's results are likely to be checked only by definitive analyses considering the problems involved in full. The staff commitment to the annual processing of the current volume of CBC returns presently precludes such analyses being undertaken.

Fuller et al (in prep) have shown that the farmland CBC plots cannot be regarded as representative of the whole country. Geographical coverage and the working definition of woodland used (which assigns some parkland plots to the woodland category) preclude the woodland indices, as at present constituted, truly reflecting national population changes in woodland. It is impossible to cover all the habitats (especially those in suburbia) necessary for a realistic national index to be produced for each of the species in the CBC scheme.

Milner and Hornby (1978) previously noted that the CBC results did not constitute a national index of the populations of the species concerned, both on account of the restricted geographical spread of the participants and because the habitats covered were limited. They recommended that increased efforts should be devoted to correcting this,

either through increased habitat coverage or through the initiation of a system of point counts in the areas in which it was impossible to recruit CBC workers. In practice, however, the tight financial limits to the contract between NCC and BTO have precluded action being taken on this issue and this situation currently continues.

The main strength of the current CBC scheme lies in its ability to gather census data from lowland farmland and woodland (excluding coniferous woodland) on a continuing basis. In view of the relatively limited finance available to support the CBC, the scheme would be most effective if it concentrated for monitoring purposes on these habitats. Lowland farmland in this context is intended to include all intensively used agricultural land that could be monitored on a recurring basis and as a homogenous sample. Although some pure coniferous woodland is included in the current sample of plots they are so few that it is unrealistic to contemplate the annual monitoring of bird population trends in this habitat at all; some other, less frequent survey approach would be more appropriate to the problems of this habitat. Plots of mixed deciduous and coniferous woodland are more frequently represented in the CBC samples, however, and are worth trying to maintain, though the main value of the woodland CBC lies in its surveillance of semi-natural broad-leaved woodland.

The current CBC results can be analysed on a regional or on a selective habitat basis where this is thought necessary. The introduction of such indices on a routine basis would significantly increase the amount of staff time necessary in preparing the reports of the latest year's results. In

the absence of clear-cut mechanisms for the utilization of CBC data on an "early warning" basis, routine sub-divisions of the CBC data is unlikely to be useful. The potential for sub-division of the CBC sample for particular studies involving regional or habitat sub-populations over longer periods is, however, valuable.

3.1.1 Species coverage

A list of the species currently covered by the CBC indices is presented in Table 3. Since the CBC technique is expressly based on the concept of territorial defence, it does not work well with colonial or semi-colonial species that do not defend individual territories. Thus, species such as House Sparrows and Reed Warblers are not indexed. On the other hand, a number of other species may nest with different dispersion in different conditions and thus be mapped with greater or lesser difficulty in different places. For this reason some observers include species such as Starling in their CBC mapping whilst other observers just list them as present. Again, some observers return nest counts for these difficult species rather than attempt the standard mapping and, provided this procedure is adopted each year, this is acceptable within the rules of the CBC.

Certain species are difficult to analyse on the basis of non-nest registrations, as in the case of the Swallow which defends only the approach to the nest. Other species difficult to census without nest site records are Carrion Crow, Magpie and Jackdaw.

Given the time-consuming nature of the analysis (map interpretation) stage of CBC work by staff, one possibility of altering the overall workload is to analyse only a defined sub-set of the available species maps for the commoner species. Thus returns from observers whose plots contain uncommon species would be processed for the rare species but not necessarily for the commoner ones if they were already well-represented on the other plots processed. However, observers would be unlikely to accept selective analysis of their maps in this fashion and would expect all data they submitted to be analysed. It is unlikely that they could be persuaded to continue in a scheme that did not meet their expectations on this, since the amount of field time they would need to put in would not be significantly reduced by the subsequent selectivity of analysis.

3.1.2 Monitoring scarce species

A major issue for census work in general is the monitoring of less common species. The Common Birds Census has made some attempt to develop this aspect through the Scarce Species Index. The results have not been entirely satisfactory owing to the wide range of habitats necessarily included in the sample. Results for scarce species are pooled from farmland, woodland and "special" plots. It is worth noting that although only the scarce species results are used from special plots, the CBC staff have to analyse all species on these plots. Hence, the amount of use made

of the results from special plots is much lower than that from either farmland or woodland. For rare species, Dawson and Verner recommend the use of large-scale surveys to identify their presence, followed by a second stage process of detailed counting in those areas. This is effectively what is done within the BTO by some single species surveys. However, most of the species covered by the Scarce Species Index are too common for the present conception of a BTO single species survey. This is not to say that carefully designed studies based on sampling defined areas of habitat could not provide valuable information for some of these species. Many of the most sensitive species are always disproportionately well represented in reserves, both National Nature Reserves and RSPB reserves, where they obtain more detailed attention than can be provided by the general CBC scheme.

3.2. EXAMINING COMMUNITY STRUCTURE

Much recent work on community structure has focussed on the use of diversity and overlap indices derived from information theory. Such indices assume that all species in the community have been censused with equal efficiency, an assumption that is certainly not true for the CBC. Against this, Dawson and Verner (in press) suggest that the results of mapping censuses perhaps more closely approach the goal of equal efficiency across species than do any of the other census techniques available, so that the error involved may

be tolerable. The total omission of certain species, such as Rooks on farmland, from the scope of the CBC may be more of a problem, though useful comparative results may still be obtained. Pimm (1975) has used computer simulations to estimate the effects on species diversity indices of bias in density assessment. He found that diversity was critically dependent on sampling errors, increasing as the error increased, and with the evenness component of the diversity description even more severely affected. However, species richness was little affected by these errors, so provided the presence or absence on the census plots of species such as Rooks is actually recorded, species number can be used as a descriptor of community structure.

Similar arguments apply to the use of rarefaction indices, which effectively simulate and predict the number of species expected for sub-samples of individuals drawn from the whole sample, and thus allow standardization to common sizes of community. Dawson and Verner (in press) point out that in these studies the full sample will contain fewer of the less detectable species than would actually be the case with repeated drawing of real sub-samples, so the whole rarefaction curve is depressed by this effect. However, the error should be lower the larger the number of individuals in the original sample.

The CBC data have been rarely used for the study of successional changes in birds. Glowacinski and Järvinen (1975) and Blondel (1981) provide good examples of what can be done using extensive bird censuses in relation to succession. A

prime requirement for the study of succession is that species densities should be measured on the same scale (Dawson and Verner in press), so that CBC-type mapping is particularly useful (Glowacinski 1975). However, successional stages often have strikingly different bird numbers so that quite crude measures may be used, as by Kendeigh (1946) who used only 3-5 mapping visits and by Ferry et al (1976) and Blondel (1981) who used densities derived from point counts via a calibration against mapping method results.

Overall, it may be concluded that trends in CBC levels for individual species reveal what is happening in broad terms but collectively are rather weak indicators of what is happening to the variety of species present in a community. Although in theory such summation measures as information-theory diversity indices can be used to integrate individual species abundance data, this approach cannot be used with the CBC data where the abundance spectrum from each plot may be confounded with species-specific census efficiencies. However, the absolute number of species recorded on the CBC plot is less sensitive in this way and so provides some information on trends in community structure.

3.3 HABITAT LOSS AND MODIFICATION AND RELATED SUBJECTS

The CBC scheme is not intended for, nor is it generally suitable for, monitoring habitat loss but it does provide information on the ornithological implications of losses documented in other ways. The CBC data are potentially useful in studies of habitat modification but their value here depends partly on the quality of the habitat data submitted by observers. Wiens and Rotenberry (1981a) have reviewed the various habitat features that may be measured and the analytical methods available for comparison between birds and habitat. They classify such studies into three types: (1) those based on a small number of habitat variables (2) those based on a general system of habitat classification, and (3) those that take many variables into account, and conclude that the careful application of this final approach is to be preferred. In general, the CBC habitat data as currently submitted do not measure up to the standard required and the quality of these data needs improvement; this is especially true in the case of woodland.

The mapping method offers a fairly robust (in the sense of insensitivity to observer variation) technique for assessing the effects of habitat management. Dawson and Verner (in press) suggest that the mapping method is the best available census technique for use in habitat studies, except perhaps in very heterogenous areas. However, they recommend the use of the original registrations rather than the derived clusters for this purpose. Nevertheless, significant differences in habitat correlates of farmland species have been demonstrated on the

basis of cluster data (Morgan and O'Connor 1980, O'Connor 1981b, O'Connor and Fuller in press) and cluster data from CBC 'expedition'-type fieldwork have given valuable information on the gross habitat preferences of woodland species (Williamson 1972, Williamson 1974, Batten 1976, Fuller and Taylor 1983). However, although the level of habitat data available in the CBC has thus been shown to be useful in demonstrating the ornithological implications of changes in habitat elements, it is not suitable for defining totally the habitat requirements of individual birds. The CBC method can be used to indicate habitat preferences wherever the differences between habitats are much greater than the differences in detectability of birds between these habitat types. The study by Williamson (1969) of the changing habitat distribution of the Wren on British farmland as its population built up following a cold weather crash provides a classic example. The value of the CBC scheme in this area would be even greater if the quality of habitat data asked of observers were to be improved. Greater guidance to observers as to the additional information desired should be provided.

Where BTO staff and expedition studies have been used in past fieldwork, various derivatives of the basic CBC fieldwork protocol have been used. The validity of these variants as assessors of community structure were validated by O'Connor and Marchant (1981) and could therefore continue in use for such purposes. On the other hand, some flexibility in census techniques used in these non-standard

studies is valuable, in that point counts or possibly transects may be more time-effective within such studies than either standard or modified CBC mapping. However, these alternatives do not offer adequate substitutes for data gathered under the main CBC scheme.

Milner and Hornby (1978) criticised the previous emphasis of CBC research on the use of specific case studies, arguing that the BTO should place greater emphasis on analysis of the national databank. With computing facilities available only in the last four years such national analyses have now begun: Morgan and O'Connor (1980) and Pearson (1980) provide examples of studies based on selected sub-sets of the CBC returns, and other work both on the woodland and on the farmland data are in progress. Such analyses are not as straightforward as may at first appear: a major review of the statistical problems involved is provided by Johnson (1981), who cites as major problems the need to consider non-linear responses by the birds to the habitat, the need to validate the generality of findings from particular studies, and the need to define the confidence zone of predictions made from the statistical analysis. Case studies based on follow-up of habitat alteration on routine CBC plots are especially valuable and should be undertaken wherever possible. A particular strength of the CBC scheme is its ability to provide both the wide-ranging databank needed for effective statistical analysis of habitat correlates and a range of "before and after" case histories with which to cross-check statistical conclusions. However,

one weakness in the present system of processing CBC returns is the absence of any systematic checking of the annual intake for cases of special management or other conservation interest that might warrant special study.

The CBC method is not intended to provide a means of site assessment on a national scale but can obviously be used for acquiring information about particular sites. Some of the more interesting case studies are those based on sites of special conservation value, such as nature reserves and SSSIs. CBC fieldwork is frequently conducted, often by a reserve warden, on such sites but the results are either not submitted for inclusion in the national CBC scheme (usually because the fieldwork deviates from the CBC standard to meet some real or imagined local conditions) or can be included only in the "Special" plots because the site is neither farmland nor woodland. Indeed, it may be argued that the CBC scheme should never routinely include data from such sites because their protected status may mean that their bird populations will be unnaturally high and buffered against the vicissitudes of the habitats the CBC is intended to study. Despite not contributing to the national scheme, however, these plots impose significant map analysis on BTO staff, since it is common for the observers concerned to want to standardize their results against the BTO "expert" analysis. In principle, however, such workers need to keep their fieldwork consistent only with respect to their own previous fieldwork on the site

and should be able to accept the uncertainty associated with lack of training as an analyst (see Svensson 1974, Best 1975) as an unknown component additional to that of their (unknown) census efficiency.

3.4 POPULATION DYNAMICS AND MANAGEMENT

A good understanding of the processes contributing to the dynamics of individual populations - recruitment by birth and by immigration and loss of death and emmigration - is essential for the understanding of the natural dynamics of populations and can potentially be used to formulate guidelines for management. For this purpose it is particularly important that the population estimates are both precise and accurate, particularly where the incidence of density-dependence in population processes is to be studied. Slade (1977) discussed how errors in the estimate of population size can contribute to biased estimates of the proper relationships between density and population processes.

Census methods have occasionally been used in before-and-after experiments of the effects of some manipulation of bird numbers. For such purposes Dawson and Verner (in press) have suggested that relatively coarse measures of abundance will suffice and in keeping with this Edwards (1977) has shown that short-term CBC surveys may be adequately used for detecting the changes brought about by insecticide used on test plots. Shields (1979) and Conner and Dickson (1980) discuss the detailed design of such experiments. Of particular importance here is the need to ensure the manipulation does

not affect the detectability of birds on the plots (Shields 1979, Grue and Shipley 1981). Dawson and Verner emphasise the need to conduct such experiments on more than one experimental and controlled plot to assess the results confidently. Moulding (1976) has also stressed the double nature of the results of some of these experiments: for example, the application of an insecticide may have a short-term toxic effect on birds but may have an additional long-term effect because of the effect of the insecticides on the food supply of the birds concerned. O'Connor (1980a) and Fuller and Taylor (1983) have also shown that quite short-term CBC surveys may be used for assessing the impact of major management practices on birds, even though such work does not meet the full IBCC guidelines.

One possible factor that has been only recently taken into account in habitat studies is the dynamics of populations across habitats, particularly in relation to hierarchies of species habitat preferences (Brown 1969, Fretwell and Lucas 1969). When a species increases in population size these theories predict that the preferred habitat will fill up first, and only when that one is full will the other less preferred habitats be used. Kluyver and Tinbergen (1953) have described a "buffer effect" based on this: as a population fluctuates in numbers, the less preferred habitats are the first to be vacated during decreases and the last to be re-colonised during increases. Consequently, the theories predict that densities in the preferred habitat should fluctuate less than do densities in the less preferred habitats, providing one characteristic by

which to identify habitat preference. Dawson and Verner (in press) point out that this factor may allow one to identify habitat preferences even with rank measures of species abundance, such as is provided by the CBC index. Pearson (1980) has relied upon this approach to identify detailed features of CBC habitat records of significance to individual species, by correlating fluctuations in abundance with the availability of these different habitat elements. Those woodlands in southern England with the preferred elements were less variable in their CBC counts from year-to-year than were woodlands with fewer of the preferred habitat elements. Combining the CBC results with information from the Nest Record Cards has allowed demonstration that the preferred habitats are those in which birds are most successful at reproduction, at least in the case of Yellowhammer (O'Connor 1980b) and Kestrel (O'Connor 1982).

The Brown (1969) and Fretwell & Lucas (1969) hypotheses may thus provide useful bases for assessing habitat preferences in birds but it is important to appreciate that they take no account of the degree of breeding site fidelity shown by individual birds. More information is needed on the extent to which an individual remains faithful to the habitat in which it was reared or in which it initially bred. The above models take no account of any historical components that might be involved in habitat selection by individuals.

3.5 CONCLUSIONS

A major strength of the CBC is that it focusses mainly on those habitats which form the fabric of the lowland English landscape. It thus has the unique potential to monitor the populations of birds in the wider countryside and is not restricted to nature reserves or semi-natural habitats forming a small part of the landscape. Nevertheless, it is necessary to redefine more exactly which bird populations, in terms of habitats and regions, the CBC is concentrating on. The present strength, farmland and lowland broad-leaved woodland, should be consolidated and there should be a reduction of the number of plots in other habitats.

In order to fulfil satisfactorily its monitoring role, the CBC must continue to develop beyond the mere calculation of indices. There is a need to increase the biological monitoring function of the CBC through periodic reviews of population trends of species and groups of species in relation to climatic changes (especially for migrants in their winter quarters), to weather variations and to trends in land-use. Such reviews should include thorough appraisals of sampling limitations.

The CBC has considerable potential applications in habitat-related studies which feature strongly in the NCC contract. Studies of the relationship between the abundance and distribution of birds and variations in properties of their habitats can be pursued using CBC data in several ways, each with conservation implications. Firstly, the scale of the CBC data base is sufficiently large to conduct broadly-based studies of bird densities and community structure in relation to a range of habitat features in both farmland and woodland environments. Secondly,

the CBC includes case histories of habitat changes. Some of these involve long-term vegetation management for conservation purposes, others are examples of habitat loss resulting from changes in land-use. Such case studies provide valuable "before and after" studies which complement the more extensive habitat analysis outlined above. Thirdly, quantitative studies of vegetation dynamics and bird populations are lacking for most seres in Britain yet reserve management is frequently concerned with the modification of successional processes and a more thorough knowledge of successional changes is desirable. Fourthly, the CBC (or a modification of the basic mapping method) can be used to study particular problems of habitat management or to conduct experimental "before and after" studies (on an expeditionary basis if appropriate). Fifthly, the CBC data have a role to play in defining hierarchies of habitat preferences which may reveal themselves by examining patterns of habitat distribution at varying population levels.

Long-term development of the potential of CBC for habitat studies is dependent on improving the quality of the habitat information currently available for each plot. There is also a need to annually list those plots on which habitat changes have occurred.

CHAPTER FOUR

RECOMMENDATIONS OF THE REVIEW GROUP

This chapter presents a complete summary of the Review Group's recommendations. These have been ordered in relation to the different aspects of the CBC.

Recommendations in relation to monitoring

(1) A greater proportion of the CBC staff time should be devoted to aspects of the CBC results other than the production of an annual index.

(2) The CBC scheme should reduce the number of census plots handled by admitting for monitoring purposes new plots only from arable, grazing and dairy farmland and from semi-natural woodland habitats. As far as possible new plots should be typical of either the farmland or woodland in their vicinity.

(3) The publication of annual indices in Bird Study should cease with the 1981-82 results and thereafter be published only in BTO News, as feedback written in popular fashion. Species with special problems of index interpretation should not be treated on this annual basis.

(4) A programme of in-depth review of the population trends in the revised samples (farmland, woodland) should be introduced, with targets of approximately five-year reviews of each species or species group. Detailed attention should be given in these papers to the special problems associated with indexing these species and to regional variation in population trends.

These papers should appear on an annual basis in Bird Study, as part of a regular programme of CBC analysis conducted with the savings in staff analytical time brought about by the recommended reduction in the annual volume of CBC plots processed.

(5) Special attention should be given to devising an effective method of using the CBC data from the revised farmland and woodland samples as an early warning system. The procedures adopted need to take account of the effects of weather and population density on population trends so as to increase the sensitivity of detection, at an early stage, of any underlying environmentally induced changes.

(6) Greater effort should be devoted to improving regional representation in each of the continuing farmland and woodland samples, within an overall total of about 100 plots in each of the two categories. The west and southwest of Britain, and lowland Scotland, are of particular concern here. In upland areas "farmland" should be defined as enclosed land.

(7) The Populations and Surveys Committee of the BTO should review those species not covered by the CBC or the Waterways Bird Survey and consider how annual censuses might be achieved for those species thought desirable to cover in this way.

(8) The CBC samples should be checked for long-term homogeneity before major analyses are published for particular species. This will involve significant programming effort at Beech Grove beforehand and this will inevitably restrict the rate at which research use of the data can proceed. Consequently, early attention might be given to the analysis of weather effects on bird populations, since such studies were less sensitive to any changes in homogeneity that might be present.

Recommendations in relation to species coverage

(9) There should be no change in the practice of recording all species but the list of target species should be standardized more tightly in relation to current variation between observers as to inclusion or not of Starling, House Sparrow, Woodpigeon and Rook.

(10) The CBC instructions should be revised to emphasize the critical importance of certain kinds of information for particular species. This guidance should come from the current analysts. If necessary, separate instructions for farmland and woodland censusing should be prepared.

Recommendation in relation to community structure

(11) Population changes within ecologically or taxonomically related groups of species should be periodically reviewed by BTO staff for evidence of parallel trends that might be indicative of general processes bringing about broad alterations in community structure, especially on farmland.

Recommendations in relation to habitat studies

(12) Case studies based on follow-up of habitat alteration on routine CBC plots are especially valuable and should be done wherever possible.

(13) BTO staff should compile an annual list of plots subject to habitat change and should review the possibilities for research based on these case studies.

(14) The CBC scheme should not (and could not) be used to provide a framework for national site assessment but has a particularly useful role in providing background information on typical densities and species richness of particular habitat types (though this role does not imply a need for annual censusing of all such habitats).

(15) Members should be encouraged to continue with particular case studies of habitat modification and management and, particularly, to continue with plots where modification was relevant to management. BTO staff should similarly use appropriate opportunities to gather this type of information, although where BTO staff are involved it may or may not be most appropriate to use the standard CBC procedures.

(16) The Guiding Principles for the analysis of CBC species maps should be published by the Trust to permit participants who wished to carry out their own analysis for case studies to do so and to provide a standard reference for future publications.

Recommendation in relation to CBC sample composition

(17) The annual sample of CBC plots analysed in the scheme should be limited to 100 for farmland and to 100 for woodland, together with a reserve of 50 plots to compensate for annual turnover of participants. For woodland, BTO staff should review the composition and representativeness of the present sample with the ultimate aim of broadly monitoring the spectrum of semi-natural woodlands. This should include a review of the scrub and parkland components of the present sample, though it is recognised that the limits of definition of these habitat

types in relation to "woodland" are difficult to define. For farmland, more plots are needed in west and south-west England and in Scotland. In reducing the number of current plots towards this re-defined sample, staff should discourage participants whose fieldwork was unsatisfactory and should encourage satisfactory participants, presently working on special plots, to change to a farmland or woodland plot. Although the bulk of the change would have to be brought about person by person, appropriate publicity should appear in BTO News.

Recommendations relating to the efficiency and appropriateness of CBC methods

(18) Manual cluster analysis by BTO staff should continue.

(19) Nest counts should be used for Magpie, Carrion Crow, Jackdaw, and Swallow in farmland habitats, though in some places counts of pairs might be more appropriate for Jackdaw. This recommendation should be included in the intended revision of the CBC Instructions or be incorporated into the advice provided participants as to how they should census the different habitats (see below).

(20) Most of the resources freed by the recommended reduction in number of CBC plots should be spent on exploring more fully the information already in the CBC scheme rather than spent on other aspects, even though the proposals put forward here leave certain habitats unmonitored.

(21) The remaining resources freed should be used to encourage "one-off" studies, in particular the re-development of expeditionary studies and the encouragement of observers in

censusing sites of special habitat or management interest.

(22) Some staff time should be devoted to examining how far the changes in population status or distribution detected by single species surveys parallel the changes in population abundance detected by the CBC indices (although the different function of the two techniques is acknowledged). The available CBC data should be reviewed routinely in parallel with any single species survey. Conversely, the CBC trends should be reviewed periodically for otherwise unsuspected candidates for single species surveys.

Recommendations in relation to consistency of observer effort

(23) The main ways in which annual or spatial consistency can be breached and the consequences of doing so should be emphasized in a revision of the CBC Instructions. This should also include a warning that failure to observe the necessary standards may result in the data concerned being discarded.

(24) In all cases where there has been a change of observer at an ongoing plot, the results of the first year with the new observer should not be included in the index. In the case of group surveys, where turnover of observers was frequently high, the results can be used in the index provided that no one observer does more than half the visits and that there is substantial continuity from one year to the next.

(25) A standard form should be sent to all observers each year on which they should give the following information relevant to that year's census:

names of the observers carrying out the work, number of visits, dates of visits, visit duration, time of day, age (in broad classes) of observer, nestfinding effort (and which species, if selective). Participants should also be requested to indicate any reason for suspecting a recent deterioration in hearing ability. Tapes of selected bird song should be available for observers to test their hearing. Similar tapes of "difficult" songs and calls should also be available to new and potential observers.

(26) The CBC Instructions should state categorically that tapes of birdsong should not be used during CBC fieldwork.

(27) The question of whether first year censuses are comparable with later ones needs to be investigated either by making available the results of earlier unpublished investigations on this point or by conducting new studies.

Recommendations in relation to habitat recording

(28) On farmland plots the recommendations set out in Appendix 6 should be adopted for annual recording of strictly defined plot components, using a pro-forma system. Observers should be encouraged to visit their farmland plots in September and in January to collect certain habitat data (discussed in Appendix 6). Details of chemical usage are considered important and BTO staff should develop a system of soliciting this information from the farmers concerned where observers were reluctant to do so themselves. Consideration should be given to organising this collection of data through the good offices of farming members of the Trust, who might reasonably

be expected to be more successful in persuading farmers to supply the data requested than might be the BTO itself.

(29) For woodland, observers should be requested to carry out a minimum level of broad habitat recording each year, providing information that can be readily entered on maps. Such information should include such details as stand types and gross structure, as well as information indicating the type of active management (if any) received by the plot. A guide to woodland habitat recording in the context of the CBC would be valuable.

(30) Detailed habitat recording (vegetation measurement and sampling) in woodland is best dealt with by BTO staff on special visits as and when this information is required. Habitat recording in woodland should therefore be regarded as a proper use, within the remit of the NCC contract, of BTO staff time.

Recommendations on validation of techniques and the cluster analysis procedure

(31) The Review Group considered that for most species CBC cluster densities and absolute densities were of the same order. However, the existing literature on this question should be reviewed so that an indication is available as to which questions, potentially answerable by the CBC scheme, are likely to be affected by major inaccuracies in cluster densities for particular species.

(32) The possibility of long-term drift in the techniques used by CBC analysts needs more consideration than it receives at present.

(33) Observer saturation at high density of birds could possibly depress the estimate of bird density made by the CBC method and requires a methodological examination.

Recommendations relating to service aspects of the CBC

(34) Trust staff should cease undertaking the analysis of special plots censused by non-members, e.g. for management purposes of local nature reserves and should encourage other "special" plot participants to undertake their own analysis in future.

(35) The present practice of returning original CBC maps to observers and the associated practice of tracing map records for observers should cease as soon as practical. Interim arrangements may have to be made for people currently receiving their original maps back.

Reporting on implementation of the recommendations

(36) Progress in implementing the recommendations of the Review Group will be reported annually in the BTO's Annual Report to NCC. A copy of this progress report should be sent to members of the Populations and Surveys Committee.

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APPENDIX 1.

BRITISH TRUST FOR ORNITHOLOGY

Beech Grove, Tring, Herts

COMMON BIRDS CENSUS INSTRUCTIONS

INTRODUCTION

The primary aim of the Common Birds Census is to investigate the status and number of common birds by means of breeding season censuses on a nation-wide scatter of sample plots. The comparison between successive years' results enables us to maintain an 'annual index' of fluctuations in population levels and to discover if there are any definite trends in numbers of different species.

The Census was started in 1961 at the request of the Nature Conservancy Council, with the original appeal being made for censuses in the agricultural environment, since it is on farmland plots that the growing use of toxic chemicals as weed-killers and pesticides, together with the destruction of hedgerows and other features of habitat, have created widespread hazard to bird populations. However, for nation-wide representative census work cannot be limited to farmland, so woodland, moorland, wetlands and parkland are included in our list of habitats.

It is important that, once established, a census plot is CONTINUED over a number of years.

This work is invaluable to conservation and we are constantly in need of new areas. The work is exacting but it is informative and pleasurable. We appeal urgently to anyone who can help with this enquiry to do so, and thus enable us to learn more about the numbers of our common birds and the factors influencing them.

Results of our work regularly appear in the BTO's Journal Bird Study which is free to members of the Trust.

THE CENSUS METHOD

A mapping technique introduced in 1964 has simplified both the field-work and subsequent analysis, but considerable time could be saved for research at headquarters if more observers would help in the routine preparation for analysis by:-

a) adopting the species symbols and other conventions supplied with these instructions, using them meticulously in preparing maps

b) preparing accurately plotted species maps from the data on their visit sheets.

UNIFORMITY IN METHOD OF PLOTTING IS MOST IMPORTANT, AND WE WOULD PARTICULARLY ASK OBSERVERS TO FOLLOW THESE INSTRUCTIONS CLOSELY AND TO CONSULT THE TRUST'S STAFF IF IN ANY DOUBT. It is astonishing how confusing and time-wasting even small departures from the normal can be.

All species should be included in the census except gulls, heron, rook and late individuals of winter-visiting species, unless nesting or holding territory. Territories for House Sparrow, Woodpigeon, Swift, the hirundines and Starling will normally be assessed on the basis of nests found.

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Records of nests found and revisited at least once will be welcomed by the Trust's Nest Records Scheme, and observers are asked to enter the details on Nest Record Cards issued by the Trust.

It is emphasised that CONTINUITY OF RECORD is an important aim of the census work and this should be borne in mind when selecting one's area.

PLEASE REMEMBER THAT THE PERMISSION OF THE LAND-OWNER OR FARMER SHOULD BE OBTAINED BEFORE BEGINNING THE CENSUS.

SELECTION OF CENSUS PLOT

a) Farmland: The plot chosen should be typical of the local countryside and should preferably be part of a larger area of similar type. While large stands of timber, lakes and tracts of marsh should be excluded, it must be borne in mind that copses, gardens, small orchards and scrub-grown fields are characteristic of much agricultural countryside and should be treated as an integral part of the environment. However, it is important that farmland census plots should not contain more than 10% of woodland and scrub (other than field hedgerows).

It is essential to choose well-defined boundaries, such as main roads, streams, canals, railway lines etc. On no account should an 'imaginary' boundary line be drawn through the middle of a field, as this creates considerable difficulties in the analysis.

b) Woodland: Any type of woodland (including orchard) is of interest, whether with or without clearings and secondary growth, but where possible woods of a specific type should be chosen, e.g. oak, beech, hornbeam etc. Here it is not usually possible to select such well-defined boundaries, though small streams, rides and pathways may serve. If the area chosen is part of a larger tract of similar kind, birds recorded in the boundary zone should be marked on the maps whether inside or just outside the boundary. A more detailed note on how a woodland census may be tackled is given in Appendix A.

c) Other habitats: Censuses carried out in other habitats such as moorland, commons, suburban gardens or parks, sewage farms, developing gravel and sand pits etc. are of interest, particularly to relate bird populations with habitat change.

d) Nature Reserves: A number of nature reserves administered by such bodies as the Nature Conservancy, The Royal Society for the Protection of Birds, and the Society for the Promotion of Nature Reserves, and County Naturalists' Trusts are being censused, and we would welcome additional areas of this kind, since information arising from census work will be of great value in planning reserve management. Equally the inclusion in census plots of S.S.S.I.'s (Sites of Special Scientific Interest) or other areas of conservation interest is of value.

