A BEST PRACTICE GUIDE

for wild bird monitoring schemes

Editors:
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First edition

EBCC European Bird Census Council every bird counts

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Voříšek P., Klvaňová A., Wotton S., Gregory R. D. (editors).
A best practice guide for wild bird monitoring schemes.
First edition, CSO/RSPB. 2008.
ISBN 978-80-903554-3-9
Printed by JAVA Třeboň, Czech Republic.
Line-drawings by Václav Bartuška and Alena Klvaňová (stonechat only).

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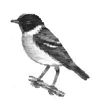

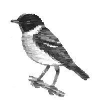

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Chapter 1

INTRODUCTION

Petr Voříšek and Richard D. Gregory

The European Bird Census Council (EBCC) is an association of like-minded expert ornithologists co-operating in a range of ways to improve bird monitoring work and thereby inform and improve the management and conservation of bird populations in Europe. It brings together ornithologists and other scientists with an interest in the study of the distribution, numbers and demography of European birds. The EBCC encourages the monitoring of bird populations through the promotion of monitoring schemes that are rigorously planned and have clear objectives. It aims to monitor birds so that changes may be detected, and if possible, understood and the relevant agencies provided with sound information to base management and policy responses. It promotes the development of 'bio-indicators' based on bird information that measure environmental change in Europe.

The EBCC actively encourages communication and collaboration between organisations, institutions and individuals interested in monitoring bird populations and their distribution, and promotes the exchange of news, ideas and expertise through its journal *Bird Census News*, and through a regular programme of conferences and workshops. It works closely with international ornithological and conservation organisations, and encourages links between ornithologists, land managers and policy makers. The EBCC is probably best known for running two major international projects, the EBCC Atlas of European Breeding birds and the ongoing Pan-European Common Bird Monitoring Scheme (PECBMS). The publication of a Best Practice Guide has been a long held ambition of the EBCC and we are delighted to be able to present the first edition here.

The PECBMS is an international initiative based on the shared goals of EBCC and BirdLife International, which aims to deliver policy relevant indicators using information on bird numbers in Europe. The PECBMS depends strongly on the cooperation of expert individuals and organisations that coordinate bird monitoring schemes in European countries. As such, the initiative depends on the smooth running and performance of each national or regional monitoring scheme. The monitoring schemes need to maintain high methodological standards in order to produce scientifically credible outputs and, importantly, they need to secure and maintain sustainable funding to operate effectively. Since most of the schemes rely on fieldwork by highly skilled volunteers, they also need to maintain and improve a network of volunteer counters. The PECBMS is very much focussed on the monitoring of common and widespread breeding birds.

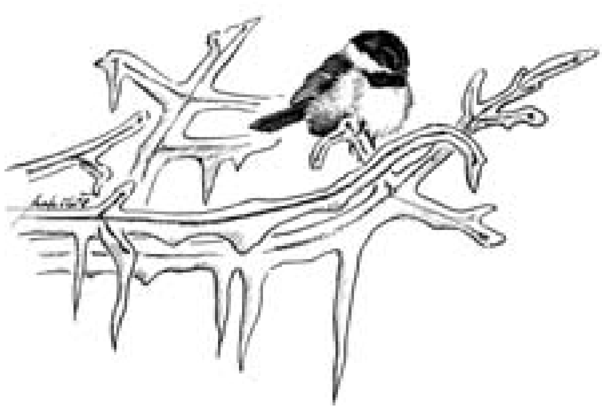
Much information on monitoring is already available. Descriptions of monitoring methods and sampling designs are available, although scattered in many different publications. Running a monitoring scheme, however, poses challenges that are not obviously covered by standard textbooks because they are very specific and diverse, depending on the particular conditions and situation in each country. Furthermore, running a bird monitoring scheme is not only about counting birds, but also involves, for example, data management and analysis, data presentation and communication, promotion of the use of monitoring data, and the scientific publication of the results. Methodological approaches to these issues can also be found in textbooks and guides, but again, information is scattered across many publications. There is, of course, a good deal of experience and knowledge in running such schemes at a national level that can be usefully shared and used by others; the Best Practice Guide is a prime example of how this information can be shared. In general, there is no single approach or method for bird monitoring that can be applied in all countries. A key is to define very clearly your objectives and follow guiding principles. Each country is a unique and specific case and uses its own modifications of methods and approaches in developing and running a scheme. It is the role of scheme coordinators to pick the methods that best fit their circumstances, conditions and needs. A common and very sensible approach is to modify existing approaches for their specific purpose because their strengths and weakness are well established and methodological and research work will have been completed. The diversity of bird monitoring designs in Europe has been apparent at many EBCC/PECBMS meetings and this is where the idea for the publication of a Best Practice Guide first emerged.