SIZE OF PLOT AND NUMBER OF VISITS

Generally speaking, accuracy in census work is a function of the size of the plot, the spacing of visits, and the time spent per unit area. The following guide is based on the assumption that the observer will be working alone; if the census work can be shared by a team, then careful planning of visits can increase efficiency, and cover of a sample plot larger than the one indicated may be possible.

It is better to tackle a smaller plot throughly than attempt a larger one and risk inadequate cover. Accuracy is likely to be greater for larger areas, provided a balance can be struck between size of area and the time available for each visit, since the margin

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of error due to 'edge effect' is lessoned. It is most important not to 'rush' the observations, and one's progress should be fairly slow and thorough so as to give the maximum opportunity for registering the birds.

a) Farmland: Experience has shown that 200 acres is the amount of fairly open farmland that most observers can cover adequately with a season's total of 10 full visits. If the fields are small and bounded by thick hedgerows, or there are a number of small copses and similar scrub, about 150 acres should be manageable on the same basis. Farmland areas should not be less than 150 acres.

It is very desirable that there should be a mimimum of 10 visits with not less than 3 each in April, and May but if no more than 7 or 8 complete visits can be achieved observers are asked to make short supplementary visits to boost the number of registrations. An indication of the extent of cover and of time spent in the field should be made for each partial or complete visit; this can be done effectively by using biros of different colours if one map in used for two or three partial visits.

b) Commons and moors: such areas are frequently more uniform than farmland and do not have such a high bird density, so that censuses of wider extent are possible. Lack of topographical features, however, may make accurate mapping more difficult and some system of marking posts may be necessary, as described in Appendix A.

c) Woodland: The bird density in woodland is high compared with farmland and more time in relation to unit area is necessary to ensure efficient fieldwork. Employing 15 visits, about 50 acres is a suitable plot size in fairly open woodland/scrub, but only 25 acres should be attempted if there is a lot of secondary growth and no clearings, or in more open woodland if only 10-12 visits are possible.

d) Orchards and parks: These should be treated in the same way as open woodland.

e) Suburban gardens: Bird density is highest in suburban areas with mature gardens, but accurate mapping is usually easier since each bird has an 'address', and large-scale maps are often available at the local surveyor's office. On the basis of, say 15 visits, 30-40 acres should be possible.

SPREAD OF COUNTS

This is essentially a breeding bird census and counts should be made at regular intervals between the first fine spell after mid-March (south and midlands) or the beginning of April (north of England and Scotland) and the end of June. Special attention should be paid to each species during the peak of its song period; this may be different from one area to another, depending on geographical location.

It is important that the visits should be made in favourable weather, when bird song is not depressed by wind or heavy rain. Singing and territorial behaviour are generally most conspicuous in the early morning, and some species also sing well in the evening. A slow rate of progress with frequent pauses during the course of the survey especially when working in woodland - greatly increases the census efficiency.

FIELD RECORDING

An immediate aim of our work is that the final analysis should give as accurate a picture as possible of the number and distribution of territories within the census area. This is best done by means of

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Field Recording continued...

the mapping technique described below. We are confident that this enhances the accuracy of the counting and at the same time eases the work for recorder, analyser and research student alike; and there is no doubt that it enables the observer to derive greater pleasure and knowledge from his efforts.

The technique is substantially the same as that initiated in Sweden by Anders Enemar (Var Fagelvarld, 1959) and now adopted as standard practice by the International Bird Census Committee for all habitats (see Bird Study 1969, pp 248-255). The basic unit of the census is the territorial singing male, but any evidence of territory holding, such as nest-finds, newly fledged young, alarm call, adults carrying nest material or food for young, distraction display (injury feigning) should be noted, as indicated below.

A separate blank map should be used for each visit to the census plot, unless the plot is sub-divided, when one map may suffice for two or three visits if a different coloured biro is used each time (but please use easily distinguishable colours). Successive complete visits or combinations of partial visits should be marked 'A', 'B', 'C' et seq. the date of the visit must be recorded and a brief note of the weather, and the starting and finishing times of each visit be recorded on the map. It is essential to distinguish between partial visits by adding a suffix to the letter, e.g. 'B1','B2', 'B3', et seq. In addition the extent of cover for all visits should be outlined in the same colour used for registrations.

The blank maps can be foled over a piece of hardboard and secured by strong elastic bands or bulldog clips. Always carry a pencil - biros will not work in the rain! Brief supplementary visits to check outstanding problems may not require a separate blank map, but the extent of cover should clearly be outlined, and visits denoted by a suffix as described above.

The bird should be registered by the accepted symbols (see the appended list of birds). Please use the following conventions for different kinds of registrations (the examples given are for Blackbird).

(B)	Singing male
B	Alarm call
B material	Seen with nest material in beak
B food	Seen with food in beak
BB	Two males fighting (movement of either on breaking up can be shown by an arrow)
B*	Nest
B♂ or B♀ or B or B juv	Sight-record, with indication of sex or age if appropriate.

It will be found most helpful at the analysis stage if the visit maps carry an indication of which registrations, in close proximity to one another, are definitely of different birds, or belong either definitely (or even doubtfully) to the same bird. The following conventions must be used:

(B)-------(B)	Different birds heard in song at the same time
B------- B	Different bird in view at same time
(B) ——— (B)	Singing bird seen to take up new positio
(B) — ? — (B)	Thought to be the same bird in a changed position but not certain

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Field recording continued....

OBSERVATIONS OF CONTEMPORANEOUS ACTIVITIES, ESPECIALLY THOSE INDICATIVE OF TERRITORIAL COMPETITION (the dotted line) ARE MOST USEFUL. It is also helpful if nests in close proximity known to be in use at the same time (hence to belong to different pairs) are joined by a dashed line on the map.

B*-----B*

In the case of colonial or semi-colonial birds such as Starling, martins, Swallow, Swift, Reed Warbler, Linnet (see figure), Greenfinch, Goldfinch and Tree Sparrow, use the accepted symbol and number seen at each visit, enclosed in brackets, e.g. LI(8). When the species sheets are plotted each 'colony' is encircled and an estimate made of the number of pairs present, e.g. x 4. Individual pairs for most of these species may not be colonial and can be treated in the same manner as other species which exhibit well-defined territories.

In the case of Skylark and the pipits it is often useful to mark the points of ascent (arrow point upwards from circling bird) or descent (arrow point downwards) if observed; also any considerable movement during song-flight is worth plotting (as shown for Blackbird above).

Starlings are best censused by counting occupied nests at a time when the nestlings are noisy. Search of the farm buildings is the only satisfactory way of arriving at figures for Swallow and House Martin.

Remember that actual proof of nesting is not necessary to qualify for inclusion in the census; a pair may be nesting outside the boundary yet hold part of their territory within the census area; or the whole census area may represent but a part of the total territory (e.g. Kestrel, Cuckoo, Kingfisher).

COMPILING SPECIES SHEETS

When no further visits are intended, the full complement of visit maps should be arranged in chronological order and the data transferred to 'species maps' for which the balance of the outline blanks can be used. Many observers have found it advantageous to make up their species maps as they go along, incorporating registrations after a visit has been completed.

On each species map the position of individuals Skylarks, Blackbirds, Willow Warblers etc. will be identified by the appropriate visit letter 'A', 'B', 'C' etc or where partial visits have been carried out 'A1', 'A2', 'A∅' etc. Conventions indicating 'song' 'alarm call' and so on, should agree with the records on the visit sheets. PLEASE BE SURE TO COPY EACH CONVENTION EXACTLY, both the kind and its position; attention to this point will obviate a great deal of checking and even re-plotting. If time does not permit an attempt to delimit the territories it is still important that the observer draws up his own species sheets, even if this means delaying the submission of the returns until the end of the year or even later in the winter.

In the case of farmland, it should be possible to get more than one species on one map, thus economising on materials. When this is done, a differently coloured biro must be used for each different species. Please use easily distinguishable colours. A field species such as Skylark, Partridge or Moorhen will often 'double' conveniently with one of the hedgerow species. It is desirable, however, to have separate sheets for the really common birds, which in most cases will be Blackbird, Dunnock and perhaps Skylark, Robin, Chaffinch and Wren. Please ask for more maps rather than overcrowd the ones you have left at the end of the season.

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Species sheets continued...

Individual nests should be registered once only on the species map and should be given a serial number to correspond either with a special number written at the right-hand side of the 'species' panel on the nest record card, or (if nest record cards are not kept) with the same number on a separate list giving details of nest histories. This information is required because of the need to distinguish where possible, first and second, or even third nesting attempts of the same pair. Care should be taken to determine whether a nest is of the current year or from a previous year, in which case it should be ignored.

Experience during previous years has shown that it is easy to overlook some registrations on visit sheets when transferring them to species sheets and it is therefore EXTREMELY IMPORTANT TO CANCEL EACH SYMBOL on the visit maps immediately one has transferred it to the species sheet. Failure to cancel the symbols doubles the work to be carried out on the census by the BTO Staff. Cancellation can be done by ticking or lightly stroking through the symbol so that it remains legible in case a final check is necessary. When all species maps have been drawn up, a final check on the visit sheets should be made to make absolutely sure that no symbols have been missed.

ANALYSIS

It is most helpful if the preliminary analysis is done by the observer, so that it need only be checked by the Populations Section, who have now developed a standard method of delimiting territories which is based on considerable field experience as well as the study of many different returns. A separate set of instructions can be sent to persons wishing to attempt their own analysis. The growth of the scheme has been such that we would welcome assistance of this kind; but if the observer cannot undertake this side of the analysis it will be done at headquarters. In such a case, the earlier in the autumn that the species and visit maps can be sent to headquarters the better.

When complete each species map may show discrete groupings of letters indicating the positions held by the territorial males on the different visits. Generally speaking, a cluster of symbols in which there is no duplication will indicate a particular male's territory - or, to be more exact, that part of a territory which is most closely defended. In practice, some 'double' registrations may occur, either because a bird has changed position unseen during the period of observation, or because of some temporarily visiting male (which has perhaps not established a territory of its own), or because of a migrant singing whilst on passage. Generally, however, there are unlikely to be more than two duplications of this type in any one territory.

In drawing the outlines of presumed territories, PLEASE USE A SOFT PENCIL, not a biro or pen, as staff may wish to make some adjustment to conform with the established method of analysis.

HOW TO OBTAIN MAPS

The 25" O.S. map appropriate to the census plot will be used as a basis. So that we can order the correct maps, a tracing of the selected plot from a 6", 2½" or 1" map (O.S.) giving map number, grid references, towns, main roads (with road numbers), names of farms, local landmarks etc. should be sent to the Populations Section. If known, it is also helpful to have the 25" map sheet number(s). The maps will be ordered and paid for by the BTO and will be sent to the observer if necessary.

How to obtain maps continued...

Alternatively, many large libraries (e.g. County Libraries) and County Planning Offices, hold 25" maps for their district or county and it is of great assistance if an observer who has access to these can let us have a tracing or photocopy of his proposed plot. The area can also be up-dated at this point. This type of assistance is always greatly appreciated and apart from helping us economise, it allows us to arrange for you to receive blank maps more promptly than is sometimes possible (this is particularly important when an observer does not decide to do a census until late in the winter, mid February or March.)

Finalising the plot and its boundary lines will be left to the judgement of the observer, and he or she should return the map(s) to the Populations Section as soon as this is done. Where possible however, it is helpful if the boundaries are finalised on the small scale tracing sent in when applying for large scale maps. It may be necessary to up-date the 25" maps (e.g. because of loss of hedgerows and filling in of pools, new buildings etc), and if this is necessary before the first seasons work, it is helpful if the observer can inform us that alterations will need to be made before blanks are duplicated.

A number of outline maps of the census plot will then be sent to the observer for use in the survey as described above.

FORWARDING AND FILING OF RETURNS

All the visit maps and species sheets should be sent to the Populations Section, so that a careful check can be made and the results transferred to our permanent records.

The final species sheets will be traced and kept in a carefully indexed vertical plan filing system, so that any given tracing can be laid over the appropriate habitat map and the main characteristics of the bird's territories in relation to vegetation and land-use can be seen at a glance. It cannot be too strongly emphasised that the intrinsic value of this permanent record of the census worker's time and effort depends to a great extent on the detailed accuracy of the key habitat maps.

The original materials, or any part of them, will be returned to the observer later if so desired, in which case a request should be made when forwarding the results.

The address to which returns and correspondence should be sent is:- Populations Section, British Trust for Ornithology, Beech Grove, Tring, Herts. (Tel: Tring 3461/2).

COMPILING A HABITAT MAP

Since in future years much of the research will be concerned with habitat tolerance, a detailed description of each census plot is desirable. Most of the information can be supplied in an observer's first season so that in later years only changes (e.g. loss of hedgerow, cropping changes, improved drainage etc) need be recorded. It is essential that these changes should not be overlooked, and one of the outline maps should be used to record each season's details. The main key Habitat Map should be drawn up in accordance with the specifications given below. A standard method of recording these details is important if valid comparisons are to be made. Information can be recorded as the census work proceeds, and the Habitat Map completed in mid-June.

a) Geographical Features: Any comparison that might be made regarding climatic and topographical factors will be done on a national scale, but an indication of altitude and exposure should be given and contours are useful and can be copied from the 6" or 2½" O.S. maps.

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Habitat Map continued...

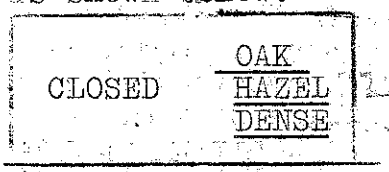
b) Soil: Soil features will also be viewed very broadly but any notes which you can give on its nature and drainage properties will be very useful.

c) Vegetation: The type of vegetation is of prime importance to the birds in providing nest-sites and determining availability of food. Information is required to show broadly the botanical character of each census area as a guide to how typical it is of the locality in which it is situated.

Characteristically plant communities exhibit a layered construction, with the upper tiers dominating the lower. In this country there are commonly four tiers:-

1)	Primary	- Tree layer (above 15ft)
2)	Seondary	- Shrub Layer (between 4-15 ft)
3)	Field Layer	- Herbaceous vegetation and low shrubs, generally less than 3ft and not more than 6ft
4)	Ground Layer	- Mosses, lichens etc.

d) Woodland/and Copses: Shade green and marked 'CLOSED' or 'OPEN' according to spacing of trees. (Closed means that tops of adjacent trees touch or almost touch when in full leaf.) Record the species of each teir one above the other. Qualify field-layer with 'DENSE' (almost continuous cover of thistles, willow-herb or other tall plants) 'MEDIUM' (short grass interspersed with patches of taller vegetation), or 'SPARSE' (short grass and low-flowering plants). Give dominant species where possible as shown below.

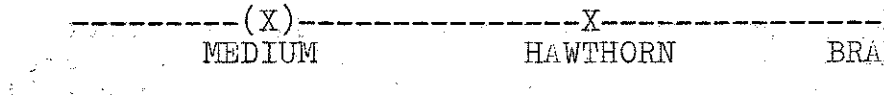


Treat orchards in the same way but give field-layer as for crops.

e) Scrub: Shade green where scrub occurs. Indicate height by using 'HIGH' (over 15ft), 'MEDIUM' (4-15ft), 'LOW' (up to 4ft). Write 'SCRUB' and name of species; if mixed give in order of abundance. Treat young plantations in the same way e.g. LOW SCRUB, HAWTHORN, BRAMBLES.

f) Boundary Vegetation: Give an indication of width by using fine or broad green lines accordingly. For remnant hedges use broken lines. Trees - large trees (more than 26ft) mark with encircled crosses (X); small trees (15-26ft) marked with open crosses X, write name of species above the boundary line.

g) Shrubs: Shade green, give names of species below boundary line. Give height and order of abundance as for scrub, e.g.



In cases where there is considerable mixing of boundary trees it may be necessary to give a more general description, e.g. MIXED + OAK, ELM, ASH.

h) Field Vegetation: i) Natural - areas covered by a thick field-layer of such plants as willow-herb, nettled, heather, bracken, coarse-grasses, rushes or reeds. Stipple green and mark. (notes and lists of other species of flowering plants found in the area would be a useful addition).

ii) Crops - mark fields with crops present during the main part of the breeding season. Distinguish between leys and permanent pasture. Gives notes on farm livestock.

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Habitat Map continued....

iii) No crop - state whether stubbled, bare fallow or newly turned soil.

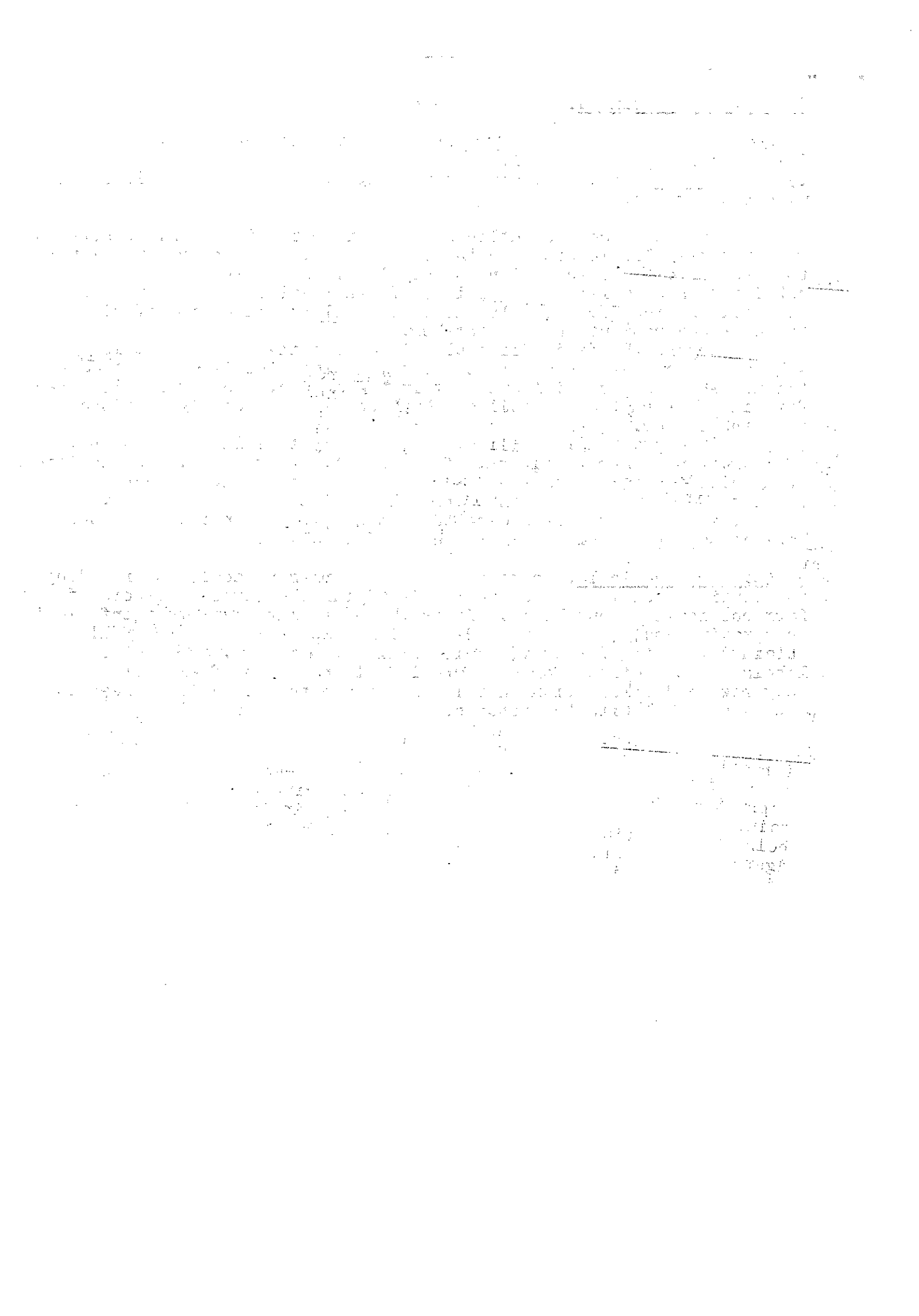
i) Water: shade all water blue. If flowing indicate direction with blue arrows.

The above scheme outlines the minimum requirements. Observers with a particular interest in the ecology of their own area are invited to give as full a description as they like. Many have already submitted information which will be of great value in the future when we shall examine more closely the individual relationships of birds to their environment and one another.

Anyone who finds difficulty in describing the habitat is welcome to ask the advice of the Trust, or may find it useful to ask a friend, who has a special interest in the subject, to cover this aspect for him. Information on soil and land use is more easily obtained from the farmer.

Photographs of the area, particularly to illustrate the nature of hedges and other features of the habitat, are welcome. The positions from which are taken and the part of the plot they embrace can be indicated on one of the blank maps. It is important that the type of habitat immediately surrounding the census plot is indicated on the habitat map, particularly in the case of woodland.

Use of Farm Chemicals: census work on the present scale is providing information useful to those who are studying the adverse effects of some farm chemicals on our birds. It is therefore important that information on spraying and the use of seed-dressings, weed-killers etc should be obtained from the farmer if he is willing to give it. Very often labels of 'Directions for Use' are left lying in the fields or hedgerows and information on this aspect can be gained from these if copies are sent with the returns.



APPENDIX A.

Surveying Woodland Plots

Census work in woodland is much more difficult than on farmland because the bird density is higher and the habitat much more uniform. Moreover, visibility is often restricted by the canopy or the shrub layer so that the registration of individual males is often imprecise. In the case of scarcer species with wide-ranging territories this imprecision may not much matter, but with the commoner species it can be an important source of confusion and error. It is, of course, these commoner species which are the most important for the construction of an 'annual index'.

The inherent disadvantages of working in woodland can be largely overcome by establishing a 'grid'. The census worker is then always aware of his exact position in the area and can plot the singing males and other bird activities with much greater accuracy. The grid enables one to follow and record exactly the movements of individual singing males and also record at what points males of the same species are 'singing against' each other, - classes of registration which are extremely valuable to the delineation of territories at the analysis stage.

The grid is simple. A base-line is established along afairly straight ride or pathway forming one boundary of the plot with points A, B, C, D, and so on at intervals of 50-metres. The trees at or close to these points are given zero marks - $\underline{A}_0$, $\underline{B}_0$, $\underline{C}_0$, etc. Lines are then set up at right-angles to these points, and further marks are set up on trees at 50-metre intervals along each line, thus $\underline{A}_{50}$, $\underline{A}_{100}$, $\underline{A}_{150}$, and so on.

If the grid is to serve for repeat censuses over a succession of years, the stems of the trees can be marked at the appropriate intervals with white paint, at or slightly above eye-level; if however, there are objections to permanent marking, white card with letters and figures about 9" high in waterproof crayon can be tied round the stems. It is useful to hang a few white or coloured streamers from the lower branches to render the marked trees more prominent. If adjacent marks, either parallel with the baseline or at right-angles to it, are obscured by intervening secondary growth, then streamers hung from the branches of intervening trees can be used to indicate the line.

A compass should be used to set up the lines at right-angles to the baseline. If a 50-metre tape is not available, the equivalent measurement in yards is 54.7. It is better to have the grid in units of 50-metres as the plot area is then easy to determine in hectares. This is the standard used in expressing bird-densities in all continental census work, and will be adopted also in Britain.

The permission of the land-owner must be sought, of course, before setting up a grid, and it is best to select census plots in areas of restricted public access, to avoid interference with the markers. It is recommended that anyone who would like to attempt a woodland census of the kind mentioned should contact the District Officer of the Forestry Commission, who will usually be able to offer helpful advice and co-operation.

.../

Coloured Fluorescent Plastic Tape can be obtained from:-

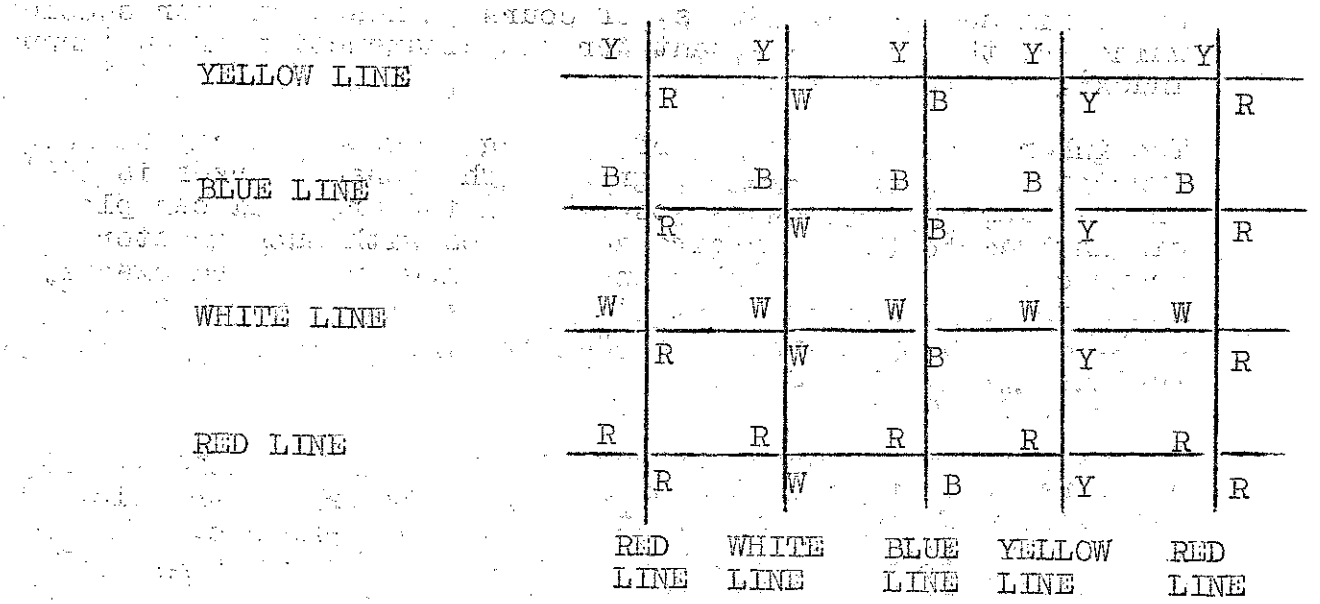
Auto Wrappers (Sales) Ltd., Tape and Bonding Clinic,
110/112 Hammersmith Road, London W6 7JS. Tel: 01-748 8863

Orange is the best colour, one inch wide will do, two inch is ideal.

OPEN COUNTRY SURVEYS

Large areas of relatively open moor, heath, salt-marsh etc. where the terrain is uniform and the majority of birds are Skylarks, pipits and other field species, require a grid. Since visibility is generally unobstructed by trees and/or secondary growth, markers can be set at 100-metre intervals.

A colour-code using combinations based on, say, red, white, blue and yellow can be used to identify the points where the grid-lines intersect, as shown below:-



The lines parallel with the baseline should be regarded as 'dominent' and their colour shown uppermost.

As a temporary expedient, heavy guage galvanised wire cut out to 4ft lengths and twisted into a ring at the top to fly coloured plastic tapes or linen streamers can be used. But only in areas from which grazing animals are excluded. Otherwise bamboo poles painted with the appropriate colours are preferable. Using this method the plot takes longer to prepare for census work, but the immense gain in precision more than justifies the extra labour.

It is no use attempted grid surveys of this kind in any area to which the general public has free access.

APPENDIX B

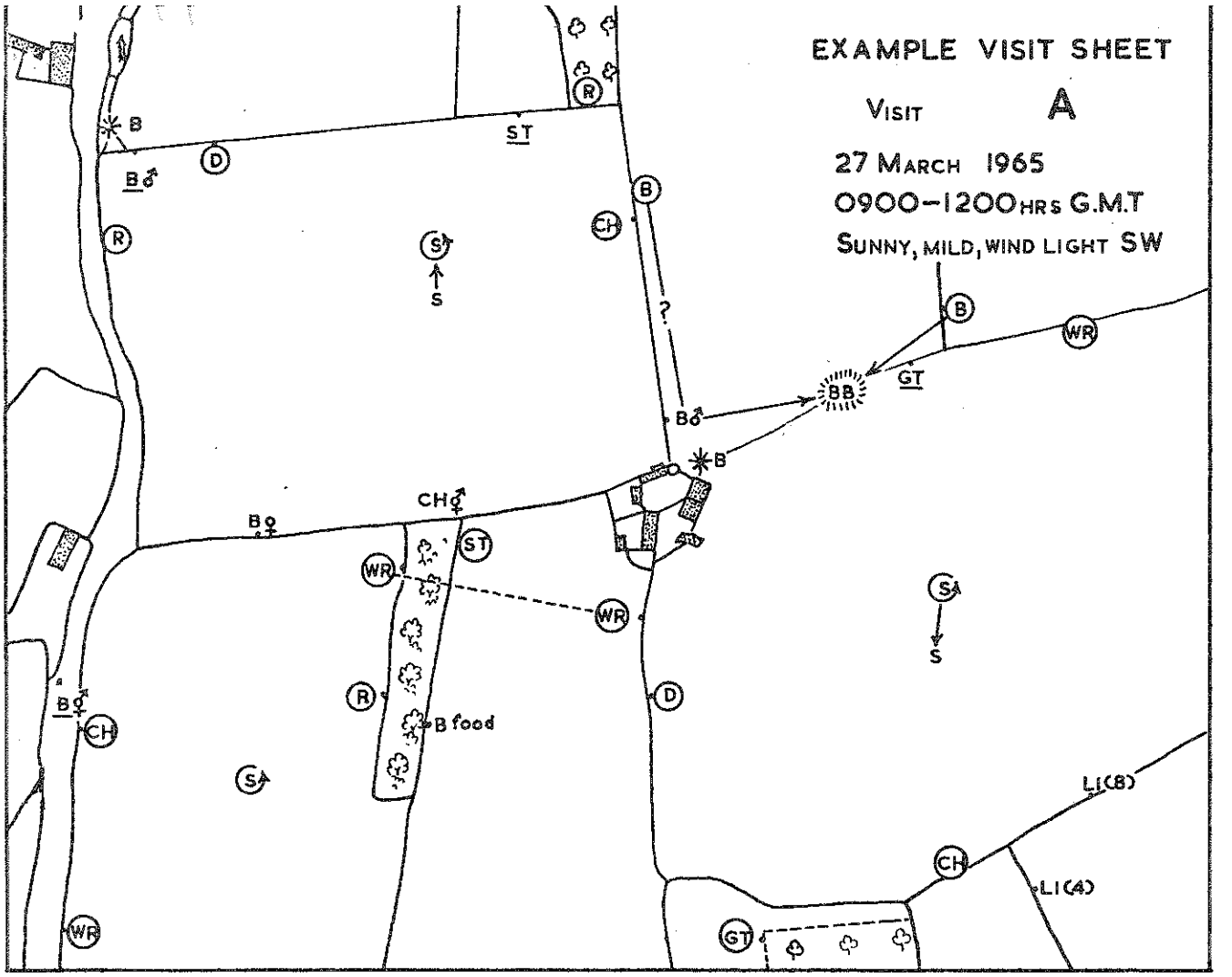
GG	Great Crested Grebe
LG	Little Grebe
H	Heron
MA	Mallard
T	Teal
GY	Gargancy
WN	Wigeon
PT	Pintail
SV	Shoveler
TU	Tufted Duck
PO	Pochard
E	Eider
RM	Red Breasted Merganser
GD	Goosander
SU	Shelduck
CG	Canada Goose
MS	Mute Swan
BZ	Buzzard
SH	Sparrowhawk
HH	Hen Harrier
ML	Merlin
K	Kestrel
RG	Red Grouse
RL	Red-legged Partridge
P	Partridge
Q	Quail
PH	Pheasant
WA	Water Rail
MH	Moorhen
CO	Coot
OC	Oystercatcher
L	Lapwing
RP	Ringed Plover
LP	Little Ringed Plover
GP	Golden Plover
SN	Snipe
JS	Jack Snipe
WK	Woodcock
CU	Curlew
CS	Common Sandpiper
RK	Redshank
GK	Greenshank
DN	Dunlin
RU	Ruff
GB	Great Black-backed Gull
LB	Lesser Black-backed Gull
HG	Herring Gull
CM	Common Gull
BH	Black-headed Gull
CN	Common Tern
FP	Feral Pigeon
SD	Stock Dove
WP	Woodpigeon
TD	Turtle Dove
CD	Collared Dove
CK	Cuckoo
BO	Barn Owl
LO	Little Owl
TO	Tawny Owl
LE	Long-eared Owl
SE	Short-eared Owl
NJ	Nightjar
SI	Swift
KF	Kingfisher
G	Green Woddpecker
GS	Great Spotted Woodpecker
LS	Lesser Spotted Woodpecker
WL	Woodlark
S	Skylark
SL	Swallow
HM	House Martin
SM	Sand Martin
RN	Raven
C	Carrion Crow
RO	Rook
JD	Jackdaw
MG	Magpie
J	Jay
GT	Great Tit
BT	Blue Tit
CT	Coal Tit
MT	Marsh Tit
WT	Willow Tit
LT	Long-tailed Tit
NH	Nuthatch
TC	Treecreeper
WR	Wren
DI	Dipper
M	Mistle Thrush
FF	Fieldfare
ST	Song Thrush
RE	Redwing
RZ	Ring Ousel
B	Blackbird
W	Wheatear
SC	Stonechat
WC	Whinchat
RT	Redstart
N	Nightingale
R	Robin
GH	Grasshopper Warbler
RW	Reed Warbler
MW	Marsh Warbler
SW	Sedge Warbler
BC	Blackcap
GW	Garden Warbler
WH	Whitethroat
LW	Lesser Whitethroat
WW	Willow Warbler
CC	Chiffchaff
WO	Wood Warbler
GC	Goldcrest
FC	Firecrest
SF	Spotted Flycatcher
PF	Pied Flycatcher
D	Hedge Sparrow/Dunnock
MP	Meadow Pipit
TP	Tree Pipit
RC	Rock Pipit
PW	Pied Wagtail
GL	Grey Wagtail
YW	Yellow Wagtail

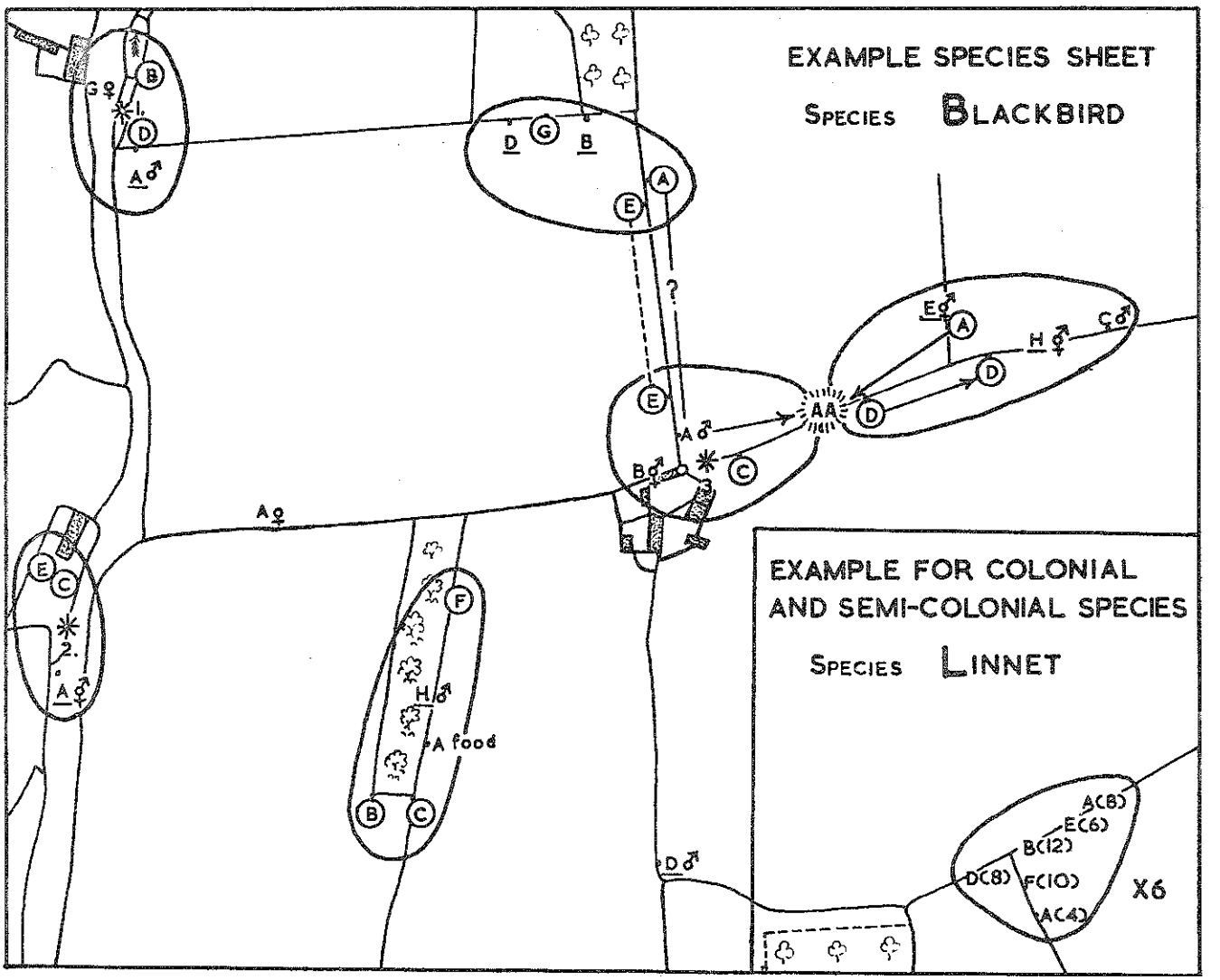
(Cont'd)

APPENDIX B (cont'd)

WX	Waxwing	CR	Crossbill
SG	Starling	CH	Chaffinch
HF	Hawfinch	BL	Brambling
GR	Greenfinch	Y	Yellowhammer
GO	Goldfinch	CL	Cirl Bunting
SK	Siskin	CB	Corn Bunting
LI	Linnet	RB	Reed Bunting
TW	Twite	HS	House Sparrow
LR	Redpoll	TS	Tree Sparrow
BF	Bullfinch		

For other species please write in full or use a different abbreviation from those listed above.


EXAMPLE VISIT SHEET
VISIT A
27 MARCH 1965
0900–1200 HRS G.M.T
SUNNY, MILD, WIND LIGHT SW
B food
LI(8)
LI(4)


EXAMPLE SPECIES SHEET
SPECIES BLACKBIRD
A food
EXAMPLE FOR COLONIAL AND SEMI-COLONIAL SPECIES
SPECIES LINNET
A(8)
E(6)
B(12)
D(8)
F(10)
A(4)
X6

APPENDIX 2.

BRITISH TRUST FOR ORNITHOLOGY
Beech Grove, Tring, Hertfordshire H P23 5NR

POPULATIONS SECTION

* * * * * * * * *

GUIDING PRINCIPLES FOR THE ANALYSIS OF COMMON BIRDS CENSUS RETURNS

Introduction

The aim of the mapping method is to assess the number of territories of each species by plotting registrations of birds encountered , particularly singing males, and any other activities considered to be of a territorial nature - such as fighting, carrying nest material etc. - on outline maps during successive visits to the census plot throughout the breeding season. Recording such contacts on the 'visit' or 'discovery' maps employs the nationally agreed abbreviations for the species concerned, and the internationally accepted code of symbols for the various events (see References).

Such registrations are subsequently transferred to new outline maps, one for each species, the contacts now becoming A,B,C etc., according to the chronological succession of the visit maps (see figures). The approximate bounds of individual territories are indicated by drawing rings round groups of registrations deemed to represent the activities of distinct 'pairs'. The boundaries of these 'paper territories' do not necessarily represent the exact confines of each individual territory, and this 'clustering' is merely an expedient forassessing the number, distribution and relationship to habitat of territory-holding males on the data available.

Nor can it be claimed that the resulting assessment is a precise representation of the number of pairs occupying the census plot. With a well conducted and carefully analysed census of 9 or 10 visits to farmland, and 12 or more visits to woodland, the mapping method undoubtedly provides a closer approximation to reality than can be obtained in any other way. Since there are limitations with the data, absolutely fixed and rigid rules cannot be defined for the analysis, and at a number of points a subjective approach to interpretation of the data is unavoidable. The decisions, however, are not arbitrary, since the analyser draws on his accumulated experience of census work in a wide spectrum of habitats, and his field knowledge of bird behaviour.

In order to reduce this subjective element to the minimum, and to establish consistency in the manner of analysis, some guiding principles were formulated by members of the Populations Section team for delineating 'paper territories', and an outline of these is given below. By applying them impartially to all areas, it is felt that the gaps which might otherwise exist if an individual approach were used are reduced, and the best possible agreement among the analysers is achieved.

A. TERRITORIAL SPECIES

A basic assumption is made that all species other than those considered in section B are potentially holders of a well defined area from which others of the same species (though they may visit) are excluded from settling. In its simplest form a species map

will therefore comprise a number of groups or clusters of visit-letters signifying song or other activity in which the same visit letter is not repeated in an identical way in the same cluster. (This is to say, if the same visit letter is repeated in the same cluster, it must represent different activities e.g. B and B food.)

In practice, however, this ideal condition is rarely satisfied. Among the reasons for this are (a) intrusion of the territory by an unmated, wandering male may occur (b) a migrant male may sing whilst still on passage, or (c) the observer may unwittingly make a 'double registration' (see paragraph 4). In these cases the analysis may have to be modified according to one or other of the rules set out below.

Clusters

1. Where non-overlapping registrations group themselves into well defined clusters, they are accepted as belonging to discrete territories, provided they fulfil the criteria stated below. Examples are given in the figures. For exceptions see paragraph 4.

2. Where two males are noted as singing at the same time (symbols joined by a dotted line) they should be assigned to different territories, provided they are supported by other registrations. A lack of supporting registrations would indicate the type of intrusion noted at 4(a) and (b) and in such cases the unsupported registration would be discarded. An example is given in figure 4. For exceptions, see paragraph 4.

Diffuse Registrations

3. Particularly with common species (and possibly also in others), where the registrations do not readily fall into groups, but are more evenly spread over the species map, a start may be made by looking for a nucleus of successive observations (e.g. B,C.D) and building outwards from this apparent focus of territorial activity. A natural aggregation of this kind should not be split to make parts of two territories. An example, showing the 'right' and 'wrong' treatment, is given in figure 1. Where a nucleus of successive registrations does not exist, it may still be possible to work outwards from an interrupted series which nevertheless looks realistic (e.g. A,D,E). In the absence of any such guide it is often useful to start from some point where the habitat is typical of the species in question. Unless it fulfils this criterion, one should not start from some quite arbitrary point, such as a corner of the map. Where habitat is of little practical assistance (as with a farm hedgerow species), the intersection of two or more hedges may afford a useful starting point.

Double Registrations

4. Within apparently good clusters, double or repeat registrations are not infrequently found. Such registrations might belong to the same individual, or to different birds (see 2 above). They may be joined together on the visit map (and copied to the species map) by an unbroken line, indicating actual movement by the same individual; or by an unbroken line with a query, indicating that although movement of the same individual was suspected, this could not be proved. In the first instance there is no difficulty in interpretation, the joined symbols clearly belonging to the same territorial grouping; in the second case, a decision as to whether two separate territories are involved will depend upon each

of the symbols having the support of an adequate number of other registrations. For an example see figure 3.

There is also a danger that the same individual may give two or more identical registrations in different positions, on the same visit; the extent to which this happens varies with different species. With small secretive birds such as the Wren, and woodland canopy songsters such as Blackcap and Chiffchaff, unobserved changes of position are not unusual. Experience shows that it is much less usual in birds with relatively small territories such as Robin, Chaffinch and Willow Warbler.

In obvious natural groupings one double registration may be allowed for any territory, particularly if the species is a summer visitor, when confusion is possible because of a passage migrant or wandering unmated male. For some species (e.g. Wren, Blackcap, Garden Warbler, Lesser Whitethroat, Chiffchaff) it is often advisable to consider the possibility of two double registrations; but the analyser must seriously consider the possibility of a second territory if there are more than two. The analyser will have to bear in mind the following considerations:-

(i) the frequency of visits to the census plot (see para 5).

(ii) the fact that separation on the basis of there being two registrations might create two unnaturally small and unusually crowded territories quite unrealistic for the species in that kind of habitat. An example is given in figure 4.

Minimum requirements

5. The minimum requirements for a CBC territory cluster are two registrations when 6 - 8 visits have been made to the plot, and three registrations in the event of 9 or more visits. Each registration (or the first and last of three) should be separated by a period of 10 days. Thus, two Robin (or any other) records in less than 10 days in mid-April would not qualify as an established territory, whereas one made in mid-April and one made in mid-May would be acceptable (assuming 6 - 8 visits).

Song registrations have the highest valency, but field-work has shown that there are species which sing rarely or intermittently, and it is permissible to use other criteria provided these have territorial implications.

In deciding what minima to apply, the analyser must take into account the total number of visits to the plot, or to different parts of it if the cover has been uneven. He must also determine the number of effective visits in the case of individual species; thus, visits on which a given species could not have been present anyway (e.g. migrants such as Whitethroat or Spotted Flycatcher at end of March or early April) must be disregarded. The rule followed in the case of summer visitors is to count the number of visits from the first on which that particular species was actually present on the census plot. As so few census visits are made late in the evening two records for a crepuscular species (e.g. Woodcock, Nightjar, owls) occurring 10 days apart are sufficient evidence of a territory, even if 9 or more visits are made.

Large territories

6. In the case of species having very large territories (e.g. Kestrel, Green Woodpecker, Partridge) and in which more than one pair may have only part of its territory within the confines of the plot, some judgement as to spatial separation of the registrations is necessary if there are no helpful duplications on which to base clusters. If the registrations fall close to two corners, or near two edges of a plot, with a substantial gap between, then parts of two territories should be recorded.

With birds having medium to fairly large territories the distance between putative clusters should be greater than the normal territory size of the species concerned in that particular habitat.

Edge Territories

7. Edge territories are counted for CBC 'annual index' purposes, since the greater the number of territories available, the narrower will be the confidence limits. A territory may be so counted even if there is only one registration inside the plot. This procedure presumes strict compliance with the Instructions, that events just outside the boundary should be noted, and that there is consistent observer treatment in this respect from year to year.

It should be noted that this procedure is at variance with the International Rules, in which, assuming that studies of bird community structure and density will be paramount, the following rules apply:

(1) If a majority, or an equal number, of the registrations falls inside the boundary line, then a territory is accepted. If the majority falls outside, the territory is ignored. This applies particularly to woodland.

(2) With farmland there is a difficulty that nearly all the boundaries are hedgerows, and the placing of registrations on either side of the boundary is not necessarily significant, since the birds were in all likelihood singing or moving in the hedge. Practice would be to include good groupings even if a majority of the registrations were shown on the 'wrong' side. An exception would have to be made if such registrations showed an apparent affinity with other records associated with a hedge at an angle to the boundary but outside it. An example is shown in figure 5.

Excess Registrations

8. With some species (e.g. Blackbird, Blue Tit) the species map may have 'excess' registrations which it is difficult to assign satisfactorily to any territory cluster. Such records are commoner early in the season (visits A,B) before territories are stabilised than later, and they are common again after young have fledged.

With Blackbirds and Song Thrushes they may also arise because there are neutral feeding areas (e.g. lawns, permanent pasture) and the majority of such 'sight records' have little significance. However, those showing movement (indicated by an unbroken line and arrow) may be helpful, particularly if two or more appear to converge on one particular part of a hedgerow or other suitable habitat. An example is shown in figure 7.

Non-overlapping registrations

9. In common species (e.g. Blackbird, Dunnook) it often happens that where the number of visits is small (6-7) two apparently 'natural' groupings are situated sufficiently close together, without any overlapping registrations, to leave some doubt in the analyser's mind as to whether to accept one 'large' territory, or two 'normal' ones. His decision must have regard to the type of habitat, the spatial distribution of registrations in relation to normal territory size (paragraph 6), and the distribution of the records in time (paragraphs 5, 10).

Shifts of Territory

10. With territorial birds it is not possible to be sure of shifts of territory due to early nest failure and subsequent re-nesting in a different position. Cases of this kind must occur, but the only provision that can be made to avoid inflating the final count is to allocate neighbouring territories to the one pair if the occupation is at different, non-overlapping periods as shown by the visit-letters. An example is given in figure 2, where (A) would be regarded as a shift of territory, and (B) would be counted as two because of the overlap on visit F.

Family Parties

11. A record of "fam" (= family party) is not acceptable as the basis for a territory unless it has the support of at least one (6-8 visits) or two (9 or more visits) other registrations, since family parties may move a considerable distance and my originate outside the census plot.

Nests

12. A nest containing eggs or young is acceptable as the basis for a territory even if it is not backed up by other registrations. An empty nest, even if apparently used in that season, has no such standing, as the pair may have moved to a new site (see paragraph 10). Nests are not necessarily near the middle of the 'paper territory' indicated by the male's song-posts, but they may nevertheless serve as useful pointers to the delineation of clusters where the registrations are diffuse.

B. NON-TERRITORIAL SPECIES

With semi-colonial species (e.g. Linnet and some other finches, occasionally Lapwing) rings can be drawn round obvious groups of registrations and the number of pairs within each ring is taken as being the largest number of pairs substantiated on any two separate visits. If one visit should contribute a greater number than on all others it is best ignored, since it might represent a concentration for feeding purposes (see paragraph 8). A larger number noted on a late season visit might, however, represent a family party, in this context representative of one pair (but see paragraph 11).

Difficulties sometimes arise in these species if the registrations are diffuse and no clear groupings emerge; in such cases the likelihood is that the plot is a feeding rather than breeding area - as often happens with Swifts, Swallows and other hirundines. In these and some other colonial species (e.g. Jackdaw, Starling) the most satisfactory figure is gained by an

actual nest-count, or, failing this, a count of the number of pairs regularly seen at a colony.

Kenneth Williamson
Roger Bailey
Leo. A. Batten

First issued 28th February, 1968.

Reissued (with minor revisions) April, 1976.

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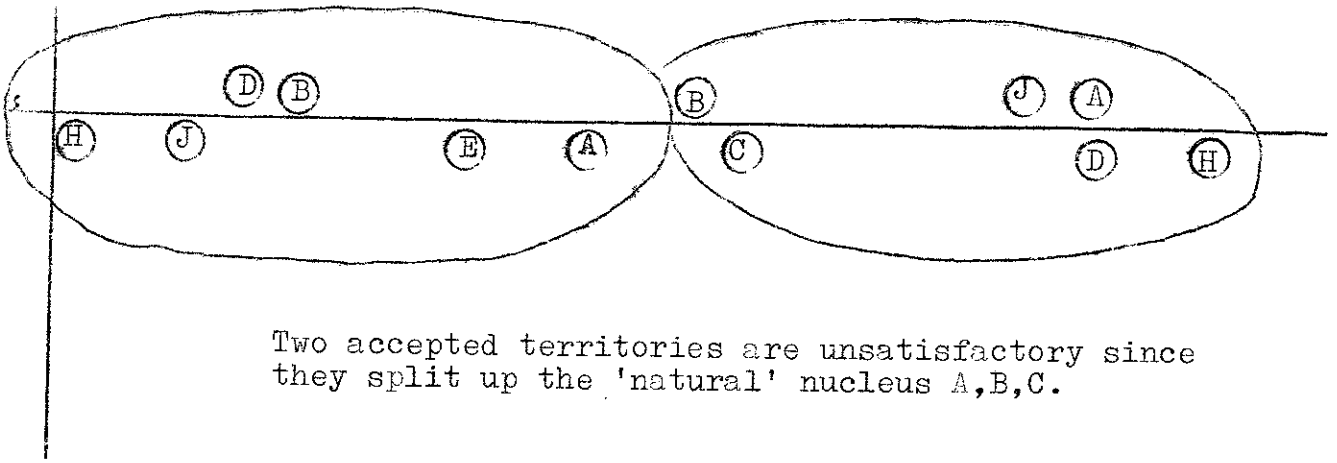
ENEMAR, A. 1959. On the determination of the size and composition of a passerine bird population during the breeding season. Var Fagelvärld 18. Supp. 2.

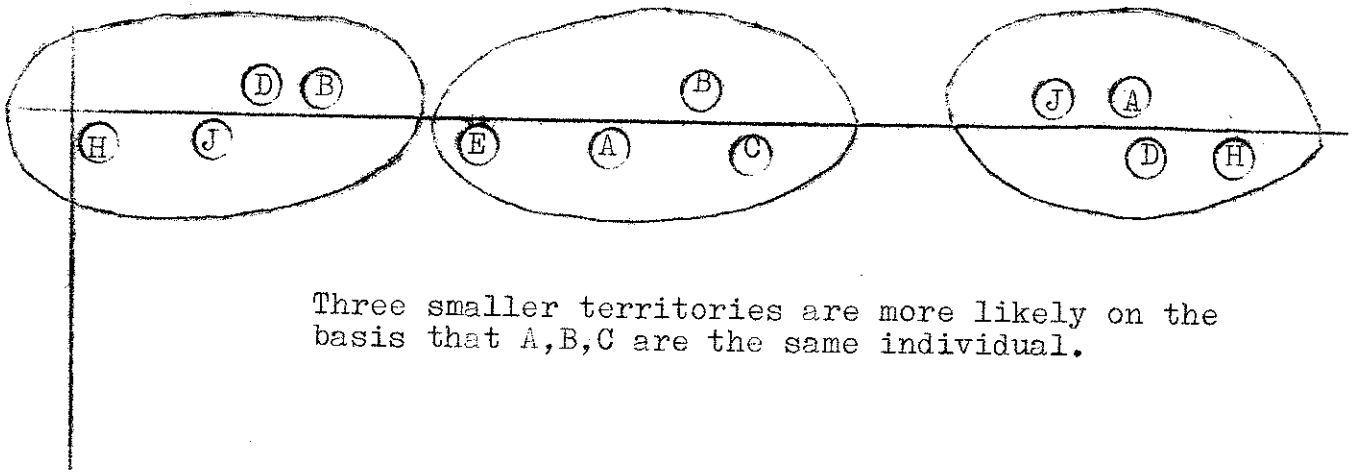
INTERNATIONAL BIRD CENSUS COMMITTEE. 1969. Recommendations for an international standard for a mapping method in bird census work. Bird Study 16: 249-255.

WILLIAMSON, K. 1964. Bird census work in woodland. Bird Study 11: 1-22.

SPECIES MAP - DUNNOCK Prunella modularis (9 visits)

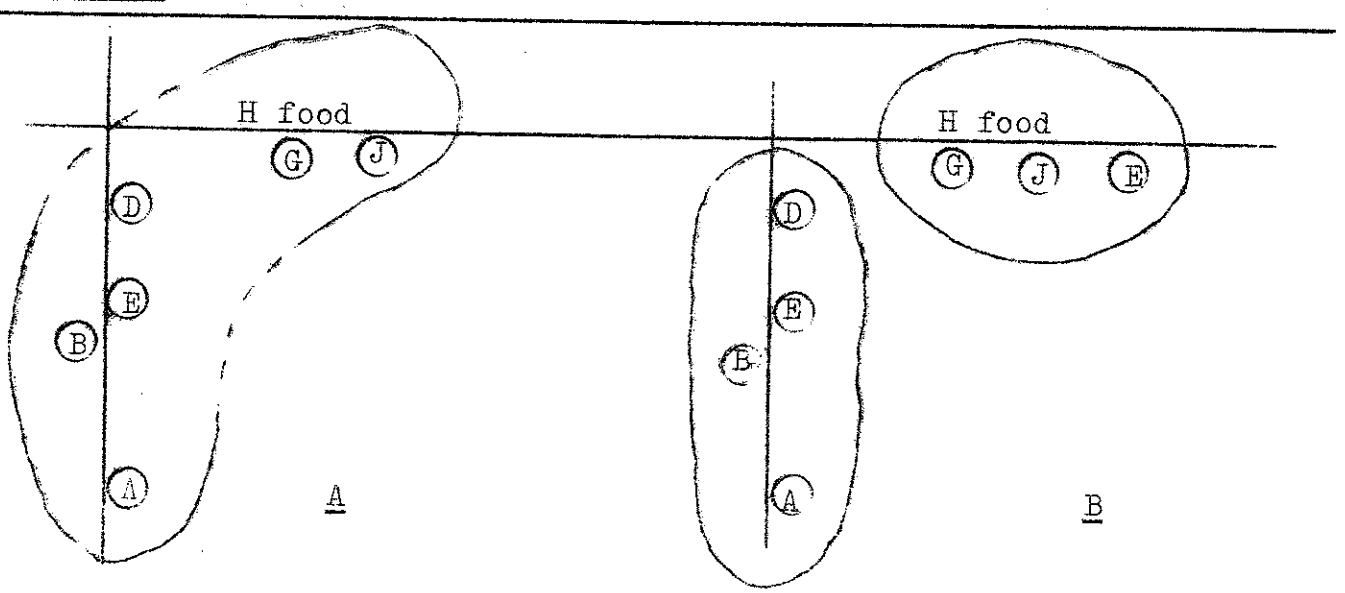


Two accepted territories are unsatisfactory since they split up the 'natural' nucleus A,B,C.



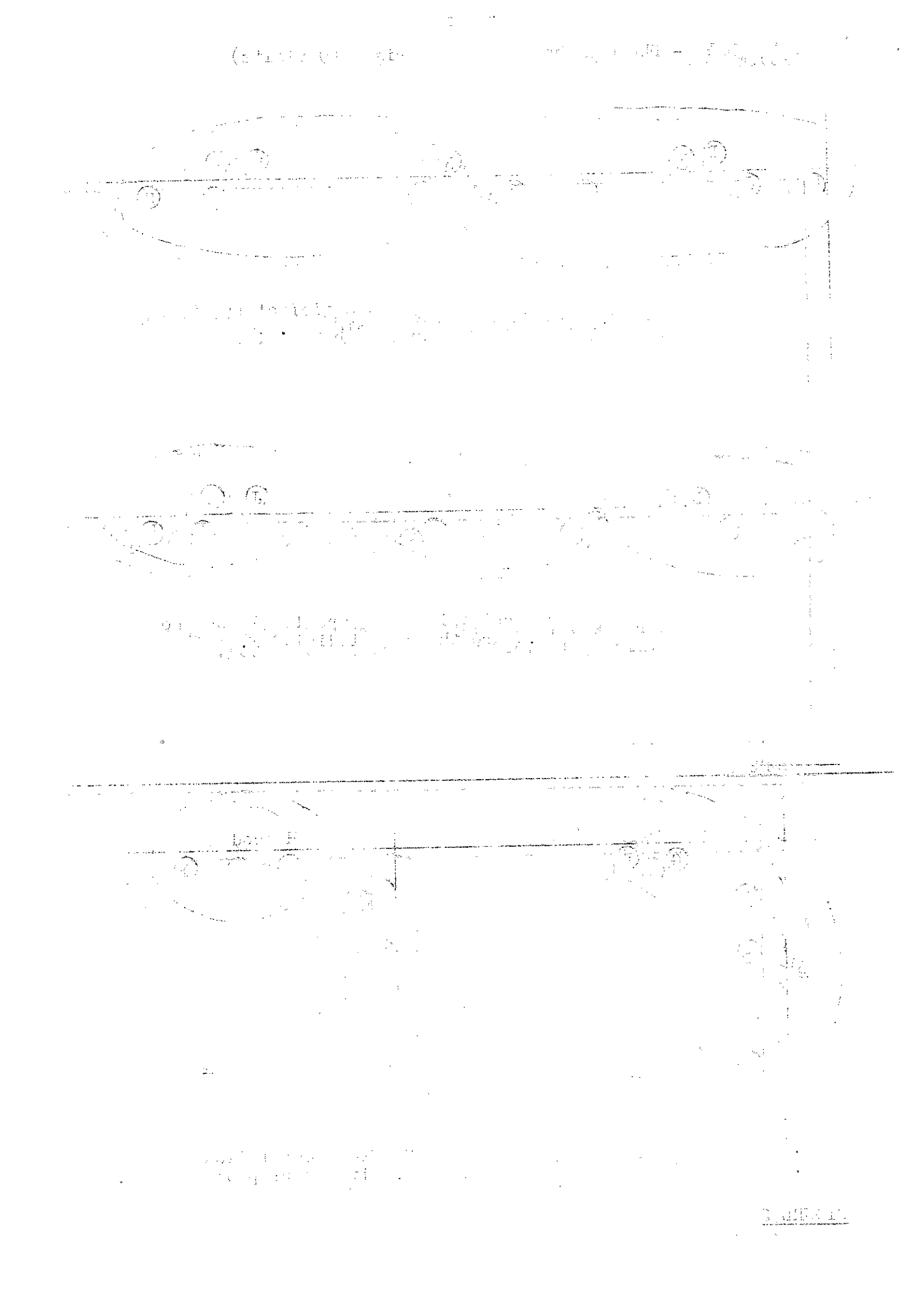
Three smaller territories are more likely on the basis that A,B,C are the same individual.

FIGURE 1

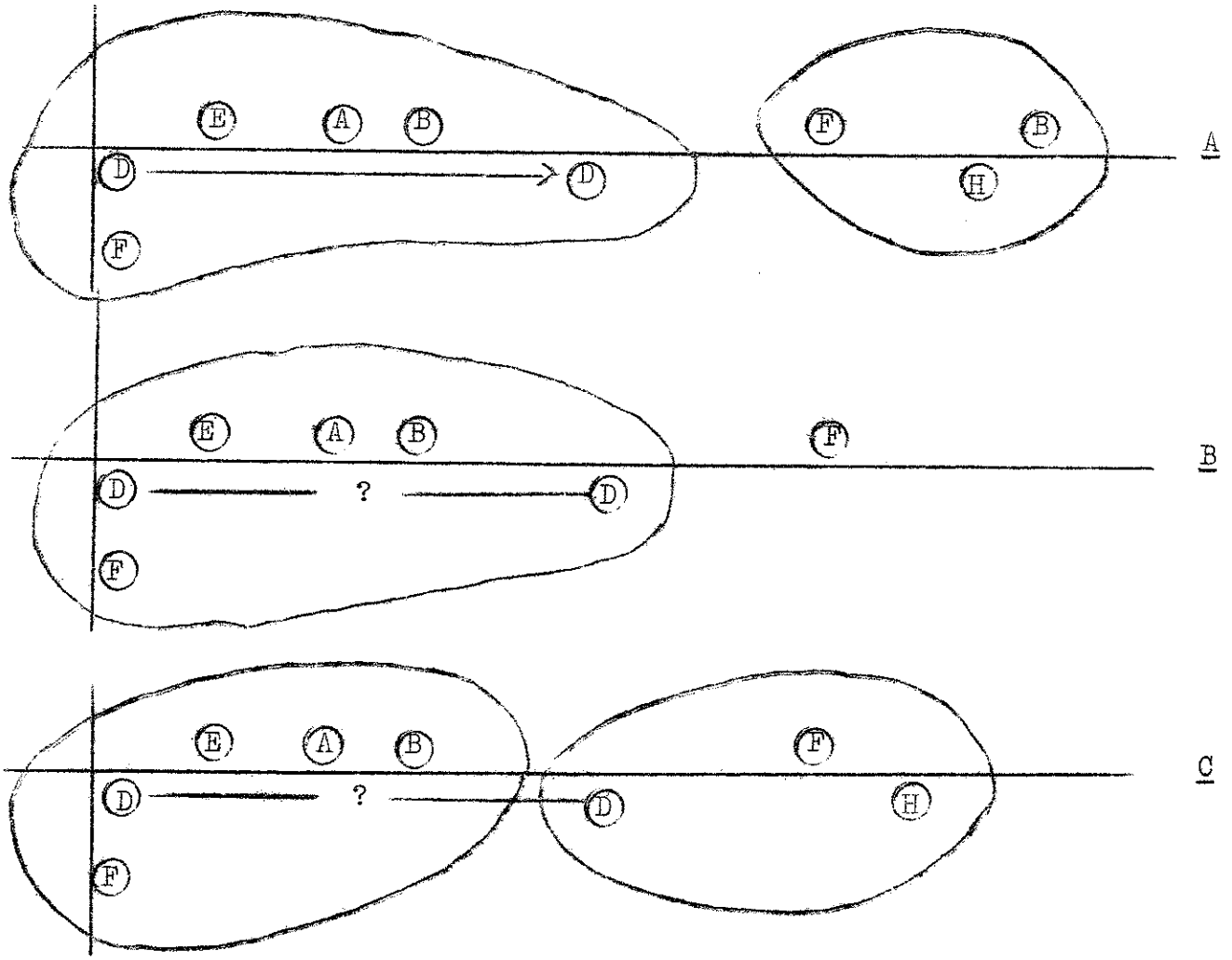


A. Shift of territory to new site (? after nest failure).
B. Two distinct territories involved, with overlap on visit E.

FIGURE 2



SPECIES MAP - DUNNOCK Prunella modularis (9 visits)

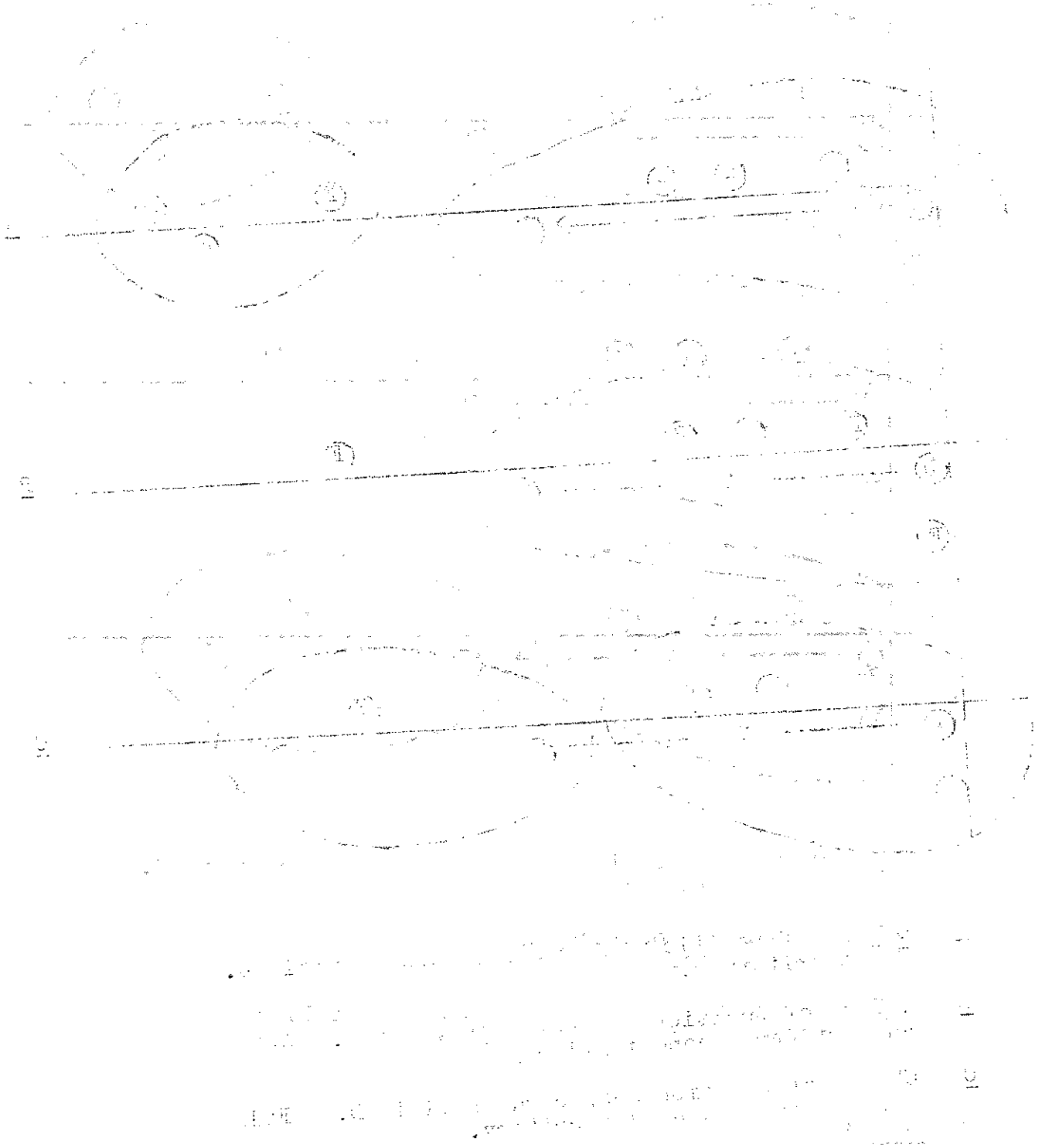


A Change of position clearly recorded on visit D. Two territories.

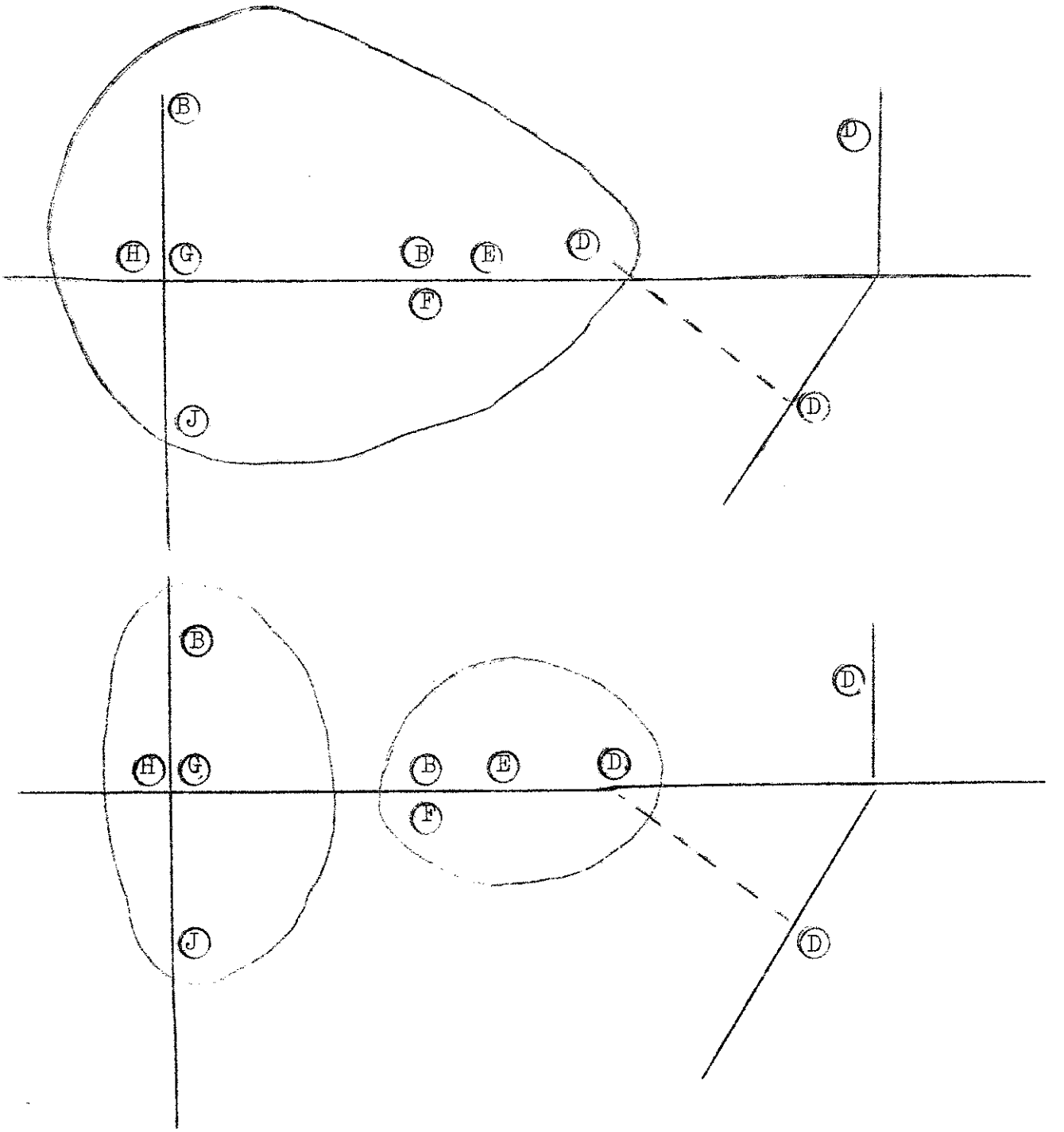
B Change of position suspected on visit D. No support for second territory.

C Change of position suspected on visit D. Full support for a second territory.

FIGURE 3



SPECIES MAP - CHIFFCHAFF Phylloscopus collybita (9 visits)



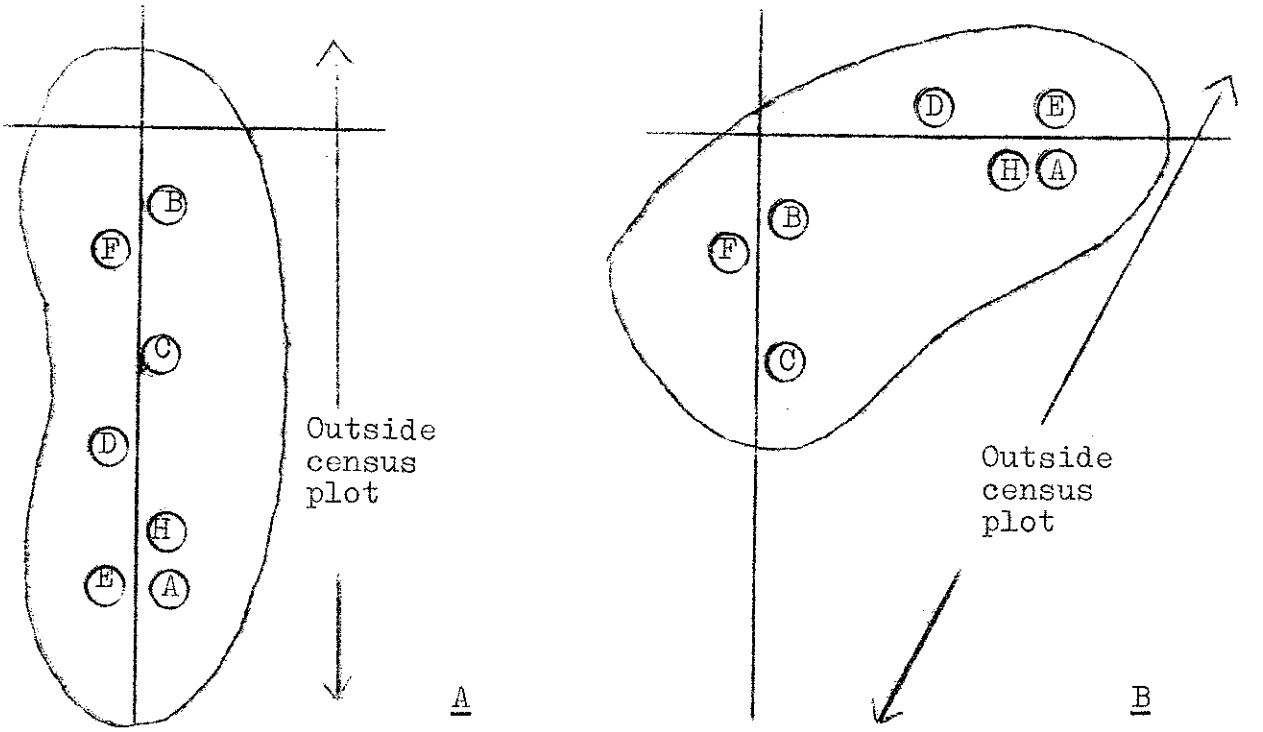
A Double registration on visit B - almost certainly same bird.

B Unsatisfactory interpretation as it opts for two unnaturally small territories, unusually close together, for this species.

NOTE: Passing migrant singing on visit D

FIGURE 4

SPECIES MAP - ROBIN Erithacus rubecula (9 visits)

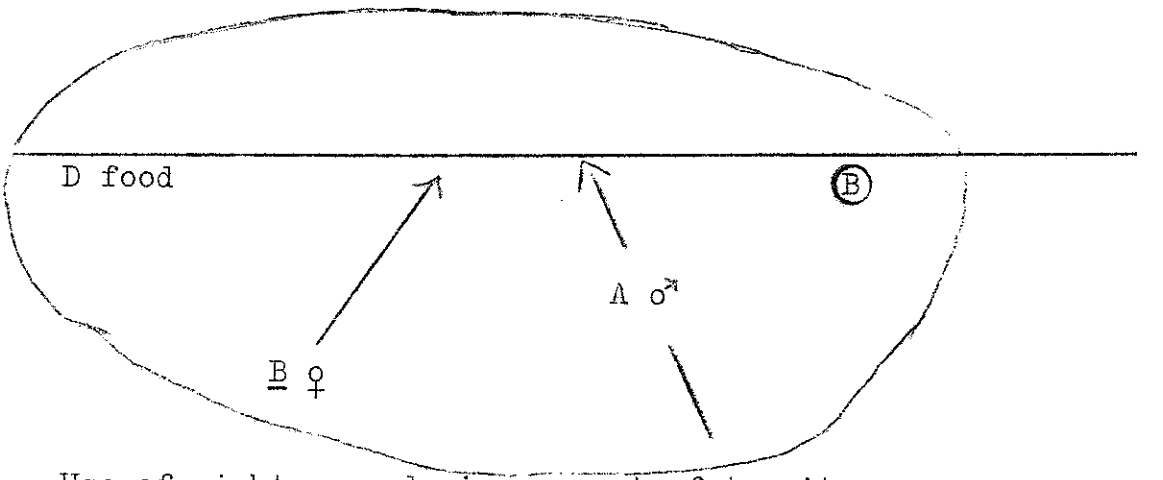


A Territory counted on the basis that all song posts are along the boundary hedge.

B Territory not counted (under International Rules) as the majority of registrations fall along hedge outside the plot boundary.

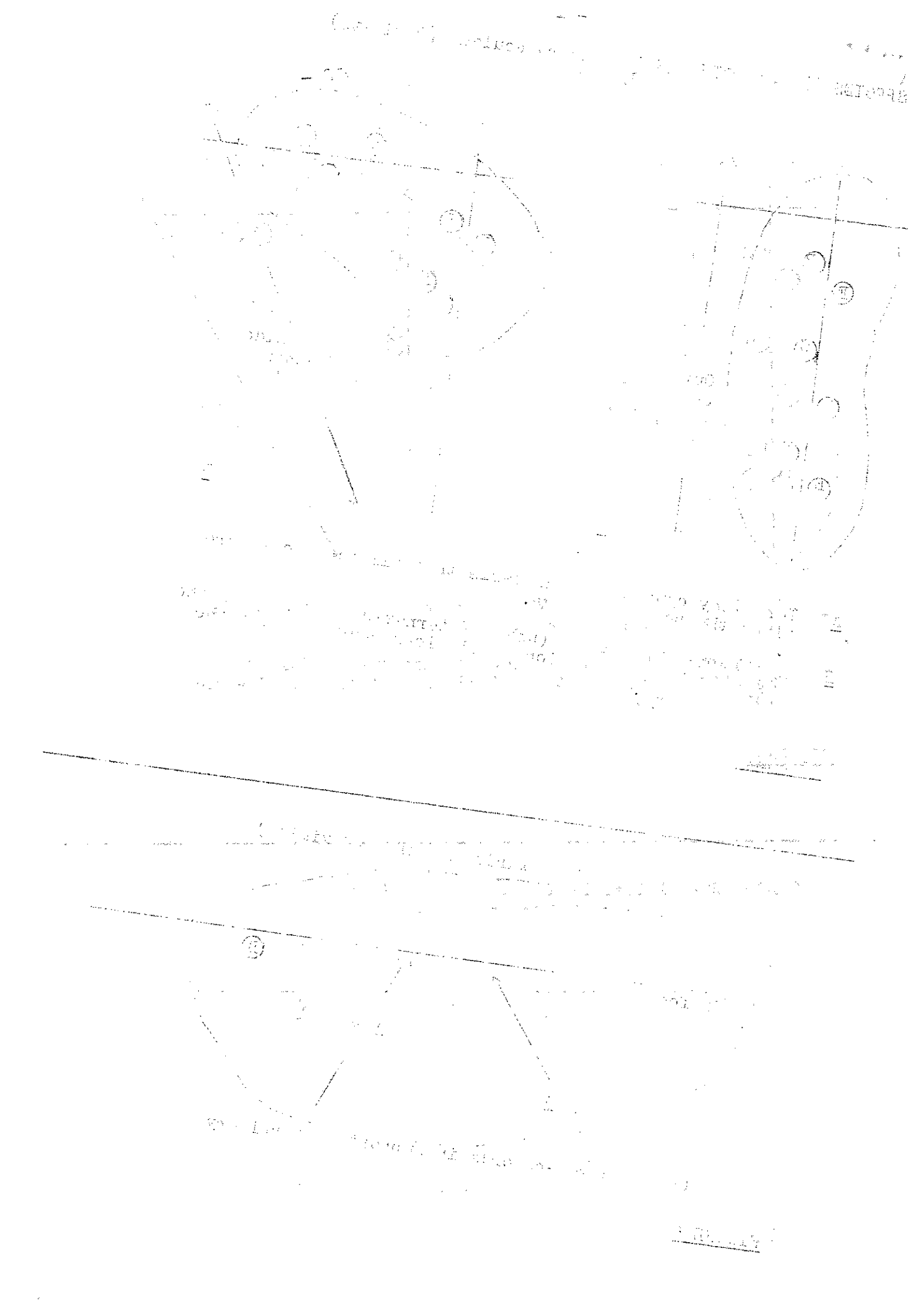
FIGURE 5

SPECIES MAP - BLACKBIRD Turdus merula (9 visits)



Use of sight-records in support of territory

FIGURE 6



BTO
COMMON BIRDS CENSUS
INSTRUCTIONS

Text: John Marchant

AN INTRODUCTION TO THE CBC

A frequent talking point among bird-watchers, particularly in summer, is the status of the various breeding species. Questions might be raised such as "*How badly were Wrens affected by the latest cold winter?" "Are there fewer Lesser Whitethroats breeding this year?" "Has there been a change in the relative status of Blackcap and Garden Warbler over the last decade?"***

The Common Birds Census provides a solid base for answering such questions using the BTO's network of active members. It was started in 1962, following pilot trials in the previous year, at the instigation of the Nature Conservancy (now Nature Conservancy Council). Its aim was to monitor bird population numbers chiefly on farmland, where the growing use of agricultural chemicals and the accelerating destruction of hedgerows were causing particular concern. Other habitats, notably woodland, were also included in the scheme (especially from 1964). The method is as objective as possible, which is essential for wide acceptance of the results. Fieldwork is carried out according to specified guidelines, minimum levels of effort are set down, and a paired sample technique is used by which results are only compared between seasons where the effort has been consistent (see below).

Birdwatchers everywhere found that Whitethroats had suddenly become scarce in 1969 : the CBC was able to estimate these decreases at 71% on farmland and 65% in woodland habitats. Drought in West Africa was later identified as the cause of the decrease.
Photo: Eric Hosking

In addition to monitoring, the CBC offers other information of particular value to local and national conservation. A by-product of the method we use is a set of maps showing the location of each territorial bird. These species maps can be used to estimate the density of the various species on the plot, for comparison between years or between plots, and provided that the habitat description is sufficiently detailed it is also possible to see how the birds are distributed in relation to different elements of the habitat.

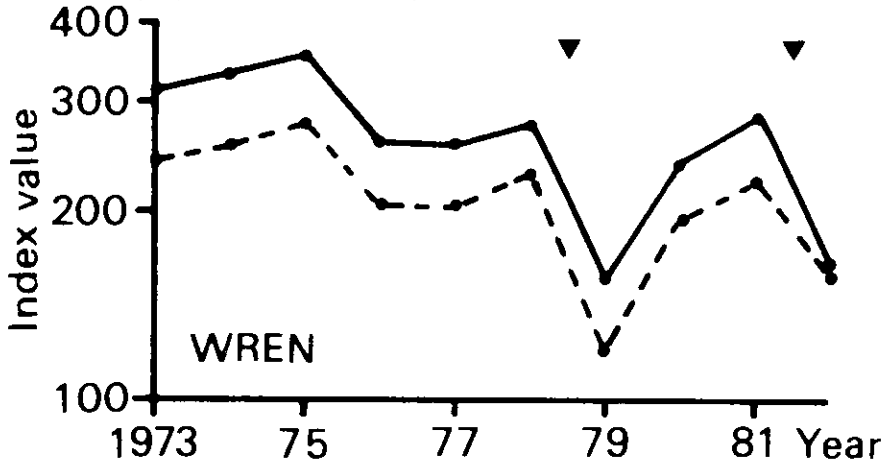
Where the habitat alters during the lifespan of a census, for example by removal of hedgerows on farmland or by a change in management in woodland, the effects of these alterations on bird populations can be measured by comparing the species maps before and after. The CBC can also be used to predict the likely effects of proposed management, by extrapolation from established case studies.

In 1982 the CBC scheme (and five of the original observers!) completed 21 years of continuous monitoring of populations. Current applications of the CBC data include study of the effects of changes in farming practice on birds, the effects of woodland management and the significance of the reductions in resident birds brought about by the recent severe winters. The NCC continues to fund the CBC and is the major user of the results.

INDEXING POPULATION LEVELS

The results of the CBC provide indices of population change for (currently) sixty bird species. Many of the indices have been running since 1962. The scheme is called the **Common** Birds Census simply because only species which are fairly numerous provide samples large enough to build a population index.

The index for any particular species is a measure of its change in abundance relative to an arbitrarily chosen 'datum-year', in which the index value was set at 100. It is not a measure of relative abundance between species. For most species 1966 is usually given as the datum year: thus an index of 620 for Stock Doves in 1982 means that the CBC data estimate it to be 6.2 times as common as a territory-holding bird as it was in 1966, but the fact that this was the highest index value in 1982 does not mean Stock Dove was our commonest bird in that year!



An example of a CBC index graph. The indices for Wren over ten years 1973-82 clearly show the impact of the two hard winters 1978/79 and 1981/82 (marked with triangles). The changes on farmland (solid line) are clearly parallelled in woodland (dotted line). Indices are given relative to 100 in 1966. Data are available from 1962.

Each index is updated annually by applying the total percentage change detected between the year in question and the previous year on the available sample of census plots. Only plots where coverage was adequate and comparable between the two seasons can be included in the sample. The territory totals for each species and plot are compared with those on the same plots in the previous year, to give paired estimates of the change between the two seasons. This pairing procedure ensures a robust method of indexing, but it does mean that **single-season censuses, and those lacking consistent coverage between seasons, cannot be used in the index calculations.**

THE METHODS OF THE COMMON BIRDS CENSUS

The basis of any method of monitoring bird numbers must be some standard way of counting birds which can be repeated exactly between breeding seasons over a long period of time. The CBC method is based on the **mapping method**, in which a series of thorough visits are made to all parts of a defined plot and **contacts** with birds (by sight or sound) are recorded on large-scale maps. The maps on which the contacts are registered in the field are referred to as the **visit maps**. At the end of the season, the registrations are copied across onto a separate map for each species (the **species map**) which summarises all the information obtained for that species during the season, and each species map is then analysed to estimate the number of territories found.

A special advantage of the mapping method is that maps are produced which show the approximate location of every territory detected. These maps can be compared in detail between years to show the preferred sites of each species in relation to the habitat, and any effects of habitat change. Where species maps are not needed to answer the questions posed in a particular study, simpler and less time-consuming methods are available, such as those involving point counts or transects, but only the mapping method as described here can be used in the Common Birds Census.

The visit map is clipped to a board and carried around the plot. Binoculars are essential for finding birds and locating them accurately.

Marking a registration on the visit map. Brightly-coloured ballpoints are best, so that the entries stand out well from the background.

Photos: Jane Marchant

Who can help?

For effective monitoring on farmland and in broad-leaved woodland, a total of about 250 plots is required, half in each habitat category, scattered throughout the UK. New contributions meeting the following criteria are welcome:

1. **Observers must be competent to identify readily both by sight and by sound all species likely to occur, and fit enough physically to cover all parts of the chosen plot without excessive fatigue.**
2. **Unless it is a specially approved case study the chosen plot must be representative of the farmland or woodland in the surrounding region, and must meet all the other requirements specified below under "Selecting a plot".**
3. **The fieldwork procedure must be in full accordance with these Instructions.**
4. **The observer must intend at least two consecutive seasons' work on the same plot, employing the same thorough fieldwork effort, so that the results can be used towards the calculation of population indices. This applies even where an already-established plot is being taken over from another observer.**

Considerable commitment is demanded of the observer both for fieldwork and the subsequent paperwork, but most observers find census work very enjoyable. It is most rewarding to gain both the intimate knowledge of a particular area that a census gives and the satisfaction of contributing to conservation nationally; most observers also find their results are of local value for conservation or simply for the county bird report.

If in doubt about the value of your potential contribution, or if you have any other queries relating to the Common Birds Census, please write to:-

Common Birds Census, Populations Section, British Trust for Ornithology, Beech Grove, Station Road, Tring, Herts HP23 5NR.

HOW TO START

To ensure the best use of resources for map analysis and research at Beech Grove, only those plots which can be classified as either 'farmland' or 'semi-natural woodland' can be accepted as new plots for monitoring purposes.

Farmland can be any type of arable, horticultural or grazing land except unenclosed sheepwalk, provided that it is more or less typical of the local countryside. Where small woods and copses occur among fields, they should be treated as part of a farmland plot, but the proportion of woodland included should be typical of that in the surrounding area and in any case should be less than 10% of the plot. **Please aim for at least 60 hectares (150 acres):** plots smaller than 40 hectares (100 acres) cannot be accepted.

Woodland includes all kinds of semi-natural broad-leaved and mixed woodland but excludes parkland, scrubby heathland and even-aged plantations of conifers. As far as possible, plots should be typical of woods (other than conifer plantations) in the area. **At least 10 hectares (25 acres) are needed.** 'Parkland,' for which no new plots can be accepted, is itself a vague term; it is meant to encompass all sorts of open land with scattered trees which cannot be described as semi-natural because it has a *use* aside from its value as woodland (eg. town parks, cemeteries, golf courses). (Ancient ornamental parkland now converted to arable or grazing might be acceptable as farmland.)

Case studies. We can sometimes accept plots not falling into the above categories where the CBC method can be used to assess the effects of an anticipated change in the habitat. Please contact Beech Grove if you have such a study in mind.

A general consideration regarding the size and shape of plots is that the edge effect, which gives rise to inflated estimates of territory density (see back page), should be minimised by reducing the edge: area ratio as far as practicable. Large plots have a lower ratio than smaller plots and plots approximately square or rounded are much better than plots which are long and thin. While minima are given, there are no upper limits to plot-size. However, it is better to census a smaller plot thoroughly and for a long period than risk inadequate or short-term cover of a larger one.

Plot boundaries must be clearly discernible features, such as permanent features of the landscape or an artificial marked grid-line. You must be able to walk the entire boundary, so use field edges on farmland rather than draw imaginary lines across open fields. On farmland, areas known to be particularly rich in birds, such as shelterbelts, should be avoided as plot boundaries.

In all cases, you must ensure that you have the permission of the landowner(s) or tenant(s) to carry out a census and to visit every part of the proposed area. Special permission must be sought if the plot needs any gridding (see opposite).

Obtaining maps

Once you have chosen provisional boundaries, send to Beech Grove a tracing from the relevant Ordnance Survey map, preferably at the 25 inches to the mile scale (1: 2500). The local library will often have them. If you are unable to obtain the 25 inch maps, send us a tracing from a smaller-scale map and we will order the full-scale maps from the Ordnance Survey. (Plots which you have surveyed and gridded need not be traced from the O.S. map, but please be sure to use 1:2500 scale.)

The final tracing of the plot should show not only the plot boundaries copied from the 1:2500 map but also sufficient internal detail to enable accurate plotting and transcription of registrations. This would include tracks, buildings, hedges, isolated trees (mark with a cross), grid lines if present, and perhaps other features such as telegraph poles (mark with a dot) and tree-stumps where detail is otherwise sparse. Too much detail may however mean that registrations have to be plotted aside from their true positions, thus decreasing the accuracy of the plotting, and may conceal the registrations. Unless you can provide your own outline maps for the census (normally 25-30 maps a year) we will prepare and keep the master-tracing and send you a supply of blank maps at the start of each season. **If you run short of maps during the season, please ask for more rather than economise on visits or overcrowd the species maps.**

The process of obtaining maps may initially take as long as six weeks if we need to order from the Ordnance Survey. It is therefore a good idea to begin as far in advance of the proposed first visit as is possible, and in any case by the end of February so that fieldwork can begin not later than mid-April.

Probationary Period

Censusing is a skill for which some potential observers are better suited than others. Please regard your first two years of census work as a 'probationary period' during which you can improve your census skills. After this time we will be able to continue analysing your maps only if they are comparable with those of other contributors. Most observers will have no difficulty achieving the required standard. From time to time we will be staging weekend courses on census methods both for novices and as 'finishing schools' for observers who already have some censusing experience.

GRIDDING A WOODLAND PLOT

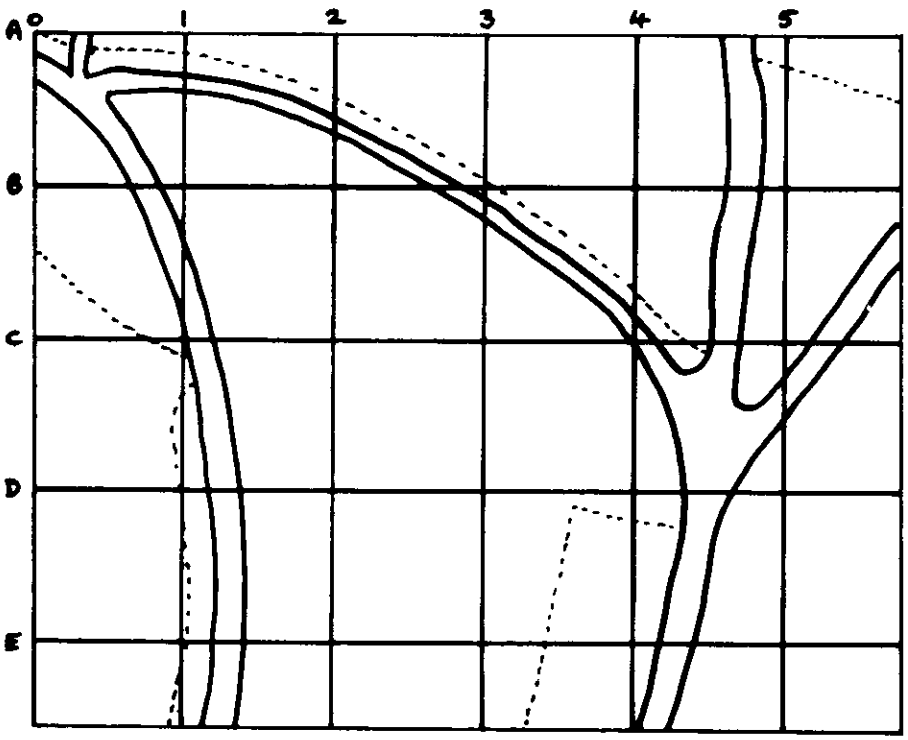
Census work in woodland requires special care. The habitat often appears fairly uniform and visibility, especially in the height of summer, tends to be restricted by the lower canopy or shrub layer; it becomes very difficult for the observer to know his own position, let alone those of the birds! Particularly for species with small territories, inaccurate plotting may lead to over-estimation of territory numbers. The solution to the problem is to locate a number of features, widely scattered, which are easily recognisable as you walk around the plot, and to mark them on the master-tracing. These can be used as reference points when censusing and when compiling species maps. However, if after marking all tracks, paths and other accurately located features some parts of the plot remain empty of reference points, some **gridding** will be necessary.

In its simplest form gridding involves only the addition to the master-tracing (copied from the 25" Ordnance Survey) of a few accurately surveyed points. For example, if there are insufficient natural features along a particular path (already on the master-map) to enable you to judge your position accurately, a simple line of markers at 50 metre intervals may suffice. A 30 or 50 metre tape-measure and a supply of marking tape are all the equipment required for the fieldwork. Each marker must be semi-permanent and easily visible : two-inch wide fluorescent orange tape is ideal. It is necessary to label each one individually (best done using a broad-tipped black waterproof pen) and to enter the location and label of the marker on the master-map.

Compass-line gridding is needed when large areas of the master-map are devoid of features, and (in the extreme case) when no Ordnance Survey map is available. The first step is to choose a base-line, normally along part of the plot boundary but along an internal ride if no other straight lines are available. This is marked at 50 metre intervals, and then grid-lines are set up at right angles until the required area is completely covered by a 50-metre grid. An accurate sighting-compass is required. Grid-lines parallel to the base-line can be labelled alphabetically, and those at right angles with numbers, so that each grid-point has a logical and unique label (**A1, A2, A3; A1, B1, C1**, etc).

This sort of gridding is best accomplished by a team of three people, each of whom carries a lightweight surveying pole (a stick marked with fluorescent tape); the three poles can be used to carry a straight line forward through the woodland quite accurately without constant recourse to compass-bearings. Gridding should ideally be tackled in the winter, when visibility inside the wood is at its greatest.

Further advice can be sought from Beech Grove. In all cases where gridding is needed, it is necessary to seek special permission from the landowner even though access to the plot may already have been obtained.



Part of an outline map for a woodland plot with a full 50 metre grid, reproduced at the standard 1:2500 scale. Grid-points are marked A1, B2, C3, C4, etc. The observer can follow the grid-lines, using a compass if necessary, so that he always knows his position on the map.

IN THE FIELD

The mapping visit

The basis of the CBC fieldwork is the **mapping visit**, involving full coverage to all parts of the plot. Normally each visit should be completed within a period of a few hours; *partial visits are to be avoided if at all possible.*

Carry an outline of the plot (the visit map) attached to a clipboard or suitably-sized piece of hardboard using a bulldog clip or elastic bands. Use a brightly-coloured pen: BTO staff find that fine-pointed red ballpoints are ideal. Do not use ink which runs when wet. Always write as small and as neatly as possible.

You will need your binoculars, but no other equipment. You must not use tape-recorded calls to elicit playback responses from the birds.

When to visit

The number of territories you find will depend to some extent on the number of visits you make. **It is therefore essential that the number of visits is the same – plus or minus one at the most – from year to year, so that any changes detected are not simply due to the change in effort.**

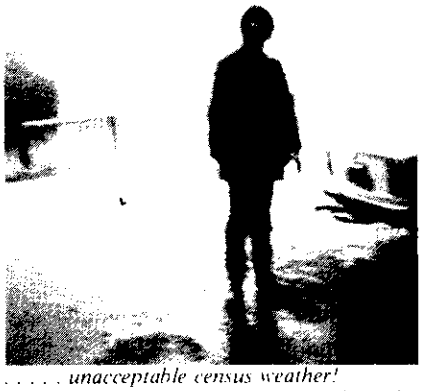
The standard now adopted for the CBC is **10 complete mapping visits** during the census season, mid-March to late June. This is sufficient for detection of a high proportion of the real territories present (the proportion depending on your own characteristics as a birdwatcher). If it is absolutely impossible for you to attain the 10-visit standard it may be possible, by prior arrangement with CBC staff, for you to choose the next highest number which you can maintain. Making more than 10 thorough visits usually gives only a small improvement in census efficiency and the resulting abundance of registrations can obscure the territorial patterns.

While mid-March is the official start of the CBC season, the first visit to Midland sites need not be until early April. Extending the visits into early July may be helpful in some areas.

The spacing of the visits should be fairly even throughout the season, within the constraints imposed by weather and your own other commitments. Making three consecutive visits in a period of less than 10 days is wasteful of effort. Weekly visiting over most of the season is ideal.

Morning is generally the best time to make a census visit, since activity and song output are usually at their greatest, but a few evening visits in the early part of the season may be helpful for species such as Song Thrush which are most easily detected then. A combination of 8 morning visits and 2 evening visits is probably the ideal for most plots; the evening visits should not be consecutive. Do not persist with evening visits if you find them unproductive. Avoid the early afternoon, when bird activity is low, and avoid also the dawn chorus when bird detectability may change rapidly during the course of your visit and lead to uneven cover. In British conditions, bird activity on farmland and in woodland remains at a moderately high level until about noon. For a three-hour census visit (about the average) it is best therefore to start either **before 9 a.m. or after 5 p.m.**

Cold, windy or wet days are to be avoided since the activity and detectability of the birds are much reduced. Showery days make acceptable census weather, since birds are often quite active after each shower; it is important to protect the visit map as much as possible from the rain, and to carry a pencil since ballpoint pens do not work when wet. On particularly fine days an early start is recommended since bird activity may tail off somewhat earlier than expected. **Please do not allow persistently bad weather during a season to prevent you from carrying out your full complement of visits.** It is better to make a relatively inefficient visit, perhaps on a windy or showery day, than to miss a visit entirely. Ending the season short of visits is likely to jeopardise the comparability of your results.



. . . . . *unacceptable census weather!*
Photo: Kenneth Taylor

SPECIAL PROCEDURES

Partial visits

Normally, a full mapping visit covering all parts of the plot should be carried out during a single outing. If this is not possible, it can be composed of two or more **partial visits**. Partial visits should **only** be used in the following circumstances:-

(a) where a full visit was rained off before completion, to complete the coverage of that visit. (Alternatively, it may be better to make a new start.)

(b) to record extra observations, made outside full visits, for species otherwise poorly recorded, for example any Tawny Owls or Woodcock seen or heard on a special short visit at dusk. Casual registrations for common species are not required. Remember that, if you are making special visits for crepuscular species, you must do so every year if your effort is to be comparable.

(c) where a non-standard procedure for regular partial visits, for example in a group census (see below), has been specially approved by CBC staff.

In every case, it is essential that **each partial visit is given a different visit letter** so that the registrations made on each partial visit can be readily distinguished on the species map. Suffixes are the best way of doing this; for example if the third visit was composed of four partial visits they could be labelled C_1, C_2, C_3, and C_4 – they must not be lumped under **C**. It must always be clear which visit map registrations belong to each visit letter. Use different coloured ballpoints for each partial visit, or if necessary different outline maps.

Group censuses

A group census is one where a large plot is divided into sub-plots and covered by a team of observers; each full visit to a sub-plot is effectively a partial visit to the full plot. Partial visit letters must be used.

Regular use of partial visits, as in a group census, has two important drawbacks. Firstly, coverage of the plot is necessarily uneven; the internal boundaries between sub-plots will tend to receive up to twice the cover given to other parts of the plot. Secondly, if the observers stick to the same sub-plots, real differences in bird density between different parts of the plot will be obscured by the differences in censusing efficiency between the observers. These drawbacks do not affect the value of the results for assessing population change between years, but may bias the investigation of territory distribution in relation to habitat.

To minimise these biases:-

(a) please be sure to make 10 full visits, so that all parts of the plot are well-covered, and

(b) please try to set up a rota by which each sub-plot is visited by different observers in turn.

Where full visits to a plot are shared between several observers, the number of visits made by each should be the same (plus or minus one at the most) from year to year. If the team is of 3 or more and some turnover of observers is likely, please ensure that no observer makes more than half the visits.

Fieldwork procedure

The aim of your visit is to mark on the map the location and movements of every bird present or flying over during the visit, but to **record each individual once only**. The symbols section and the example maps show how this can be done. Since birds are small, difficult to see, and fast-moving relative to the observer, some inadvertent double-recording is bound to occur: the procedure for assessing the final total of clusters (usually performed by BTO staff) makes allowance for this. **If however individual birds are persistently plotted more than once the final total of territories will be an over-estimate.**

It is essential when registering birds on the visit map that the standard codes are used for species and activities. This will ensure that the maps can be readily understood at Beech Grove. The full list of codes and symbols is given overleaf. **Please take special note of the section describing dotted and solid lines between registrations**, since proper use of these symbols is essential for easy and accurate analysis of your maps.

As you enter the plot, record the date and your starting time. On completion, note your finishing time - we use your total time spent censusing as a measure of consistency in effort between years. Make a brief note of the weather (e.g. "fine, sunny, NW3", where NW3 indicates the wind direction and force, or "cool, showery, cloud ⅜, SW2") and the extent of your coverage during the visit.

Farmland plots: special hints on coverage

About 3–4 hours are required for thorough coverage of the average farmland plot (70 hectares). Progress can be quite fast, since the number of birds detectable from any one point is usually rather limited, but the route should take the observer at least once along every major internal hedgerow as well as completely around the perimeter of the plot. Accurate placing of the registrations on the map is normally made easy by the network of field boundaries.

Take care not to damage crops and hedgerows. If there is no path next to a hedge that must be walked, the best alternative is the first set of tractor wheel-tracks (tramlines), usually about 5m. from the hedge. Only where the fields are unusually large (greater than 25 hectares) might it be necessary for you to stray further from the field edge, and for this you should seek special permission.

Most farmland plots are an intricate patchwork of fields and hedgerows.
Photo: Kenneth Taylor

Frequent use of binoculars is essential for an efficient census on farmland, since typically most of the birds in view will be some distance away. Sequential movements of individual birds should be recorded carefully: the point beyond which a bird cannot be driven along a hedge is likely to correspond closely to the edge of its territory.

Coverage should be as even as possible, but more time should be allowed for areas where bird density is higher. The direction and, if possible, starting point of the route should be varied between visits.

Woodland plots: special hints

A thorough visit to the average woodland plot (20 hectares) should take about 3–4 hours. A route should be followed which takes you to within 50 metres of every part of the plot at least once during the visit; the direction and, if possible, starting point of the route should be varied between visits to improve the evenness of cover. As on farmland, **even cover of the whole plot is essential**. In particularly dense woodland, a compass may be helpful to enable the observer to follow a marked grid-line or to cross a block of woodland between marked paths. Progress should be quite slow and careful so that there is time to register all the birds seen or heard, and so as to disturb the birds as little as possible. The majority of contacts in woodland will be by sound; practice will help you estimate the positions of birds you can hear but not see. If unsure of how far a singing bird is away from you, try the method of triangulation – walk twenty metres or so and estimate its direction from another point.

In contrast to the situation on farmland, where you are more or less restricted to the field-edges, you can wander anywhere within a woodland plot during the course of a visit. It is well worth using this freedom on occasion to follow distant noises of particular interest to ensure that the birds in question are recorded accurately on the map. Examples might be a tapping noise (a Nuthatch, one of the spotted woodpeckers, or just a Great Tit?), a Chaffinch singing against the one you have just recorded (it will be important to plot this valuable registration accurately) or your first record of a Golden Oriole! Where you have deviated from your planned route, however, it is important to reassess carefully the route for the rest of the visit so that all parts of the plot are covered evenly.

SOME STATISTICS

At the 25" (1:2500) scale: one centimetre represents 25 metres, one inch represents about 70 yards, an acre is represented very accurately by one square inch, and one hectare (a square with sides of 100 metres) is represented by 16 square centimetres (or four 50-metre grid-squares). These Instructions, closed and laid across your census map, would cover about 39 hectares (or 96 acres).

What to record . . . .

All species seen or heard during visits are relevant to the census and every bird should be recorded on the visit and species maps, with the following specific exceptions:-

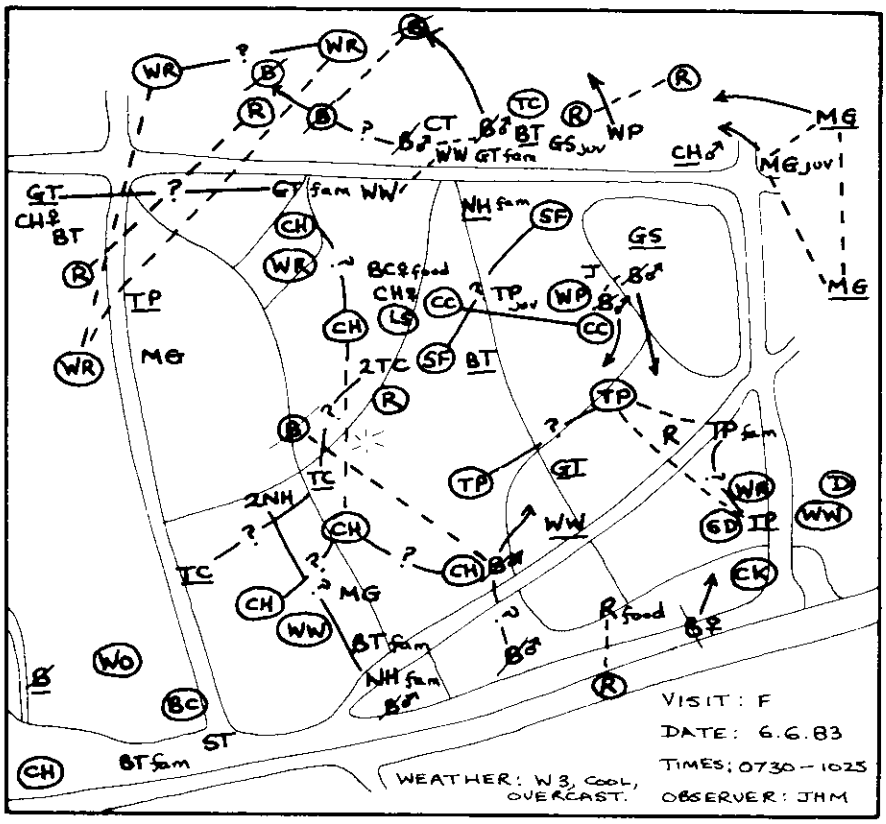
(1) Grey Heron, Rook, Sand Martin, Feral Pigeon and all gulls and terns. If nesting, please give a count or estimate of active nests and record them on the maps. No other registrations are needed. If present but not nesting, just note their presence at the edge of each relevant visit map.

(2) Woodpigeon, Swift, Swallow, House Martin, Magpie, Jackdaw, Carrion Crow, House Sparrow and Starling. These species are best censused by a nest-count on most plots. Please make special efforts to locate as many nests as possible of these birds. If you are confident that you are recording nearly all the active nests, you may omit all other registrations if you wish, as for species listed under (1), but please make it clear that you are doing so. Normally, however, the assessment will be made using a combination of nests and other registrations. Observations of song and display, for example in Woodpigeon and Starling, will be of particular value. For Magpie and Carrion Crow, special attention should be paid to looking for active nests on the early visits, before they become concealed by too much foliage.

(3) Fieldfare, Redwing, Brambling and other common winter visitors seen only on the early visits will usually be ignored by the analyst. However, any of these species, or any unexpected spring migrant, might be recorded on later visits and perhaps qualify as a territory-holder (even though out of normal range and probably unmated); it is best to plot everything and allow us to discard what turns out to be irrelevant at the end of the census.

Birds just outside the plot boundary should be plotted since this extra information is essential for defining the full extent of the territories which straddle the boundary. Remember that such birds may be found within the boundaries on later visits. Simultaneous registrations (dotted lines) are, as always, especially valuable. It is important to be consistent between seasons in the extent to which you record birds outside the boundaries.

Intensive nest-searching is not recommended. It is exceedingly time-consuming to find enough nests to make a significant contribution to the census results. Additionally, it is



Part of a completed visit map for a woodland census, reproduced at the 1 : 2500 scale as used in the field. It was a productive visit and all parts of the map are crowded with registrations. The dotted lines will be particularly helpful in the later analysis of territories. Blackbird registrations have already been copied to the species map and cancelled with a light stroke of the pen.

important (but very difficult in practice) to standardise nest-finding effort between years. However, please record all active nests you find during normal census work, using dotted lines where appropriate to denote nests of different pairs. Do not spend time nest-searching to the detriment of mapping the birds, except for those species (Rook, Sand Martin, Magpie, Carrion Crow, etc.) for which nest counts are particularly important. Remember to distinguish between natural sites and nestboxes. Submit nest record cards separately. As with all nest-finding, it is essential to keep disturbance to a minimum. Finally, do not change your nest-finding effort on the plot between seasons to an extent which may affect the results.

COMPILING THE SPECIES MAPS

This is normally a job for the late summer, in the weeks following the fieldwork, but it can be done concurrently with the fieldwork if you prefer. Compilation of species maps cannot be undertaken by BTO staff.

Check that you have given each visit a **visit letter**. These should start with A and typically run through to K (omitting I) for a ten-visit census. Suffixes should be added to the visit letters to distinguish any partial visits. Select each species in turn, and copy neatly all registrations of the chosen species from the visit maps onto a fresh outline map. As you transfer them **substitute** the visit letter for the species code (so that, for example, **CH** on visit G becomes **G** on the Chaffinch species map) and **cancel** the visit map registration with a light stroke of your pen. **It is essential to cancel the registrations, so that the visit maps can later be checked for any registrations missed. All registrations must be transferred to the species maps: do not let your information be wasted by leaving it on the visit maps.** Copy all conventions (arrows, dotted lines, etc.) exactly as they appear on the visit maps. The single exception here is when a nest is recorded on more than one visit: the asterisk for any one nest should appear only once on the species map, with the appropriate visit letters listed beside it. Some slight displacement of the registrations may occasionally be necessary, for example where a bird repeatedly uses the same songpost, but plot them as close as possible to the original spot.

Brightly-coloured pens are best for species maps, so
soluble pens which fade quickly in sunlight and ma
different colours, several species can be combined o
based in different parts of the plot: for example on
might make a good combination. Take care not to
results of 10 visits appear on roughly 15–18 specie

Once the species maps are complete, please double-c
will almost certainly find some! If you wish, you ma
species, following the guidelines given below. This w
several species on a sheet please use **only a soft lead**
to make any necessary amendments. An example

SPECIES AN

This standard list of conventions is designed fo
necessary. Additional activities of territorial signif
clear abbreviation.

CH, CH♂, CH♀ 3CH juvs, CH2♂1♀	Chaffinch sight rec one pair of Chaffin
R fam	Juvenile Robins wit
R	A calling Robin
R	A Robin repeatedly territorial significan
R	A Robin in song.
RR	An aggressive encou
* R	An **occupied** nest o significance by them
BT	Blue Tits nesting in nest in a nestbox.
* PW on	Pied Wagtail nest w
PW mat	Pied Wagtail carryi
PW food	Pied Wagtail carryi

Movements of birds can be indicated by an arro

GR	A calling Greenfinc
D	A singing Dunnock
B♂	A male Blackbird fl
WR WR	A Wren moving bet

The following conventions indicate which registra
proper use will be essential for the accurate asses

WR WR	Two Wrens in song **simultaneous registr** territories.
* * (L1 L1)	Two Linnet nests o another example of t
CK CK	The solid line indic
SD ? SD	The question-marke bird. This conventio already covered it before, **without risk** marked solid line, **o**
WR WR mat	No line joining the r depending on the pa involved. (You may registrations were al
C* C*	Where adjacent nest and second broods.

**Please use the following abbreviations of species n
the list, use a longer (unambiguous) abbreviation.
the Waterways Bird Survey and Winter Atlas; yo**

that the registrations stand out well from the background. Avoid water-
ay tend to spread. Fine-pointed ball-pens are recommended. By using
a single map. Try to combine species of differing abundance and those
farmland, Skylark (a field species) and Dunnock (chiefly in hedgerows)
overcrowd the maps. Good economy of materials is achieved where the
sheets.

heck the visit maps for registrations missed. Experience shows that you
y then make a provisional estimate of the number of territories for each
ill be very useful to us when we finalise the analysis. Even when there are
pencil for your provisional analysis, so that it is easy for the BTO analysts
pecies map is shown overleaf.

D ACTIVITY CODES

clear and unambiguous recording. Symbols can be combined where
icance, such as display or mating, should be noted using an appropriate

ds, with age, sex or number of birds if appropriate. Use CH♀ to indicate
hes, so that 2CH♀ means two pairs together.

parent(s) in attendance.

iving alarm calls or other vocalisations (not song) thought to have strong
e.

nter between two Robins.

Robins. Do not mark unoccupied nests, which are not of territorial
elves.

specially provided site. Please remember to use this special symbol for a

h an adult sitting.

g nest material.

g food.

using the following conventions:

flying over (seen only in flight)

perched then flying away (not seen to land).

ng in and landing (first seen in flight).

een two perches. The solid line indicates it was **definitely the same bird**.

ons relate to different, and which to the same individual birds. **Their
ment of clusters at Beech Grove**.

the same time, i.e. **definitely different** birds. The dotted line indicates a
tion (or contemporary contact) and is of very great value in separating

cupied simultaneously, and thus belonging to different pairs. This is
e value of dotted lines. Only adjacent nests need to be marked in this way.

s that the registrations definitely refer to the same bird.

solid line indicates that the registrations relate to **probably the same**
s of particular use when your census route brings you back past an area
possible to mark new positions of (probably the same) birds recorded
of double-recording. If you record birds without using the question-
er-estimation of territories will result.

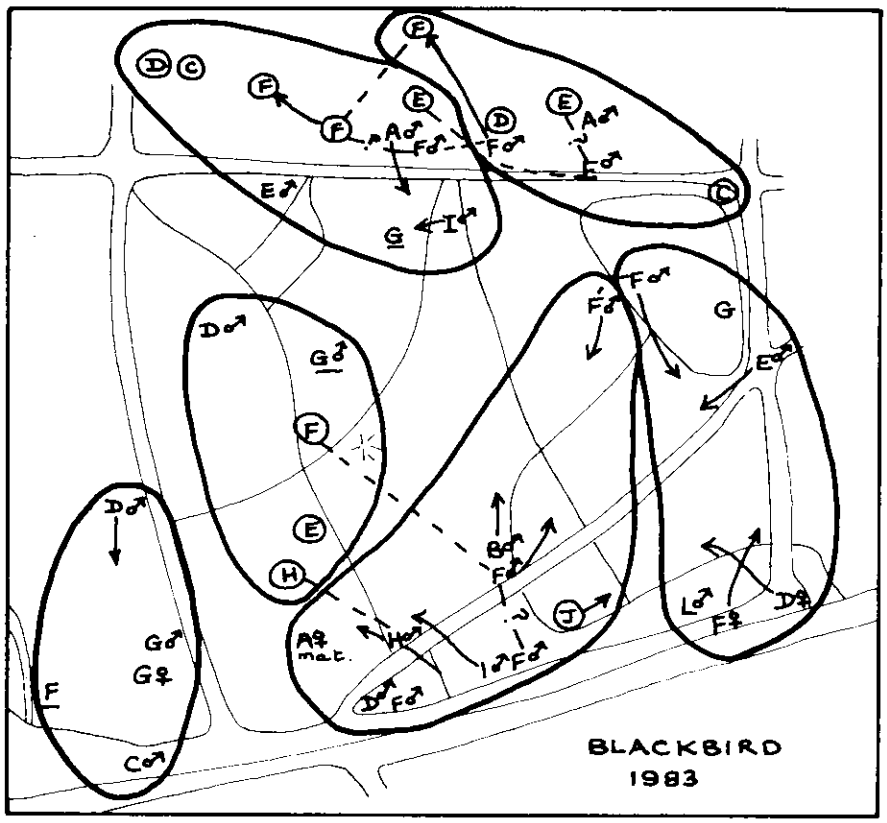
gistrations - it will be assumed that the birds are **probably** different, but
ern of other registrations they may be treated as if only one bird was
it you wish use a question-marked dotted line, indicating that the
ost certainly of different birds.)

are marked without a line, it will often be assumed that they were first
r a replacement nest following an earlier failure.

**nes. If uncertain of the correct code, or if you encounter a species not on
hese codes are the same as those used for other BTO schemes including
may also find them helpful in other birdwatching studies.**

SPECIES CODES:

BO	**Barn Owl**
BH	**Black-headed Gull**
B	**Blackbird**
BC	**Blackcap**
BT	**Blue Tit**
BL	**Bramblin**g
BF	**Bullfinch**
BZ	**Buzzard**
CG	**Canada Goose**
C	**Carrion Crow**
CW	**Cetti's Warbler**
CH	**Chaffinch**
CC	**Chiffchaff**
CT	**Coal Tit**
CD	**Collared Dove**
CM	**Common Gull**
CS	**Common Sandpiper**
CN	**Common Tern**
CO	**Coot**
CA	**Cormorant**
CB	**Corn Bunting**
CR	**Crossbill**
CK	**Cuckoo**
CU	**Curlew**
DW	**Dartford Warbler**
DI	**Dipper**
DN	**Dunlin**
D	**Dunnock**
E	**Eider**
FP	**Feral Pigeon**
FF	**Fieldfare**
FC	**Firecrest**
GW	**Garden Warbler**
GC	**Goldcrest**
GF	**Golden Pheasant**
GP	**Golden Plover**
GN	**Goldeneye**
GO	**Goldfinch**
GD	**Goosander**
GH	**Grasshopper Warbler**
GB	**Great Black-backed Gull**
GG	**Great Crested Grebe**
GS	**Great Spotted Woodpecker**
GT	**Great Tit**
GE	**Green Sandpiper**
G	**Green Woodpecker**
GR	**Greenfinch**
GK	**Greenshank**
H	**Grey Heron**
P	**Grey Partridge**
GL	**Grey Wagtail**
HF	**Hawfinch**
HH	**Hen Harrier**
HG	**Herring Gull**
HM	**House Martin**
HS	**House Sparrow**
JD	**Jackdaw**
J	**Jay**
K	**Kestrel**
KF	**Kingfisher**
L	**Lapwing**
LB	**Lesser Black-backed Gull**
LS	**Lesser Spotted Woodpecker**
LW	**Lesser Whitethroat**
LI	**Linnet**
LG	**Little Grebe**
LO	**Little Owl**
LP	**Little Ringed Plover**
LE	**Long-eared Owl**
LT	**Long-tailed Tit**
MG	**Magpie**
MA	**Mallard**
MN	**Mandarin**
MT	**Marsh Tit**
MW	**Marsh Warbler**
MP	**Meadow Pipit**
ML	**Merlin**
M	**Mistle Thrush**
MH	**Moorhen**
MS	**Mute Swan**
N	**Nightingale**
NJ	**Nightjar**
NH	**Nuthatch**
OC	**Oystercatcher**
PH	**Pheasant**
PF	**Pied Flycatcher**
PW	**Pied Wagtail**
PT	**Pintail**
PO	**Pochard**
Q	**Quail**
RN	**Raven**
RG	**Red Grouse**
RM	**Red-breasted Merganser**
RL	**Red-legged Partridge**
LR	**Redpoll**
RK	**Redshank**
RT	**Redstart**
RE	**Redwing**
RB	**Reed Bunting**
RW	**Reed Warbler**
RZ	**Ring Ousel**
RI	**Ring-necked Parakeet**
RP	**Ringed Plover**
R	**Robin**
RC	**Rock Pipit**
RO	**Rook**
RY	**Ruddy Duck**
SM	**Sand Martin**
SW	**Sedge Warbler**
SU	**Shelduck**
SE	**Short-eared Owl**
SV	**Shoveler**
SK	**Siskin**
S	**Skylark**
SN	**Snipe**
ST	**Song Thrush**
SH	**Sparrowhawk**
SF	**Spotted Flycatcher**
SG	**Starling**
SD	**Stock Dove**
SC	**Stonechat**
SL	**Swallow**
SI	**Swift**
TO	**Tawny Owl**
T	**Teal**
TP	**Tree Pipit**
TS	**Tree Sparrow**
TC	**Treecreeper**
TU	**Tufted Duck**
TD	**Turtle Dove**
TW	**Twite**
WA	**Water Rail**
W	**Wheatear**
WC	**Whinchat**
WH	**Whitethroat**
WN	**Wigeon**
WT	**Willow Tit**
WW	**Willow Warbler**
WO	**Wood Warbler**
WK	**Woodcock**
WL	**Woodlark**
WP	**Woodpigeon**
WR	**Wren**
YW	**Yellow Wagtail**
Y	**Yellowhammer**



This is the Blackbird species map from the same census as the example visit map on page 6. On transfer to the species map the B for Blackbird has been replaced in every case by the visit letter F, but the symbols indicating sex, song and movements have not been changed. The map has already been analysed, and six territories found on this portion of the plot, although two of these lie mostly beyond the northern boundary.

HABITAT DESCRIPTION

Information on the nature of the habitat is an essential complement to the data you supply on the numbers and distribution of the territorial birds on your plot. It enables us to assess how representative is our index (by comparing the habitat of our plots with that of farmland or woodland as a whole), to compare the birds on plots of differing habitat and, most importantly perhaps, to measure the effects on birds of specified changes in the environment.

If the habitat of your plot is subjected to major change, subsequent census results may form the basis of a detailed case study. **We are likely to welcome the continuation of a census following such a change, even where the changed area is substantially less attractive for birds**, but please check with us first to ensure that the results will be worthwhile.

The following items are needed annually to accompany each completed census sent to Beech Grove:-

(a) a habitat map. A full habitat map is essential in the first year but in subsequent years it is necessary only to show changes from the previous year's map, and any special information which is relevant to that year (including field-use on farmland plots). Details on compiling habitat maps are given below.

(b) a completed habitat questionnaire. Each observer will be sent a questionnaire before the start of the season, to be completed as fully as possible and returned with the maps. The content of the questionnaire may vary from year to year but for farmland will include field-use (cropping, management, farm chemicals used, etc), hedgerow management and other detailed aspects of habitat change. If there has been no change on the plot, whether farmland or woodland, this will be your opportunity to say so.

In addition, photographs of the plot are very helpful to the analyst, since they give an accurate impression of the habitat; they must be regarded as a complement to the habitat maps and questionnaires, **not a substitute**. Colour slides are particularly welcome. Please enclose with them a map showing the points from which the photographs were taken, and a note of the date.

Farmland habitat maps

In your first season, and in any subsequent season if you wish, please complete a **full habitat map**. This should be on one of the outline maps sent to you for the census and should describe the permanent skeleton of the plot - including any hedges, fences, ditches, tracks and lanes, farmsteads, gardens, scrub, copses, permanent pasture, streams and standing water - together with a note of the field use in that season. Conventions are to mark hedgerows and wooded areas in green, and any streams or standing water in blue. Mapping should extend for 50-100 metres beyond the plot boundaries. The following details should be given:-

(a) the plot boundaries, clearly marked.
(b) contours, copied from the 6″ or 2½″ O.S. maps.
(c) a six-figure grid reference for a point near the centre of the plot.
(d) a description of each copse or block of woodland (see woodland section opposite).
(e) the structure of each hedge in terms of height, width, shape, main species of hedgerow shrubs and species and height of standard trees. The positions of standard trees should be marked with a cross.
(f) position of any nestboxes.
(g) any other details you think may affect the distribution of birds on your plot.

Estimate hedge width at the height at which the width is greatest; for hedges not recently trimmed it may be necessary to give ranges for height and width rather than single values.

A full habitat map will be welcome in any subsequent year of the census, and would be particularly useful following a period of habitat change, but the only requirement following the initial year is for a '**crops and changes**' map. This should show:-

(a) any changes in the habitat since the map for the preceding year, e.g. hedgerow losses, streams which have been dredged,
(b) the cropping or field-use,
(c) the hedgerows present in that year, marked with a green line, and
(d) the period of the season for which any standing water was present.

The 'crops and changes' map can be used to illustrate points you mention in your answers on the annual questionnaire. Please remember that unless you inform us of changes we might assume that the information on your previous habitat map is correct, so it is very important to **keep up to date with recording habitat change**.

Habitat information is best collected during the course of normal visits, but make a special visit if you wish. Notes made on the visit maps should be cancelled as they are copied to the habitat map.

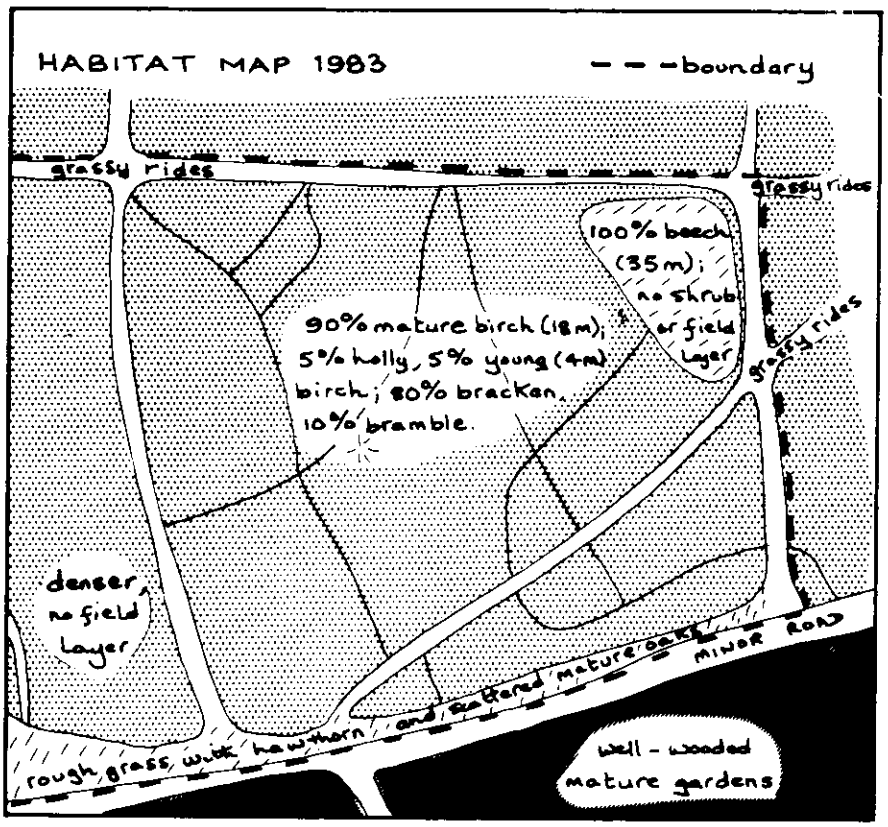
Woodland habitat maps

As for farmland, a full habitat map is requested to accompany your first census. Please read the section on farmland habitat maps and mark all the features listed there, where relevant to the habitats present on your plot and in the surrounding 50–100 metre zone. In addition, the following specifically woodland features should be recorded:-

(a) rides, clearings and glades
(b) boundaries between the major stand types, together with a brief description of each type.

Stand types can be recognised as blocks of woodland within which the tree and shrub species and the woodland structure are broadly uniform. Please provide the following details for each stand:-

1. **Management type:** stands may vary in management (e.g. high forest, wood pasture, active coppice, derelict coppice). In coppiced woods, the boundaries of different ages of coppice should be marked and the approximate date of cutting provided. Please inform us of any management activity on the annual questionnaire.
2. **Canopy or tree layer:** list the dominant species of trees and estimate by eye the approximate % cover for each tree species contributing more than 10% of the total ground cover. Also estimate the typical height of the dominant tree species: BTO staff can advise on methods if necessary.
3. **Shrub layer** (1 to 5m above ground): list the main species, their typical height and approximate % cover.
4. **Field layer and ground composition:** record the approximate percentage cover of grass, heather, herbs, bracken, bramble, rocks etc.



The habitat map for the same section of CBC woodland plot as in the other examples. This is a simplified version of the original, which shows more details and uses colours to distinguish stand types. On the original map, the management type is given as "abandoned wood pasture now moving towards high forest structure, grazed by deer."

Many plots contain only 3-4 different stand types which can be readily identified, and it will be rare to need more than 7 or 8. A friendly botanist may be able to assist. If in difficulty consult Beech Grove.

A simplified example of a woodland habitat map is shown above, to give an indication of what is required.

Please remember to keep us informed of any changes in habitat in subsequent years. Maps showing **changes only** would be welcome in addition to the completed questionnaire.

A varied piece of woodland on an Oxfordshire census plot, holding a good variety of bird species. Both Blackcap and Chiffchaff regularly hold territory around this point in the wood. *Photo: John Marchant*

SUBMISSION OF RETURNS

When completed, the visit, species and habitat maps should be sent to Beech Grove. It would be helpful to the analyst if you could also include a separate list of the visit letters, dates and times. Please try to send us your completed maps **before the New Year.**

If the maps are relatively small they are best folded and sent in an envelope, but larger maps should be rolled tightly and (ideally) packed in a cardboard tube. In either case, please ensure that a return address is included in the parcel. For added security, you can send the visit and species maps separately so that it is unlikely both will be lost.

The final assessment of territories is made by Beech Grove staff, so that we can be certain that maps from different sites, observers and years are always analysed in the same way. Once the analysis is complete we will send you our version of the results together with a first assessment of the overall changes in population. It is a good idea for you to send a copy of the results to the county bird recorder, so that they can be summarised in the annual bird report.

The original species maps will normally be retained on file at Beech Grove. They are our ultimate authority for the statements we make based on the CBC results, and are needed to back up our conservation claims if challenged. It is not possible for us routinely to copy the species maps for observers who wish to retain their original maps, but we can supply suitable tracing paper or, if necessary, extra outline maps for observers who wish to make their own copies. Please confer with CBC staff if you wish to retain copies of the species maps. Visit maps will normally be returned on request.

GUIDELINES FOR SPECIES MAP ANALYSIS

If results are to be compared between plots and between years, it is essential that the analysis of species maps should be carried out in a consistent fashion. To achieve this, all CBC species maps for every census are analysed by a small team of trained analysts at Beech Grove, working to set guidelines. The individual analysts confer in difficult cases and are tested regularly for consistency within the team, so any differences in results between plots or years are unlikely to be due to a change in analyst procedure.

The guiding principles by which CBC species maps are analysed were first published in 1968. They are given here in clarified and expanded form so as to be a ready source of reference for CBC observers wishing to make a provisional analysis of their own species maps, and for BTO members who wish to make use of the mapping method in their own studies.

The essence of species map analysis is that rings are drawn around clusters of registrations which appear to represent the activities of a distinct pair of birds. The ring itself merely encloses those registrations treated as forming part of the cluster, and does not necessarily indicate the territory boundaries. By convention, the rings drawn are non-overlapping, although in reality adjacent territories may overlap. The clustering procedure is merely an expedient for assessing the number, distribution and relationship to habitat of territory-holding birds on the data available.

Bird behaviour varies between individuals and between habitats, and may be detected and interpreted differently by different observers. It is therefore inappropriate for the analysis guidelines to be a set of fixed and rigid rules. An element of subjectivity remains even when the guidelines are followed: sometimes there may be more than one allowable way to analyse a species map. Decisions made by the CBC analysts, however, are not arbitrary since they draw on their accumulated experience of censuses in a wide variety of habitats and on their field knowledge of bird behaviour. Examples of cluster analysis are shown opposite to illustrate various of the points made below.

1. Ideal clusters. The typical species map shows discrete grouping of letters indicating the positions held by territorial males on different visits. Each grouping or cluster may show a sequence of observations on different visits of probably the same pair of birds, but in practice will probably show some duplication whereby males or females are registered more than once on a single visit. Areas from which dotted lines radiate may be identified readily as potential clusters.

Where registrations form well-defined groupings, these are accepted as clusters provided that each meets the minimum requirements and the other criteria given below.

2. Minimum requirements for a cluster. If it is to be accepted as a valid cluster, a grouping must contain registrations from a certain minimum number of different visits. This minimum is 2 where there were 8 or fewer **effective visits** for the species in question, or 3 where there were 9 or more visits. The number of effective visits can differ from the total number of full visits only where:-

a) the species is a migrant and was not present on the early visits (count from the first visit on which the species was registered),

b) the species is crepuscular or otherwise difficult to record (e.g. Woodcock, Nightjar, owls), in which case 2 records from different visits will suffice, or

c) in rare cases, coverage of the plot has been uneven: in particularly awkward cases it may even be necessary to apply different minima in different parts of the plot.

A further requirement is that there must be **ten full days** separation between the first and last registrations in the group. This rule (only) is waived in 'expedition methodology' where the visits are compressed into a short period of the season for the purposes of a special study. To determine whether clusters span ten days, it is helpful to keep a list of the visit letters and dates to hand during the analysis.

A single record of a **nest containing eggs or young** can be accepted as the basis of a cluster, even in the rare case of being unsupported by any other registrations. This does not apply to fledged juveniles, or to chicks of nidifugous species (such as Mallard, Pheasant or Lapwing) since they may have moved a considerable distance from the nest.

3. Dotted and solid lines. Two registrations joined by a dotted (or dashed) line should not be included in the same cluster, unless it is probable that the registrations relate to male and female of the same pair, or to juveniles. Such lines are of the greatest value in delimiting clusters. Singing birds can normally be identified safely as males, but for some species females might also be recorded as being in song (e.g. Tawny Owl, Green Woodpecker).

Two records joined by a solid line are effectively the same registration and must not be treated as part of two separate territories.

Records joined by a question-marked solid line may be treated alternatively as if they were separate birds, or the same bird, according to the pattern of other registrations. If included in a single territory, the registration does not count as a "double" (see 5 below).

4. Multiple sightings. A number of birds seen together in a flock may be registered as, for example, **4BT** for four Blue Tits or **2B♂** for two male Blackbirds together. Another common example is a registration of territorial conflict between two or more birds.

Where it is undesirable that such a registration should be treated as part of a single cluster, the analyst can divide the registration between two or more clusters. This is usually the appropriate course for dealing with registrations of conflict which often indicate the boundary between adjacent territories.

5. Double registrations. Double or repeat registrations frequently occur within apparently good groupings. Such registrations might belong to the same individual unwittingly registered more than once, or to different birds (perhaps the territory-holder and a migrant or a wandering male). Where there are more than two double registrations, or where the distribution of the double registrations is associated with a spatial division in the grouping, the analyst should consider whether to draw two clusters. The following points should be taken into account:-

a) whether splitting the group would yield two acceptable clusters, in terms of the minimum requirements, which accord with the territory size and distribution to be expected at that point on the plot.

b) the likelihood of the species performing rapid undetected movements across its territory (several species are especially likely to produce double registrations in this way. Examples include Whitethroat and other Sylvia *warblers, Willow Tit, Chiffchaff and Wren.)*

c) the likelihood of migrants singing while on passage (particularly high for Willow Warbler during their peak of spring arrival).

d) the likelihood of wandering males (high for species which frequently feed outside the defended area of the territory, e.g. Yellowhammer and especially Blackbird which also has a sizeable floating population of non-breeding birds in some years).

e) the number of double registrations is likely to increase with the number of visits made to the plot.

f) double registrations of females are to be expected in polygynous species (such as Pheasant) and should not be counted.

6. Excess registrations. Some registrations will be difficult to assign to particular clusters. In general they should be included in the nearest cluster, except where:-

a) the registrations are close to the plot boundary and probably belong to territories outside the plot, or

b) the resulting cluster would then have too many double registrations, or be too large for the species and habitat concerned, or

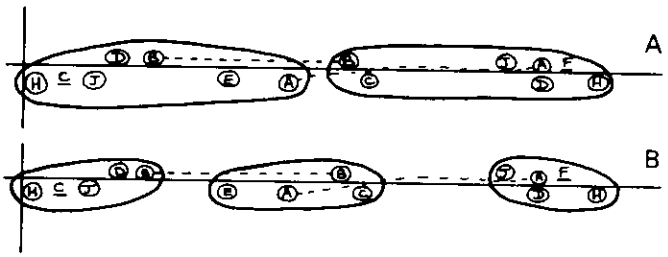
c) the registrations are likely to be of wandering individuals or late migrants (particularly early in the season) or of fledged juveniles (late season).

Excess registrations are those which do not fit into any cluster when the above guidelines are applied. It is best to draw a little arc around them to indicate their likely origin (off the plot, probably belonging to adjacent cluster, etc) and to show that their presence has been taken into account during the analysis.

7. Diffuse registrations. Common species in uniform habitats may show a diffuse rather than a grouped distribution of registrations. Dotted lines are particularly valuable in these circumstances. A start may be made by looking for the best nucleus of territorial activity (e.g. observations on successive visits, perhaps in an area from which dotted lines are emanating), drawing a cluster and then working outwards towards areas where the pattern of groupings is less clear. It is not a good idea to start arbitrarily at the edge of the map.

8. Large territories. Species with large territories (e.g. Kestrel, Green Woodpecker, Grey Partridge) present a special problem since the registrations rarely form obvious spatial groupings. Where the registrations fall close to two edges of the plot with a substantial gap between, it is often better to assign them to different groupings (either or both of which may qualify as an accepted cluster) than to draw a single cluster covering most of the plot. The size of the cluster drawn should always be appropriate to the territory-size of the species in the habitat concerned.

The following diagrams show examples of correct (and in some cases incorrect) assessment of territory numbers using the standard CBC guidelines. Assume there are ten visits throughout, the plot is farmland, and that the species is a strongly territorial resident in all but the last example. The maps are not intended to be the standard 1 : 2500 scale.

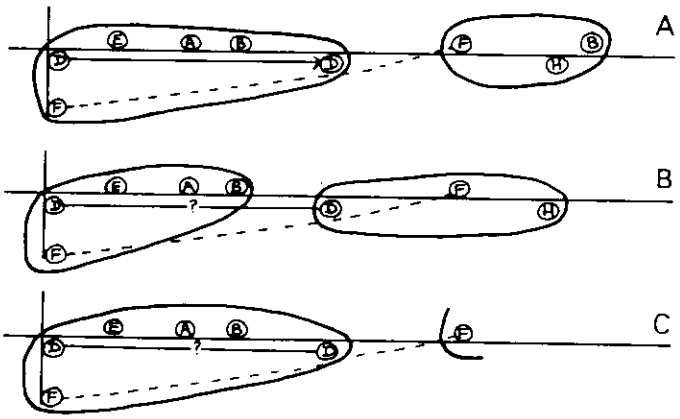


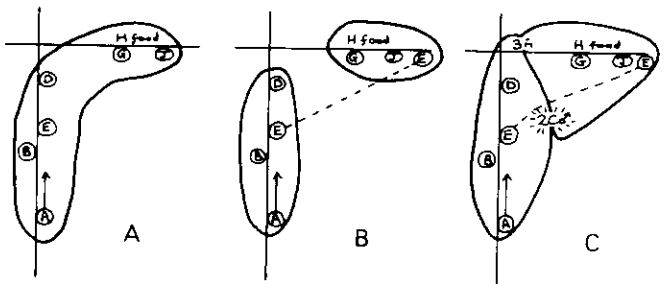
DOTTED, SOLID AND QUESTION-MARKED SOLID LINES

This example shows the correct treatment of lines between registrations. The dotted line *FF* means that the two *F* registrations cannot be placed in the same cluster (A,B and C). In C, the second *F* is treated as an excess registration. The solid line *DD* (example A) means that both *D* records were of the same bird and should be placed in the same cluster. The question-marked solid line *DD* (B and C) can be treated in either of the two ways, depending on the pattern of other registrations. In B, there are sufficient registrations to support a second cluster *DFH* and the *D* records are treated as being of separate birds. In C, there is no support for a second cluster and both *D* records are treated as if one bird was involved. These examples are correct as they stand, but on a real map might be influenced by the pattern of adjoining registrations.

GOOD CLUSTERS

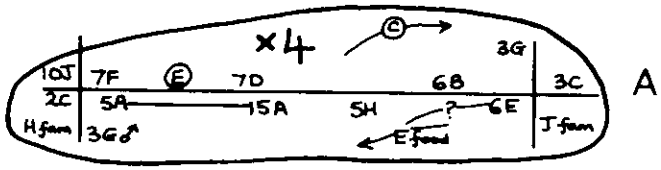
A and B show two different analyses of the same set of registrations. A is unsatisfactory because the apparent nucleus *ABC* is split between two clusters. B, giving three smaller clusters, is a better analysis because it uses *ABC* as the basis of a separate cluster. The treatment of dotted lines is correct in both examples.

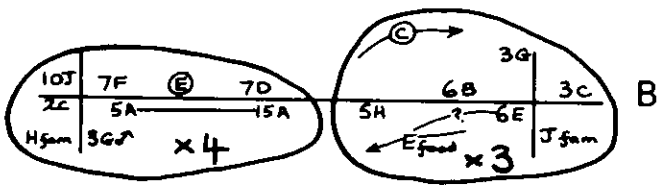




TERRITORY SHIFTS, MULTIPLE SIGHTINGS

Three correct examples of analysis. In A, the two groupings *ABDE* and *GHJ* are merged into a single cluster on the assumption that there has been a shift of territory. It would be wrong to draw two clusters where such groupings are so close together. In B, the addition of a second *E* and a dotted line makes it clear that there are two clusters. In C, the example is extended to show the correct treatment of multiple registrations. Neither cluster has any double registrations.





SEMI-COLONIAL SPECIES

For a semi-colonial species such as Linnet it is often necessary to draw clusters representing groups of territories. Examples A and B show correct and incorrect treatments of the same set of registrations. A is correct, based on totals of 7 birds on visits *D*, *E* and *F*. The high count on visit *A* is discarded as probably a remnant of winter flocks, while that on visit *J* probably includes juveniles. B is incorrect, since the peak counts in these two adjacent putative clusters occurred on different visits, and combining them as in A considerably reduces the assessment.

". . . . does not apply to fledged juveniles . . . . . since they may have moved a considerable distance from the nest." *Drawing: P. Barwick*

9. Spurious groupings. Groupings of registrations sometimes occur which, although fulfilling the minimum requirements, should not be treated as separate clusters.

a) Two distinct adjacent groupings which treated as a single unit have no more than two double registrations, may (particularly in an open or patchy environment) represent two separate songposts of a single bird. Only one cluster should be drawn, provided that this is not unusually large for the species and habitat.

b) Very occasionally, groupings are found which appear to be too small for the species and habitat. These should be incorporated into nearby clusters if the rules allow.

c) Communal feeding areas (e.g. for Blackbird, finches and Yellowhammer) may give groupings of registrations, usually lacking in observations of territorial behaviour. These should be treated as excess registrations.

d) Adjacent groupings showing no temporal overlap (e.g. visits **ABD** *and* **EGJ***) should be treated as an example of* **territory-shift** *and merged into a single cluster, unless this seems unlikely in view of the species, habitat and distribution of registrations.*

10. Clusters representing semi-colonial groups of birds. The mapping method works best for territorial and non-colonial birds (chiefly passerines). In the CBC, however, mapping is extended to cover all species present on the plot, including those which may be colonial or semi-colonial breeders. The following guidelines have been devised to cope with the assessment of these species.

Where a species is non-territorial, or has a very small defended territory as part of a much larger home range (e.g. finches, pigeons), group clusters may be drawn. Each cluster must contain a potential breeding site (e.g. trees for Woodpigeon, buildings for Swallow) or other centre of breeding activity (such as a ditch or stream for Mallard).

The registrations should be divided into groups according to their spacing (ignoring any on the early visits which appear to be of winter flocks). This division must be performed carefully, since the final cluster total may vary considerably depending on how many group clusters are drawn. Putative clusters which contain similar peak numbers of birds, but on different visits, should in general be merged. Each group cluster should be large enough to be realistic for the number of pairs assigned.

Each group cluster should then be assigned a "number of pairs". This should be the highest confirmed number of males (the second highest number of males present on any single visit): make a list of the number of males recorded on each visit, and take the second highest number. Unsexed birds should be totalled and halved between the sexes, treating any excess birds as males. The following categories of registrations should be omitted from the calculations:-

a) high numbers on early visits which may be the remnants of winter flocks.

b) exceptionally high numbers on a single visit which might represent a feeding concentration.

c) high counts after the first observations of fledged juveniles, unless recorded as birds definitely adult (birds recorded as juveniles **must** *be omitted).*

d) influxes of moulting adults in late season e.g. Mallard drakes from late May, Lapwing flocks (June onwards).

Where the number of nests in the group cluster **in simultaneous use** is higher than the number of pairs assigned on the basis of the other registrations, the nest count should be taken as the "number of pairs". For ducks, the number of different broods in the cluster should be used if higher than the assessment based on drakes.

Single clusters may also be drawn for colonial or semi-colonial species at low density; the rules for single clusters then apply.

HOW TO RECORD THE ASSESSMENT

The total number of clusters assessed should be entered on the species map and the summary sheet using the following conventions:-

✓ no clusters assessed, species probably not holding territory. Ticks for species which are common winter visitors should be omitted.

n.c. no count: species probably holding territory, but no assessment made because either it was not mapped by the observer or no proper assessment was possible from the map.

N. adjacent to the assessed number, indicates the figure was based entirely on a count of active nests.

DENSITY CALCULATION: THE TREATMENT OF EDGE CLUSTERS

Edge clusters are defined as those which overlap the plot boundary. All clusters on the species maps are included in the totals for the CBC index, since the greater the number of territories sampled the more precise will be our estimates of percentage change. Dividing the simple total by the area of the plot is likely to give an inflated estimate of the density of territories, because some of the clusters counted will probably lie outside the plot boundaries.

In studies of density and community structure, the totals should be reduced to those strictly relevant to the area within the boundaries. Any clusters lying entirely outside the boundaries should be excluded, together with a proportion of the edge clusters (those which have some registrations inside and some outside).

The method currently recommended by the International Bird Census Committee is to exclude edge clusters unless more than half of the registrations lie within the plot or on the boundary, treating birds in farmland boundary hedges as lying on the boundary. The application of such methods for correction of edge effect still results in small over-estimates of density, however, partly because observer coverage is greater (and thus birds are more likely to be registered) inside the plot than out.

ACKNOWLEDGEMENTS

The information given here on the CBC is drawn from previous sets of instructions written by Kenneth Williamson, Roger Bailey and Leo Batten, from discussions with other past and present CBC analysts (Rob Fuller, David Glue, Phil Hyde, Robert Morgan and Kenneth Taylor), and from discussions in the CBC Technical Review Group, 1983. The CBC logo is by Ashley Boon, and other artwork by Elizabeth Murray.

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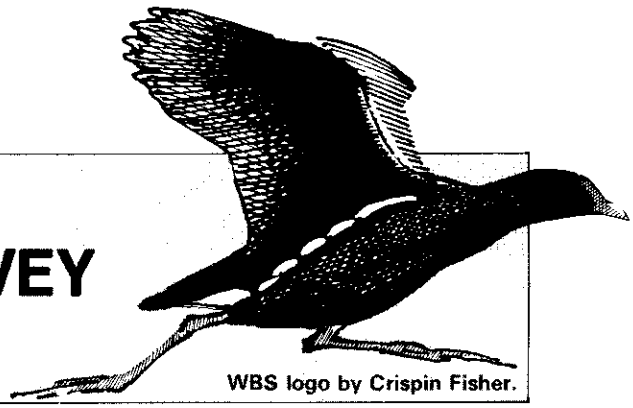
APPENDIX 4.

BTO

WATERWAYS BIRD SURVEY

INSTRUCTIONS

Text — Kenneth Taylor
Figures — Elizabeth Murray



WBS logo by Crispin Fisher.

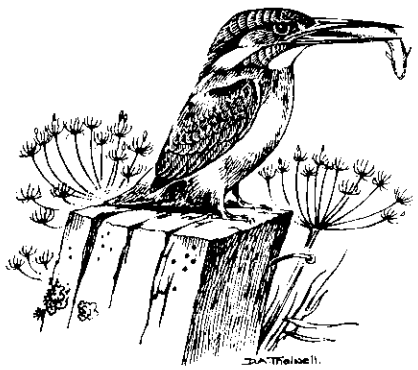
Introduction

Britain's waterways provide breeding, feeding and resting places for many different species of birds. Some, like the Kingfisher and Dipper, are exclusively associated with flowing water and could be classed as fully 'riparian' birds. The Kingfisher is thus aptly described as the 'secret splendour of the brooks', but the question is, which brooks? If a farmer in central Scotland decided to 'manage' a stream running through his land by deepening and straightening the water channel, might this have an effect on Kingfishers? If the stream froze in winter or flooded in spring, what influence would this have on birds breeding there? These are the types of questions which the BTO hopes to answer over the next few years through its Waterways Bird Survey (WBS).

WBS history and achievements

The WBS began as a national survey in 1974. Its aims were to provide an 'annual index' of population levels for several species not already covered by the BTO's national Common Birds Census, and to produce the data on habitat requirements and regional distribution needed to assess the influence of waterways management and pollution on riparian birds.

Since 1974 over 250 different stretches of waterways between Ross and Cromarty and Devon have been surveyed. This work has already allowed regional variations in territory densities of waterways birds to be documented and indicated how densities are influenced by waterway altitude and gradient. For



example, no Kingfisher territories have been recorded on Scottish WBS plots, and elsewhere in Britain Kingfisher densities are highest on slow rivers at low altitude. Data from the 1980 WBS also showed how quickly some waterways birds recovered from the effects of the harsh 1978/79 winter. There were fewer Kingfisher territories on WBS plots in the breeding season following this cold weather than in any previous survey year. Kingfisher territories increased between 1979-80 to a level similar to that in many years prior to the hard winter, and remained at this level in 1981 (see Fig. 1). For conservationists, WBS data could thus help determine whether an individual waterway was especially valuable as a bird habitat at a regional or national level, and provide a means of monitoring population trends in different habitats, for example managed and unmanaged rivers.

Sedge Warbler carrying food to its young. Photo: C. J. Smale.

The survey work

The survey work is simple to carry out, and many birdwatchers consider the WBS an excellent way to add extra structure and enjoyment to their field trips. Having chosen a stretch of waterway to survey (a minimum of 3 km or around 2 miles in length) the observer makes nine or ten visits to the survey plot during the breeding season. On each visit the positions of birds seen are recorded on a 6": 1 mile scale map of the waterway.

At the end of the breeding season data from these 'visit maps' are transferred to 'species sheets' by observers and analysed by BTO staff. Analyses provide information on the number of territories of individual species. If a plot is surveyed for more than a year, this territory information can be used to calculate indices of population change. A number of observers have been participating in the scheme every year since 1974, and many comment that each new survey year holds its own rewards as they gain a progressively more intimate knowledge of the birdlife on their plot.

WBS potential

WBS documentation of the effects of watercourse management and pollution on birds has been limited until recently, partly due to the small number of observers (usually 50-60) participating in any one year. As a result of appeals for more survey workers, over 80 new WBS plots were surveyed in 1981-82, in addition to those plots where long term monitoring continued. (The map on page five illustrates the geographical position of plots surveyed in 1981). This means that the WBS now has a greater potential than ever before for monitoring the changing fortunes of riparian birds. To help reap the full benefits of increased observer coverage, WBS workers are now being asked to submit detailed information about their plots by completing a 'tick list' of habitat features. Details of habitat recording are given on pages four to six. These habitat data can be readily stored on the BTO computer, increasing the potential for comparison of riparian bird populations in different regions or under different management regimes. The RSPB is also currently studying the effects of river management on birds, and is assisting the WBS with publicity and technical advice.

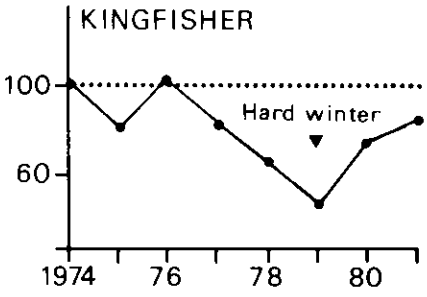


Fig 1. Changes in WBS Kingfisher index between 1974-1981, showing the rapid recovery from the effects of the hard 1978-79 winter.

WBS information has also helped the RSPB to prepare material for training Water Authority personnel. One of the RSPB's 1982 films *'The Vital River'* illustrates many of the techniques which are being developed to integrate the needs of wildlife with those of river management.

The WBS has great potential as a tool for conservation. With improved observer coverage and habitat recording techniques, the survey should be able to realise this potential in the near future. For the Kingfisher and other waterways birds it is certainly about time the secrets of the brooks were made public.

HOW TO CONDUCT A SURVEY

Contributions are welcome from anyone interested in the welfare of waterways birds. However, in order that the results can be incorporated into the scheme, the following two points should be noted: **1. The survey should be carried out as far as possible according to the methods described in these Instructions; 2. At least two consecutive seasons' work should be intended by the observer, along the same stretch and employing the same amount of effort, so that the results can be used in the calculation of population indices.**

Most contributors are individuals but work can be shared among the members of a local or school society. More extensive work can be organised by local societies, covering for example the whole length of a river, or a variety of different waterways within the society's recording area.

An average survey involves about 15-20 hours of fieldwork spread throughout the breeding season, and a further 2-8 hours compiling and checking species and habitat maps.

Selecting a plot

The selection of the waterway to be covered is left to the observer, although Populations Section staff will be happy to give advice if required. The following points should be borne in mind:

1. **Waterways which can be clearly classified as either rivers or canals will be of maximum use (although hybrid plots can be accommodated);**
2. **A tidal or partly tidal waterway is likely to be unsuitable, as few of the riparian birds will be territorial;**
3. **The observer should ensure that there is ready access to one or both banks throughout the reach, and should obtain permission beforehand if the survey requires entry to private land.**

River habitats showing all states of management will be welcomed, from little or none through management in progress to rivers after extensive deepening and straightening, so that a full picture of the effects of the bird-life can be compiled. **A length of about 5 km is considered ideal.** Longer or shorter **(minimum 3 km)** reaches are acceptable.

Obtaining maps

Experience has shown that for the relatively few species concerned, the 6-inch Ordnance Survey (1:10560 or 1:10000) provides a suitable base-map for the survey.

Most public libraries have copies of local 6-inch maps and permission should be sought to trace the outline of the waterway and its immediate topographical features, so that a number of blank maps can be duplicated. Features of the waterway which will help to pinpoint the observer's position (and thus accurately locate observations) should be included; these might be weirs, bridges, fords, belts of trees, buildings, or field hedgerows, for example. Useful features of recent origin noted on any preliminary visit may also be included. However, it is important that the clarity of the map outline should be retained, and features tending to obscure the registrations or cause them to be displaced from their accurate position on the map should be left out.

Any observer who has difficulty duplicating sufficient copies should send the completed tracing to the Popualtions Section at Beech Grove for copying. Similarly, should it prove impossible to obtain the 6-inch OS map locally, the appropriate map references (from the one-inch or 2½-inch editions) should be sent to the Populations Office, where all possible assistance will be given.

About 20-25 copies will be needed for each season's work, depending on the number of visits intended and the density and variety of the riparian species present.

The survey method

The WBS is a 'mapping census' conducted along the lines established by the Common Birds Census (CBC) which has been in operation since 1962. Observations plotted on successive visits during the breeding season are used to give evidence of the number and extent of occupied territories.

Ideal coverage comprises nine full field recording visits to the plot during the course of the breeding season, between mid-March and mid-July (in accordance with the recommendations of the International Bird Census Committee). **Observers should strive to achieve the optimum nine visits if possible.** Surveys with fewer than six visits cannot be used in computing WBS indices. Ten to 12 visits are acceptable if a higher level of coverage can be maintained. **The visits should be well spread throughout the season.** They should also be spaced out so that, if possible, no three sequential visits span a period of less than ten days. For example, three visits made on May 1st, May 7th and May 11th would be acceptable, but three on May 1st, May 7th and May 10th would be less so.

The reason we ask that visits be spaced out relates to the international rules which BTO analysts follow when interpreting mapping census reults. These rules require that for resident species mapped in a nine visit census each territory should at minimum contain registrations from three different visits made in a period of at least ten days.

Additional observations clearly relating to territory-holding birds but outside the period of the full census (perhaps relating to early nests of Little Grebes or late Tufted Duck broods) are welcome. These can be included as additional notes on a separate sheet or map when submitting maps for analysis.

Visits should be planned in such a way that similar numbers of visits, numbers of hours spent in the field and temporal patterns of visits can be maintained between seasons throughout the period of coverage of the plot.

SPECIES CODES

The species to be covered in the survey, together with the appropriate species codes, are listed below:

LG	Little Grebe	**L**	Lapwing
GG	G-c. Grebe	**DN**	Dunlin
CA	Cormorant	**RU**	Ruff
H	Grey Heron	**SN**	Snipe
MS	Mute Swan	**BW**	Bk-t. Godwit
WS	Whooper Swan	**CU**	Curlew
GJ	Greylag Goose	**RK**	Redshank
CG	Canada Goose	**GK**	Greenshank
EG	Egyptian Goose	**CS**	C. Sandpiper
SU	Shelduck	**BH**	Bk-h. Gull
MN	Mandarin	**CM**	Common Gull
WN	Wigeon	**LB**	L.B.B. Gull
GA	Gadwall	**HG**	Herring Gull
T	Teal	**CN**	Common Tern
MA	Mallard	**KF**	Kingfisher
GY	Garganey	**SM**	Sand Martin
SV	Shoveler	**YW**	Yellow Wagtail
PO	Pochard	**GL**	Grey Wagtail
TU	Tufted Duck	**PW**	Pied Wagtail
RM	R-b Merganser	**DI**	Dipper
GD	Goosander	**CW**	Cetti's Warbler
OP	Osprey	**GH**	G.hopper Warbler
WA	Water Rail	**SW**	Sedge Warbler
MH	Moorhen	**MW**	Marsh Warbler
CO	Coot	**RW**	Reed Warbler
OC	Oystercatcher	**WH**	Whitethroat
LP	L.R. Plover	**RB**	Reed Bunting
RP	Ringed Plover		

Except for Coot and Goosander these codes are the same as those shown on the cards used for *Winter Atlas* recording. Any other clearly relevant species (for example rarer species of ducks and waders) should be written in full to avoid confusion.

Use of the standard code symbols ensures that the registrations can be clearly understood by the Populations Section staff, and permits the checking of species maps and transfer of any registrations missed by the observer once the returns have reached Beech Grove.

Although not strictly a riparian species, Whitethroat is included in the survey because it is now so scarce that data supplementing those provided by the Common Birds Census are particularly useful.

FIELD RECORDING

A separate map should be used for each visit and these maps should be titled A,B,C, etc. in chronological order. If it is not practical to cover the whole reach in a single expedition to the area, it is possible to assemble a full visit from a series of partial visits. If this is done, it is essential that the coverage achieved on each partial visit can be clearly seen on the visit map (different coloured pens are the best method) and that a different visit letter suffix is allocated to each partial visit (e.g. B_1 - green, B_2 - red). **Partial visits should be avoided if at all possible.** They can be used as a last resort if, for example, rain interrupts a normal visit.

For each visit or partial visit, the following information should be recorded:

Visit letter
date
times of starting and finishing the visit
a brief note of the weather
observer

The weather information need only be qualitative rather than quantitative, and mention should particularly be made of the wind strength and direction, temperature, precipitation and cloud cover. For example, suitable summaries might be "strong cold NE wind, heavily overcast, occasional light showers" or "mild, light SW wind, ⅛ high clouds." **(It is important that visits are made whenever possible in favourable weather,** when bird activity is not depressed by strong wind, heavy rain etc. We realise, however, that constraints imposed by the observer's other activities, by the average British summer, and by the need to space out visits may make visiting in less than ideal weather a necessity).

In the field, the blank map can be secured to a piece of hardboard with elastic bands or a bulldog clip. It is a good idea to carry a pencil as a reserve -- a biro may run out or fail to write in showery weather. Registrations written in red or green biro tend to show up more clearly on duplicated maps than those written in black or blue ink.

Each encounter with a species on the WBS list should be registered on the visit map, using the appropriate abbreviation for the species and the appropriate symbol for any activity observed (given in the shaded tables). Except where an individual bird is under observation for some time (when a summary can be given of its activities and the registrations joined by solid lines), **it is intended that each bird should be registered once only. Dotted or dashed lines** between birds known to be different (seen or heard simultaneously) or nests in simultaneous occupation **are among the most useful registrations to map analysts** (e.g. SW SW). Registrations of clear territorial significance (song, chasing intruders, display etc.) are also of great value in delimiting territories.

It is important that the plotting of registrations on the visit map should be as accurate as possible. Where the exact spot for a registration is obscured by a feature of the blank map, or by another registration, plotting should be as close as possible to the appropriate spot. Do not use lines or arrows to indicate where the registrations should be.

COMPLETING SPECIES MAPS

After the final walk of the season, the visit maps should be arranged in their chronological order, A,B,C, etc. and a set of species maps should be drawn up. Taking a clean outline map, all observations referring to, say, Dipper should be entered on it in exactly the same locations as shown on the visit maps

Standard mapping census symbols

'WBS species' (listed in the first shaded table) should be registered on visit maps using the *accepted symbols.* Please use the following conventions:

RB, 3RB Juv,	Reed Bunting sight records with age, sex or number of birds, if appropriate (use ♂ for male and female together).
RB♂, RB♀	
RB♂, RB2♂, I♀	
DI fam	Juvenile Dippers with both parents in attendance.
DI	A contact with a Dipper giving an alarm call or any other vocalisation (other than song) thought to have territorial significance
(DI)	A Dipper in song.
DI DI	An aggressive encounter between two Dippers.
***DI**	An occupied nest of Dippers. Un-occupied nests can be recorded in this way if a suitable note is appended to the registration.
***MH on**	Moorhen nest with an adult sitting.
MH mat	Moorhen with nest material in beak.
DI food	Dipper with food in beak.

It is most helpful to Beech Grove map analysts if the visit maps carry an indication of which registrations, in close proximity to one another, are definately of different birds, or belong either definitely (or even doubtfully) to the same bird. The following conventions must be used:

(RB) - - - (RB) Different Reed Buntings in song at the same time.

RB♂ - - - RB♂ Different male Reed Buntings in view at the same time.

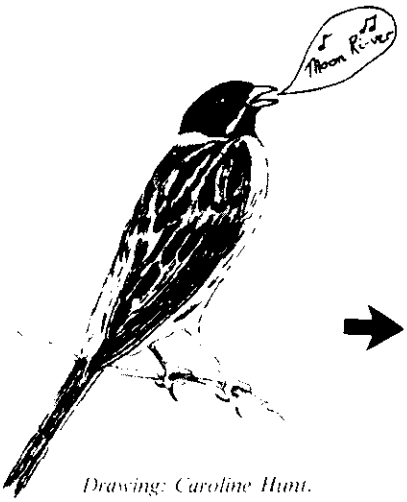
(RB)——(RB) Singing bird seen to take up a new position.

(RB)—?—(RB) Thought to be the same bird in a changed position but not certain.

If there is no line joining the registrations it will be assumed that they were probably different birds.

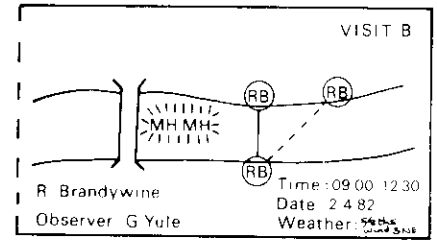
Additional activities of territorial significance, such as display or mating, should be noted using an appropriate clear abbreviation.

The story of a Reed Bunting registration

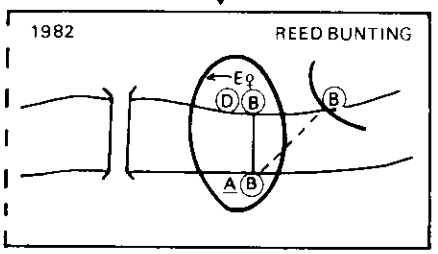


Drawing: Caroline Hunt.

1. *A Reed Bunting is seen singing on a tree near an old bridge (the scene of a fight between two Moorhens) on the second visit of the season (visit B). As you watch, the bird flies to another tree across the channel and resumes singing. You can now hear a second Reed Bunting singing against the first.*



2. *The information relating to the fighting Moorhens and singing Reed Buntings is entered on the* **visit map,** *using the appropriate species codes and activity symbols.*



3. *At the end of the season, Reed Bunting registrations from all visits are transferred to a Reed Bunting* **species map.** *Song registrations from visit B now appear as* **B** *on the species map. The map is analysed at Beech Grove, where Reed Bunting registrations near the old bridge are awarded one territory.*

(or as close as possible) but with the appropriate visit letter replacing the **DI** of Dipper for all entries. For example, **DI** on visit A becomes **A** on the Dipper species map, and **MA3♂** on visit H becomes **H3♂** on a Mallard map. The asterisk indicating a nest should only be entered once to avoid confusion, but if the nest is plotted on more than one visit the appropriate visit letters can be listed next to the nest symbol on the species map. *(An example of transferring Reed Bunting registrations from a visit map to a species map is given on page 3).*

It is important that each visit map registration should be cancelled as soon as it has been transferred to the species map. This is best done by a simple stroke of pen or pencil, so that the registration is still legible. The purpose of this is to enable checking of the visit maps to ensure that all registrations have been transferred. It is all too easy to miss some out on the first or even second time round.

Brightly coloured ballpoint pens are ideal for species sheets please do not use pencil. Where registrations are few, more than one species can be plotted on the same map. **If this is done, it is very important to use a different coloured pen for registrations of each different species plotted on the same map** (e.g. Blue for Kingfisher, Red for Little Grebe etc). Preparation of the species maps can be done concurrently with the field work if so desired.

HABITAT DESCRIPTIONS

A habitat map and a completed set of habitat forms are required for each survey plot, ideally in the first year of coverage. Details of forms and map are given on the next three pages. Once full habitat information has been lodged at Beech Grove, only subsequent changes in topography, management, disturbance or pollution need be recorded.

SUBMISSION OF RESULTS

Visit, species and habitat maps and habitat forms should be submitted as soon as possible after completion to the Populations Section at Beech Grove for territory analysis and filing of habitat data. *Maps should be returned by early October,* or handed over at the BTO Annual Conference at the very latest. Maps returned after this date may not be used in index calculations for that year.

For consistency, map analysis is performed by BTO staff analysts according to written guidelines. The basis for the analysis is the territory-holding bird; any territory where a bird was seen two or three times in a period of ten days or more may be included. Nesting may or may not have occurred and birds known to have nested elsewhere may still be included if a part of the plot was apparently a major part of the territory. *(An example of a territory on part of an analysed Reed Bunting species map is shown on page 3).*

WBS HABITAT RECORDING

There is a need for conservationists to identify good wildlife habitats along waterways and suggest ecologically appropriate techniques for watercourse management to assist land drainage engineers. Guidelines produced recently by the Water Space Amenity Commission are a welcome attempt to suggest appropriate drainage schemes for different areas but hard data illustrating the effects of management on birds, or the national importance of a site, are likely to carry more weight than general suggestions in the event of drainage proposals being contested. WBS data may yet be needed to contest proposals for watercourse development or drainage (only two rivers are currently listed as SSSIs) and now have added importance in documenting river pollution after recent Regional Water Authority cut-backs in pollution monitoring.

The new WBS habitat recording method has been designed to help survey workers provide data which will be useful in monitoring the effects of watercourse management, pollution and disturbance on waterways birds. The method, which basically involves 'ticking' relevant habitat, management, pollution and disturbance boxes on forms specially designed for the WBS, will supplement, not replace, current habitat maps.

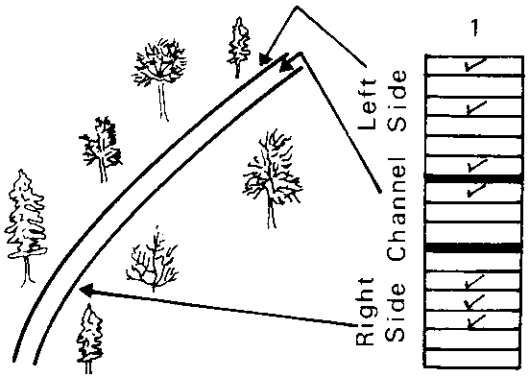
The Habitat Form

The habitat form is split up into columns numbered 1,2 etc. These columns represent different sections of your waterway, each 500 metres long. Each column is divided up into rows. These rows are where you enter information about the habitat along each section, and are labelled at the left hand side to indicate the type of information which will be recorded by making an entry into that row. Most information is entered by merely 'ticking' a box in a row. For example, for a river flowing through grazed farmland, part of the information about one bank along two sections might look like the following illustration. (There is grazed grass with scrub along one section; rough grass and hedge along the other):

	1	2	3
Adjacent land use (one bank)	27	27	27
Dominant vegetation (bank)			
Conifer wood			
Deciduous wood			
Mixed wood			
Line of trees			
Scattered trees			
Scrub		✓	
Grass	✓		
Cultivated ground			
Tall herbs			
Grass - grazed	✓		
Grass - rough		✓	

This illustrates how the form is not as laborious to fill in as might be expected at first glance many of the boxes will be left blank because the habitat label for a number of rows does not apply to your own survey plot.

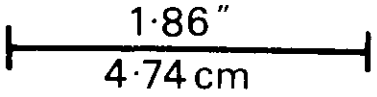
The order in which information is entered on the form is like a model of part of the waterway. The first information entered is about land use adjacent to one bank along a section, and the last information entered is about land use adjacent to the other bank. In between, information about the one bank, bank edge, channel, other edge, and other bank is filled in each column thus decribes a cross-section of your waterway:



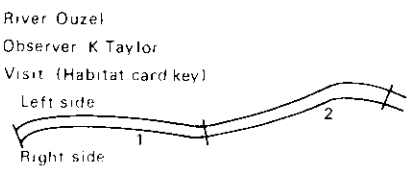
The length of 500 metres has been chosen as a sampling unit because this should give good detail about the habitat use of many WBS species, without making the job of filling in the habitat form too laborious in the field. Many of you will have a plot which can be split into about ten 500 metre sections.

First steps — marking out recording sections on a map

The first step is to take a fresh map of your plot and mark out 500 m sections along it, the first section beginning where you normally begin your walks. On the normal 6″ to 1 mile map 500 m is represented by a length of 1.86″. The easiest way to mark out your map is to take a thin piece of string 3-4″ long, and put marks on it to represent the start and finish of a 1.86″ length. This line is 1.86″ long and can be used as a standard for your marks:



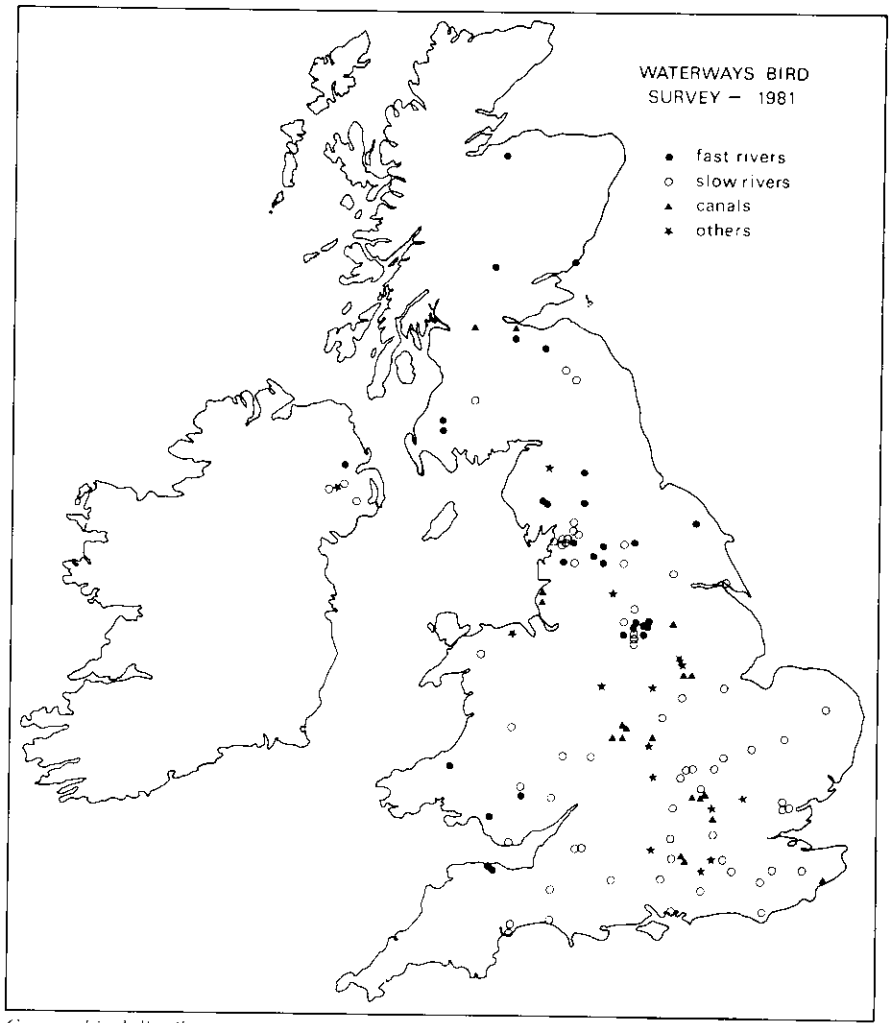
Then carefully place the first string mark at the start of your plot and let the string lie along the course of your waterway, curving with any meanders. At the point where the second string mark falls, make a mark on the map. This is the end of the first section. Repeat the procedure used for marking the first section, using the mark at the end of the first section as the start of the second section, and so on until your plot has been completely marked out in 500 m lengths. If the plot 'stops short' of the end of the last 500 m section, still mark the complete length of the section on your map. Now number the sections 1,2,3 etc., section 1 being the section where you normally begin your walks. These numbers will now indicate which column of the habitat card will contain information about a particular 500 m stretch. Now label the opposite banks of your waterway 'left side' and 'right side'. Part of a map marked out in this way is shown here:



You are now ready to fill in the habitat form in the field.

Habitat recording should be carried out in June or July, when the growth of vegetation along your plot is well advanced.

Un-managed section of the River Ouzel, Buckinghamshire. Photo: K. Taylor.



Geographical distribution of WBS plots in 1981. The WBS achieved a record level of coverage in 1981-82, but more plots are still needed, especially in areas where the survey is poorly represented. If you would like to help, write to Kenneth Taylor (WBS) at Beech Grove.

ADJACENT LAND USE NUMBER CODES

WOODLAND AND SCRUB 01 Broad leaved plantations (even aged). **02** Broad leaved woodland (uneven aged), **03** Conifer plantation (even aged). **04** Conifer wood (uneven aged). **05** Mixed woodland. **06** Orchard. **07** Pioneer scrub. **08** Carr.

'FIELD' VEGETATION: 09 Bracken. **10** Chalk downland and similar grasslands. **11** Upland heather moor. **12** Upland grassland.

WETLANDS: 13 Bog. **14** Fen and Marsh. **15** Reed bed. **16** Water meadow.

WATER BODIES: 17 Ditch. **18** Canal. **19** Pond. **20** Pool or tarn. **21** Lake or reservoir. **22** Gravel pit.

OPEN HABITATS: 23 Exposed mud. **24** High montane. **25** Cliff and crag.

MISCELLANEOUS: 26 Farmland – arable. **27** Farmland – grazing. **28** Farmland – mixed. **29** Grass with scattered trees (parkland, golf course etc.). **30** Sewage farms or purification works. **31** Buildings and constructions – continuous. **32** Buildings and constructions – scattered. **33** Gardens, allotments. **34** Waste land.

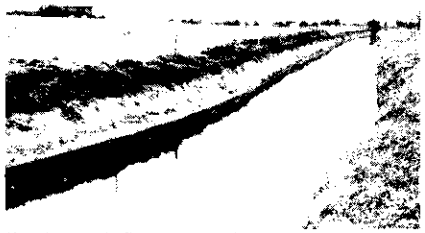
Adjacent land use code notes:

WOODLAND AND SCRUB: ' Pioneer scrub' is all scrub except young plantations and carr. 'Carr' includes fenland carrs, alder woods in water-logged situations and willow scrub in marshy places. **'FIELD VEGETATION':** 'Upland heather moor' refers to Calluna 'grouse moors'. 'Upland grassland' includes the whole range of basic and acidic upland grasslands. **WETLANDS:** 'Bog' or moss includes all wet acid peatlands — valley, raised and blanket bogs. *Sphagnum* mosses are characteristic. 'Fens and marshes' are not associated with acid peat. The vegetation of these two habitats is similar — mainly reeds and other tall grasses, rushes and sedges. **WATER BODIES:** Each category refers to open water and not to associated habitats, such as reed beds, which have separate codes. **OPEN HABITATS:** Record areas above 2,000' exhibiting 'mountain tundra' conditions with short vegetation and exposed surfaces as 'High montane'. **MISCELLANEOUS:** 'Waste land' includes despoiled areas where there is no vegetation that can be adequately described by any other code. **N.B. These number codes are not the same as those used in the BTO Sites Register.**

In the field

Equipped with the map showing numbered 500 m sections, begin to walk your waterway from your normal starting point. For section 1, habitat features should be ticked in the column numbered 1, and so on until you have covered all the sections numbered on your map. A habitat feature should be ticked if it occurs at all along a section. For example, scrub, hedge and scattered trees may all occur along one section. If so, all these features would be ticked for that section. This also applies to adjacent land use – if more than one type of land use flanks a section, enter more than one land use code number in the land use box for that section e.g. 4:32. Adjacent land use refers to land use within 100 metres of the bank only. If a habitat category does not apply to a particular section along your plot, leave the box for that category blank. Otherwise, enter all other information by a tick, except for 'adjacent land use' and 'channel type', where a number code is required, and 'vegetation overhanging channels?', where a Yes No answer is required.

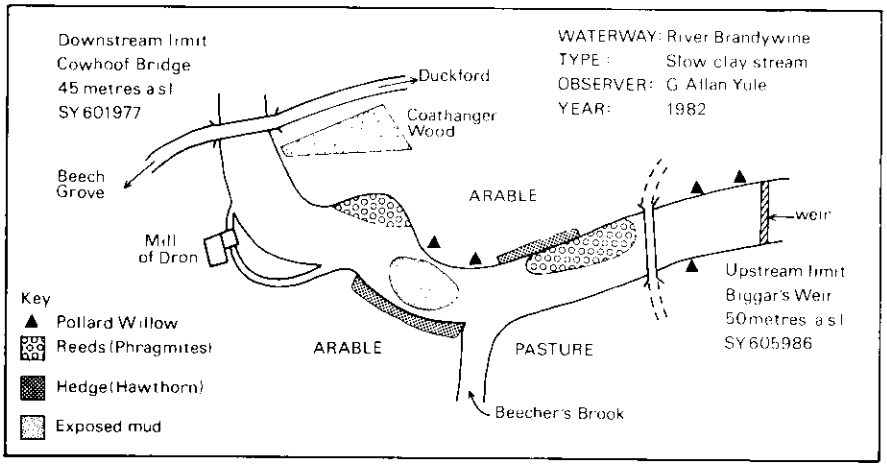
There is space at the foot of each column to enter additional information you may think useful – for example, the names of fringe vegetation species such as rushes, plantains and the like.



Section of River Ouzel downstream from photograph on page 5, after channel dredging and bank clearance by Water Authority in 1981. Photo: K. Taylor.

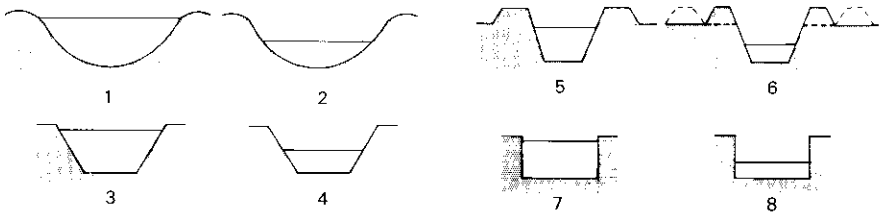
Once the habitat form has been completed, send the results to Mrs. E. Murray at Beech Grove, together with the map showing section numbers. We will return a copy of this map and file the original. Any photographs of your plot are welcome and would make a useful addition to our habitat records.

HABITAT MAP



To aid interpretation of information recorded on the habitat forms observers should also submit a simple habitat map at the end of the first season's fieldwork. A specimen habitat map is shown above. The following information should be entered on the habitat map:- **1) location, six-figure grid references and altitudes for the upstream and downstream limits of the plot 2) description of waterway type (e.g. fast-flowing rocky stream, navigated canal, deep meandering river) 3) approximate extent of vegetation such as hedge, woodland etc., along the banks and other features of ornithological importance (e.g. reedbeds, shingle banks, sand cliffs, bridges, backwaters).** *The map above illustrates how to map such features using a key to avoid clutter. Features on this map have been exaggerated. The normal WBS plot would include a longer stretch of river then the one shown here.*

CHANNEL TYPE CODES



Types 1 and 2 will apply to many upland rivers and un-managed lowland rivers.

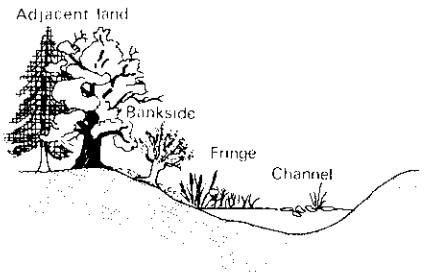
Types 3 and 4 will apply to managed rivers.

Types 5 and 6 will apply to rivers with flood banks (dotted lines indicate a varient of type **6**).

Types 7 and 8 will cover canals as well as rivers.

ADDITIONAL NOTES

1. **'Bankside vegetation'** is vegetation growing near and on the channel bank, not vegetation in the channel itself.
2. **'Vegetation overhanging the channel'** refers to bankside vegetation e.g. overhanging hawthorn bushes.
3. **'Fringe vegetation'** is vegetation growing from the bank outwards into the channel.



Drawing: Caroline Hunt.

4. **'Channel vegetation'** is vegetation growing in the channel itself, not necessarily from the bank outwards and often in mid-channel.
5. **'Rapids'** are regions with white water in fast flowing rivers or streams, often caused by boulders.
6. **'Riffles'** are ripples on the water surface caused by boulders etc., disturbing flow below the water surface. Both rapid and riffle categories refer to the 'normal' state of your waterway, *not* to spate conditions.

AFTER ANALYSIS

A WBS summary sheet listing the number of territories recorded will be sent to the observer after completion of the year's analysis batch. The original maps will be stored at Beech Grove to help future research. In special cases it may be possible for us to make copies of the species maps if the observer needs to keep the originals.

In addition to the summary sheet, WBS workers receive *WBS News*, a newsheet prepared exclusively for supporters of the survey. This gives details of recent population changes in waterways birds determined from WBS data (in advance of these details being published elsewhere) and other news of WBS progress.

If you have any queries about carrying out the survey or about habitat recording contact Kenneth Taylor or Mrs. Elizabeth Murray at The WBS, BTO, Beech Grove, Tring, Herts, HP23 5NR.

Last but not least, thanks for your help!

(1978 instructions revised 7th July 1982).

APPENDIX 5

CBC TECHNICAL REVIEW GROUP DISCUSSION PAPERS

Number	Title
TRG/1	Considerations for the review of the Common Birds Census.
TRG/2	Current CBC work and the NCC contract.
TRG/3	"Measurements of terrestrial bird populations: a view and evaluation" by D.G. Dawson and J. Verner.
TRG/4	The degree of long-term consistency and the representativeness of the CBC farmland samples.
TRG/5	Woodland and Farmland population densities.
TRG/6	How many CBC plots are required for monitoring purposes?
TRG/7	CBC - What is needed?
TRG/8	Why NCC needs the CBC and the additional uses which could be made of the data for conservation purposes.
TRG/9	Potential value of CBC products to nature conservation.
TRG/10	Annual and spatial consistency in observer effort.
TRG/11	Recording farmland habitat in the CBC.
TRG/12	Preliminary thoughts on woodland vegetation recording for the CBC.
TRG/13	Species-specific problems of cluster analysis.
TRG/14	Some statistical checks on the CBC index - 20 years on.

Information required

The information we require falls into four sections:

1. The permanent skeleton of the habitat, that is hedges, ditches, tracks and lanes, farmsteads, gardens, scrub, permanent pasture, streams and standing water.
2. Cropping.
3. Management, in autumn and winter as well as the breeding season.
4. Chemical usage.

Suggested methods of recording

1. Permanent skeleton The key habitat map will be needed still for recording this and I can see no obvious reason for altering the basic instructions here, except to separate this from crops and management. I suggest, however, that a copy map is sent to observers annually, with a standard questionnaire attached, covering the following points:

Hedges:
- have any been removed?*
- have any altered significantly in height (see note 1) or thickness?*
- are they trimmed autumn/winter or spring/summer?
- are hedge bottoms sprayed? (see note 2)
- have any remnant hedges lost further significant lengths?*

Ditches/streams:
- have any ditches been filled in?*
- are they regularly dredged?
- which hold water in summer?*
- are ditch bottoms sprayed in summer? (see note 2).

APPENDIX 6

RECORDING FARMLAND HABITAT IN THE CBC
(Originally presented as a paper to the CBC Technical Review Group)

General

1. Recording farmland habitat tends to be complicated because of the amount of management by the farmer involved. It seems worth noting, therefore, that CBC requires demanding work of the observers anyway, which over-rides objections to asking for detailed habitat observations regularly for fear of overloading them.

2. Probably few observers have much detailed knowledge of farming, so it seems better to ask them to mark off a standard questionnaire, rather than use their initiative. The latter course always results in important points being missed because their value is not appreciated.

3. Farm management continues throughout the year - how many observers look at their farm plots in the autumn or winter? Yet management at these times may be of crucial interest to us; stock management in winter, for example, may significantly alter winter survival for many species.

4. I disapprove of the existing instruction that, once a key habitat maps is drawn, only changes need be recorded. Quite true, but the observers should be asked specific questions to check each year otherwise changes can go unrecorded. The observers see them but do not notice them. This perhaps particularly applies to the slow deterioration of hedgerows that are never replanted.

Tracks and roads: are there hedges associated with these?*
are these good or remnant hedges?
are the sides of roads or tracks sprayed/mown?
when are they trimmed, autumn/winter or spring/summer?

Scrub: are there any changes in the area or location due to clearing or new planting?*
is any management carried out?*

Permanent pasture: has any been ploughed?*
has any drainage work been carried out?*
is it fertilised or sprayed?

Standing water: does it all still exist?*
which areas hold water winter and summer?*
mark any water troughs in use

Farmsteads: are the rough areas around farmsteads sprayed in summer?

* Please amend the map in accordance to the answers to these questions. A yes/no box should be provided where appropriate.

Notes: 1. I have noticed thst farmers often drastically reduce the height of hedges when they start using flail hedgers.

2. This should be very obvious as dessicants such as paraquat are likely to be used and the areas will simply brown off.

2. Cropping and management These two clearly go together. Joe Hardman suggested that cropping details should be entered on a separate map each year and I agree. However, looking at a 25" map suggests that many fields would not be large enough (even now!) to print on each a standard yes/no questionnaire, which would be ideal. So a standard questionnaire should be attached to the annual map as follows:-

Grassland:	permanent pasture/ley pasture/clover
	grazed/mown
	if mown, for silage/hay
	time and frequency of mowing
	if grazed, cattle/sheep/both/other stock
	approximate date animals turned out, if known
	approximate date animals taken out, if known
Cereals:	wheat/barley/oats/other
	autumn sown/spring sown
	is field 'tramlined', enter T on map?
	stubble burnt/unburnt
	stubble worked autumn/winter/spring
Oil-seed rape:	autumn sown/spring sown
	approximate date stubble ploughed
Other crops:	peas/beans/potatoes/sugar beet/vegetables/
	maize/kale/turnips/swedes/brassicas/fallow/
	other
	(Nearly all of these crops will be spring sown but some beans may be sown in autumn.)
	sown March/April/May/June/later
	when were crops harvested?
Stock:	is stock fed outside and when?
	grain/hay/straw
	is stock wintered outside/in buildings?

are buildings open to birds?

is stock inside grain fed/silage/hay/ straw?

Please enter relevant answers on each field/site.

These points seem to cover all the main areas which I have suggested recently to Dr. O'Connor may affect bird populations.

Notes: 1. 'Tramlines' are permanent wheel tracks left across cereal fields along which all passes of the sprayer and fertiliser distributor made in the growing season travel. Probably we should define for observers.

2. Do observers know the difference between ley and permanent pasture? I have assumed they do here and therefore left out questions about spraying and fertilisers on the reasonable assumption that they will be used automatically in leys. Pasture is covered under permanent skeleton.

3. Chemicals For a variety of reasons I fear that farmers will be increasingly unwilling to supply what they might regard as sensitive information. I am not very happy either at the idea of observers recording odd labels and other signs found, without any background. There is no real way of knowing if the chemical concerned is in regular use or was used once for an unusual problem.

While this is an important topic, I think we must consider carefully whether we need to lumber observers with the problems involved. Regular surveys of pesticide usage are carried out

by MAFF and are readily accessible. With detailed cropping information I think we can extract a great deal from comparing cropping details and MAFF survey details and CBC data. The MAFF surveys only give the overall picture but techniques are now widely standardised, which is illustrated by the surprisingly small percentage of chemicals available which are in widescale use, at least in insecticides and seed-dressings. Basic techniques are probably much more important than the variety of products used and basic chemical groups usually more significant than the variety of individual chemicals; as with products many of the latter perform the same function, variety being the result of competition for the market. Comparison of MAFF usage surveys and CBC data is likely to indicate the questions we should be asking of the farmer and these could well be asked direct from the central organisation, perhaps by a personal visit.

If this is not felt to be an acceptable approach then I suggest observers are asked to try to establish five basic points, as follows:

1. Are pre-emergent herbicides used in cereals/root or vegetable crops/both?
2. Are autumn herbicides used in cereals?
3. What seed-dressings are used?
4. Are organo-chlorines used regularly in roots/potatoes/brassicas/vegetables?
5. Are cereals sprayed regularly for leather jackets/wireworm or is slug bait used?

The problems are obvious!

4. Maps and timing I suggest that all habitat maps should be designed so that everything, year, observer's name, type of map, plan, questions, instructions and/or definitions are printed on one sheet. My memory of my own CBC plans is that plenty of gash space was available.

For timing much of the information can be accumulated during the course of the counts. But if the additional work possibly involved does put pressure on count schedules, then I believe that a visit to specifically record habitat rather than count birds should be encouraged. What use is the count without the habitat? Observers really must visit their farms at other times to look at management; I would suggest the second half of September for stubble management etc. and winter. In fact I believe that January is the best month to record much of the management detail and a visit then also allows observers to mark fields which will be worked in spring and to see what is done there.

Finally, my apologies for the length of this paper. It seems better to discard than overlook.

Appendix 7.

LIST OF SCIENTIFIC NAMES OF BIRDS APPEARING IN THE REPORT.

Grey Heron	*Ardea cinerea*
Mallard	*Anas platyrhynchos*
Sparrowhawk	*Accipiter gentilis*
Kestrel	*Falco tinnunculus*
Ruffed Grouse	*Bonasa umbellus*
Red-legged Partridge	*Alectoris rufa*
Grey Partridge	*Perdix perdix*
Pheasant	*Phasianus colchicus*
Moorhen	*Gallinula chloropus*
Lapwing	*Vanellus vanellus*
Stock Dove	*Columba oenas*
Woodpigeon	*Columba palumbus*
Collared Dove	*Streptopelia decaocto*
Turtle Dove	*Streptopelia turtur*
Cuckoo	*Cuculus canorus*
Little Owl	*Athene noctua*
Tawny Owl	*Strix aluco*
Green Woodpecker	*Picus viridis*
Great Spotted Woodpecker	*Dendrocopus major*
Skylark	*Alauda arvensis*
Swallow	*Hirundo rustica*
Tree Pipit	*Anthus trivialis*
Meadow Pipit	*Anthus pratensis*
Yellow Wagtail	*Motacilla flava*
Pied Wagtail	*Motacilla alba*

Appendix 7. cont.

Long-billed Marsh Wren	Cistothorus palustris
Wren	Troglodytes troglodytes
Dunnock	Prunella modularis
Robin	Erithacus rubecula
Redstart	Phoenicurus phoenicurus
Blackbird	Turdus merula
Song Thrush	Turdus philomelos
Mistle Thrush	Turdus viscivorus
Sedge Warbler	Acrocephalus schoenobaenus
Reed Warbler	Acrocephalus scirpaceus
Lesser Whitethroat	Sylvia curruca
Whitethroat	Sylvia communis
Garden Warbler	Sylvia borin
Blackcap	Sylvia atricapilla
Chiffchaff	Phylloscopus collybita
Willow Warbler	Phylloscopus trochilus
Goldcrest	Regulus regulus
Spotted Flycatcher	Muscicapa striata
Long-tailed Tit	Aegithalos caudatus
Marsh Tit	Parus palustris
Coal Tit	Parus ater
Blue Tit	Parus caeruleus
Great Tit	Parus major
Nuthatch	Sitta europaea
Treecreeper	Certhia familiaris
Red-backed Shrike	Lanius collurio
Jay	Garrulus glandarius
Magpie	Pica pica
Jackdaw	Corvus monedula
Rook	Corvus frugilegus

Appendix 7. cont...

Carrion Crow	Corvus corone
Starling	Sturnus vulgaris
Chaffinch	Fringilla coelebs
Greenfinch	Carduelis chloris
Goldfinch	Carduelis carduelis
Linnet	Carduelis cannabina
Redpoll	Carduelis flammea
Bullfinch	Pyrrhula pyrrhula
Ovenbird	Seiurus aurocapillus
Yellowhammer	Emberiza citrinella
Reed Bunting	Emberiza schoeniclus
Corn Bunting	Miliaria calandra

FIGURE 1

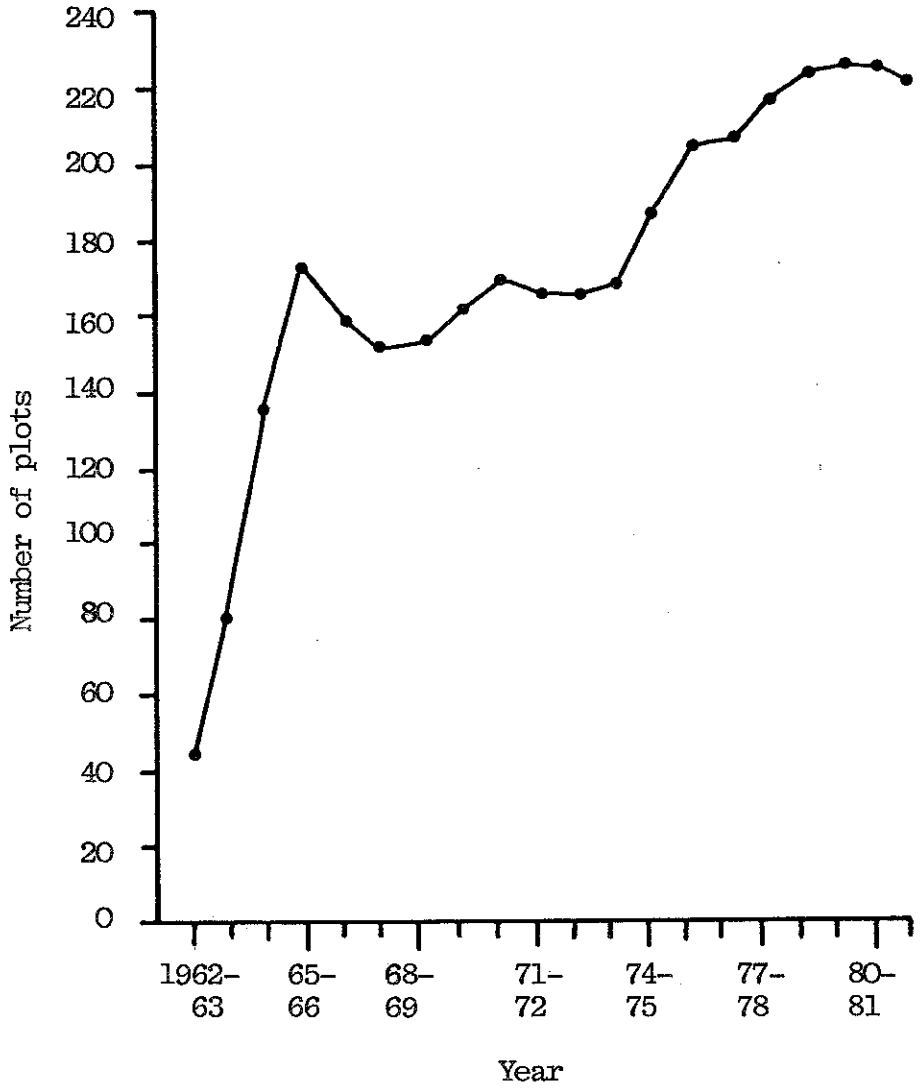


Figure 1. The number of CBC plots which have been used to calculate indices of population level. Note that the total number of plots analysed in any year was considerably larger than the totals indicated because some plots were unsuitable for index purposes. For example, of 330 plots censused in 1982 only 220 were used in the index calculations.

FIGURE 2

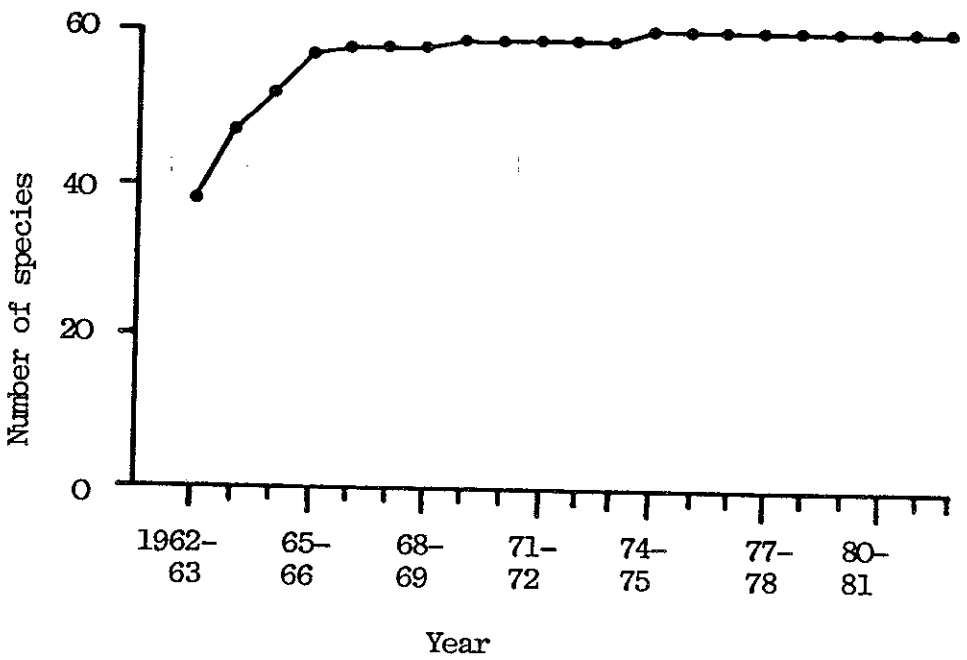


Figure 2. Number of species monitored by the CBC indices, 1962-83.

FIGURE 3

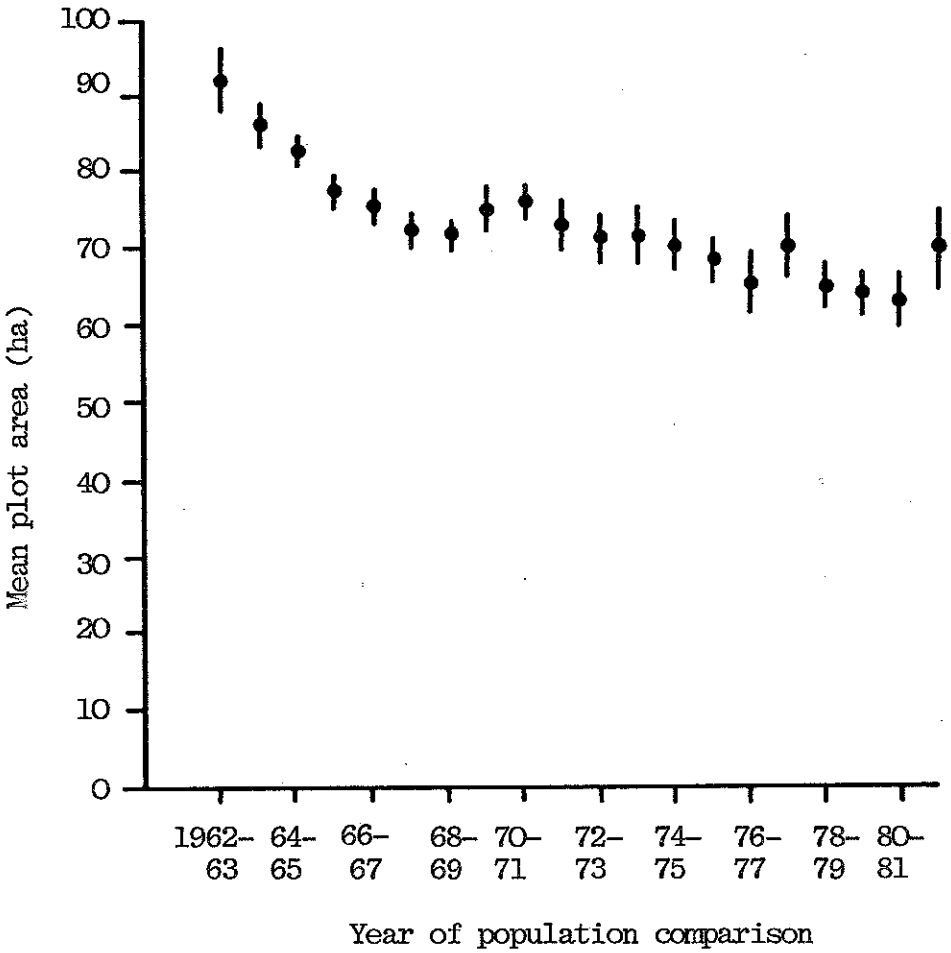


Figure 3. The mean area ($\pm$ SE) of farmland plots in the CBC

FIGURE 4

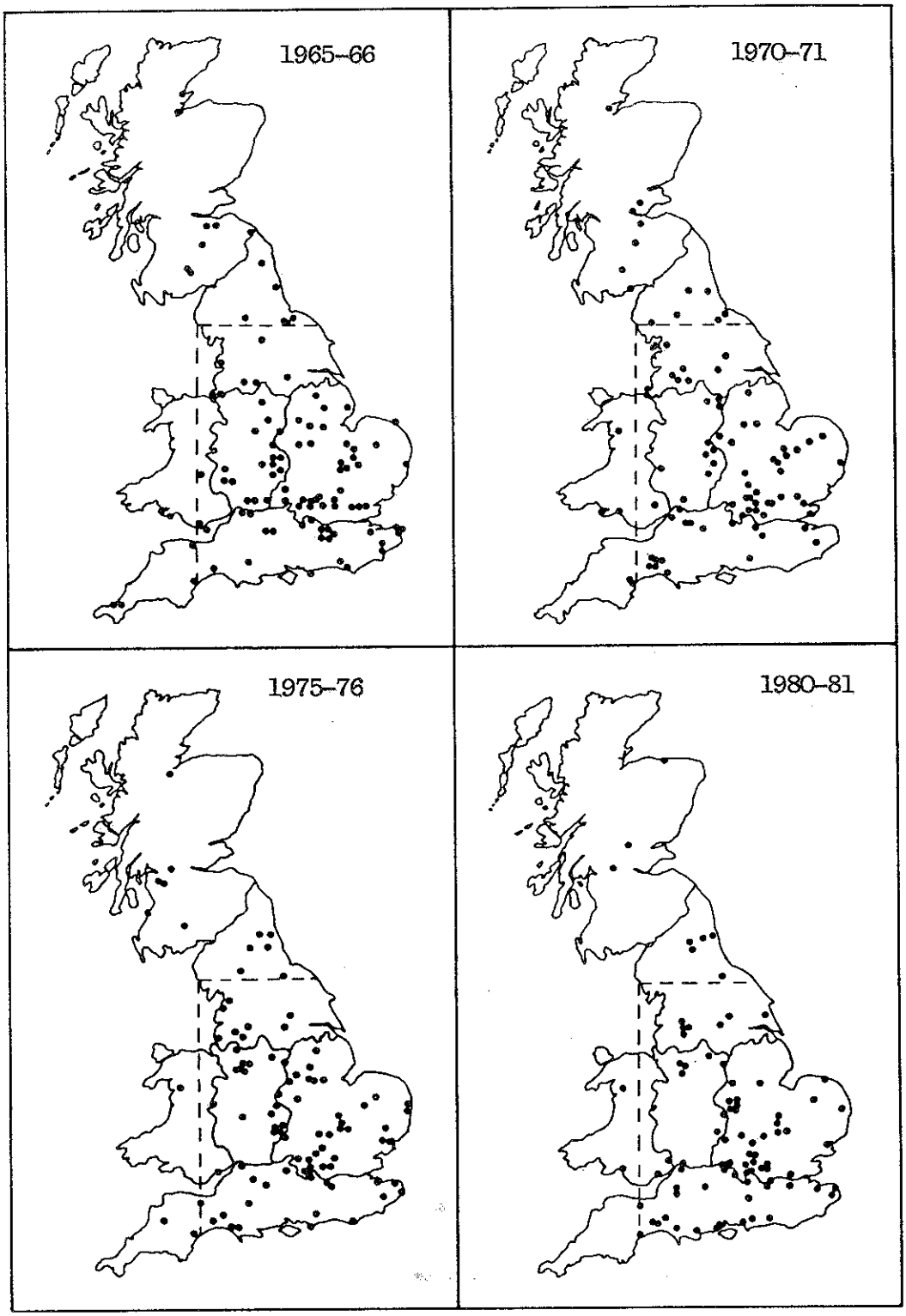


Figure 4. The distribution of CBC farmland plots used in the calculation of population indices in four pairs of years. Numbers of plots in Northern Ireland were 1965-66 zero, 1970-71 one, 1975-76 two, 1980-81 five. In 1965-66 there was one plot in the Isle of Man but none subsequently. The broken lines are the easting 3000 and the northing 5000 of the National Grid: CBC plots are broadly representative of farmland to the south and east of these lines (Fuller et al in prep.). Britain is also divided into six regions and Fuller et al have shown that the relative distribution of farmland plots between these regions has not changed significantly since the start of the CBC.

Table 1. Correlation coefficients between CBC index and densities calculated from CBC data. From Moss (1984 and other unpublished data). See text for full explanation.

Species	Habitat	(a)	(b)	(c)	(d)	N
Skylark	Farmland	0.92	0.92	0.94	0.94	19
Grey Partridge	Farmland	0.90	0.91	0.83	0.86	19
Willow Warbler	Woodland	0.71	0.68	0.75	0.65	17
Goldcrest	Woodland	0.95	0.97	0.87	0.94	15
Spotted Flycatcher	Farmland	-0.19	-0.25	-0.24	-0.33	19

Densities obtained:

a) and b) from all plots

c) and d) from occupied plots

a) and c) from number of territories in this year compared with last year

b) and d) from number of territories in this year compared with next year.

Note The Skylark, Grey Partridge and Goldcrest correlations were significant at $P < 0.001$ and Willow Warbler at $P < 0.01$. Spotted Flycatcher was not significant.

Table 2. Reasons given by CBC workers for discontinuing their census plots.

The following sample is drawn from those census plots on which census work had ceased but for which correspondence files were (wrongly) still open in August 1980. As far as is known, these plots represent a random cross-section of the CBC 1972-78, although biased towards the years 1976-78.

Total number of observers stating their reason for discontinuing:	42
Ill health/death	17 (40%)
Moving away	11 (26%)
Too busy	9 (21%)
Habitat change	3 (7%)
Personal reasons	2 (5%)

The following sites were discontinued because of habitat change:

Name	Years Censused	Habitat change
Alderman	1975	Gross pollution in brickpit pools, plus dumping of large amounts of earth (Special).
Lyon	1972-77	"so few birds now" (Farmland)
Rankin	1963-73	Housing development (Farmland)

Table 3. A list of the species for which population indices were constructed from CBC data in 1983. F = farmland index, W = woodland index, S = scarce species index.

Mallard	F	Yellow Wagtail	S	Coal Tit	W+S
Sparrowhawk	S	Pied Wagtail	F	Blue Tit	F+W
Kestrel	S	Wren	F+W	Great Tit	F+W
R-L Partridge	F	Dunnock	F+W	Nuthatch	W
Grey Partridge	F	Robin	F+W	Treecreeper	F+W
Pheasant	F+S	Redstart	S	Jay	W+S
Moorhen	F	Blackbird	F+W	Magpie	F+W
Lapwing	F	Song Thrush	F+W	Jackdaw	F
Stock Dove	S	Mistle Thrush	F+W	Carrion Crow	F+W
Collared Dove	S	Sedge Warbler	F+S	Starling	F+W
Turtle Dove	F+S	Lr.Whitethroat	F	Tree Sparrow	F
Cuckoo	F+W	Whitethroat	F+W	Chaffinch	F+W
Little Owl	S	Garden Warbler	F+W	Greenfinch	F+W
Tawny Owl	S	Blackcap	F+W	Goldfinch	F+S
Green Woodpecker	W	Chiffchaff	F+W	Linnet	F+W
Gt.Sp.Woodpecker	W	Willow Warbler	F+W	Redpoll	S
Skylark	F	Goldcrest	W+S	Bullfinch	F+W
Swallow	F	Sp. Flycatcher	F+W	Yellowhammer	F+W
Tree Pipit	S	Long-tailed Tit	F+W	Reed Bunting	F
Meadow Pipit	S	Marsh Tit	W	Corn Bunting	F