The aim of the Best Practice Guide is to improve the standard and quality of monitoring schemes through the provision of a summary of the principles of monitoring, examples from existing schemes and references where more detailed information can be found. The Best Practice Guide aims to be a source of information for immediate use as well as a source of inspiration for further development. Although the scope of this publication is mainly limited to multi- species generic surveys of common and widespread terrestrial bird species, we hope that many of the principles are of general use and that the Guide can be used more widely. The principle elements of each aspect of a monitoring scheme are summarised in the main chapters, while ideas and inspiration can be taken from a series of case studies that illustrate the different situations in some countries. Although it is not possible to cover the diversity of organisation and methods used by individual schemes here, we believe that the case studies provide a good picture of the diverse approaches used across Europe. Information on individual schemes, details of methods and scientific principles of running a scheme are given at the end of this publication. The state of common bird monitoring in Europe changes every year, new schemes emerge, on-going schemes are improved, and new data management or data analysis tools are implemented. Therefore, this publication should be viewed as a first edition, which might be updated in future depending on needs and developments in bird monitoring scheme in Europe. We would very much appreciate your views and ideas on how you would like to see the Best Practice Guide to be developed and expanded in the future.

Acknowledgements

This publication is a result of the combined effort of all the co-authors and other members of the PECBMS network who have contributed through their comments, advice or experience. In particular, we are grateful to Sylvia Barova and Ian Burfield for many useful comments and suggestions, Jana Škorpilová for her help with final proofs, and to Adrian Oates, Zoltan Waliczky, Norbert Schaffer, Lukáš Viktora, Anne Teller for their general support and help.

The publication was supported by a grant from the European Commission. Sole responsibility lies with the authors and the European Commission is not responsible for any use that may be made of the information contained in this document.



Chapter 2

WHY COUNTING IS SO IMPORTANT AND WHERE TO START

Jeremy J. D. Greenwood and David Gibbons

2.1 Why count birds?

The focus of this book is on counting birds at the national scale. This is not easy, so it is important to be clear why we might wish to do it. Only if we are clear about our objectives can we properly plan to achieve them; and only if we plan properly can we hope to design the best possible programme of work. In this context, "best" means that which achieves the objectives with the least expenditure of effort and resources.

There are many purely scientific reasons for counting animal populations, such as wanting to know what factors govern changes in numbers, how numbers may influence population genetic processes, or various macro-ecological relationships. However, the usual reasons for wanting to count national populations stem from the needs of conservation managers, organisations and agencies, and governments. Those reasons fall into two broad categories; status assessments and monitoring.

2.1.1 Status assessments

To assess the status of a species, or of a site for its bird populations, we need to determine how many birds are present at a particular time. The reasons for wanting to know this are several, but are mostly to do with the conservation of species and sites. Taking these in turn:

1. Species conservation

There are two separate reasons for undertaking status assessments for species conservation:

a) Identifying those species for which one‘s own country holds internationally significant numbers.
   Countries with a high proportion of the international population of a particular species have a moral, and sometimes legal, obligation to pay particular attention to that species' conservation.

b) Knowing the population sizes of species within one‘s country.
   The most important reason for obtaining information on population sizes is that they are used to set conservation priorities, allowing conservation effort to be focussed on those species that most need it. In general, species with smaller populations in a country are more prone to extinction, and often in more need of

conservation attention. Such information is also invaluable when publicising the parlous status of threatened species, and improves our understanding of how to manage their populations.

2. Site conservation

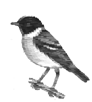
It is important to be able to determine the total number of birds at a site, as well as the populations of individual species that are present. This is because sites that hold either large congregations of birds (for example >20,000 waterbirds), or an important proportion (often taken as >1%) of a species' international population, can be designated for special protection under national and international legislation. Very small populations of particularly threatened species can also trigger site designations. Once a site is designated, it – theoretically – receives legal protection against damaging activities, helping improve the fortunes of the species present.

For the purposes of species conservation, one frequently needs absolute population estimates, as conservation priorities at national, international and global levels, are commonly based on threshold population sizes (for example, are there fewer than X pairs in the country?). For site conservation purposes, relative measures can also be used: if one knows that locality X has 50% of the national population of a threatened species it may be enough to identify it as a priority site – one does not necessarily need to know that it holds exactly 27 breeding pairs and 4 unmated males. Such relative measures, from which population 'indices' can be calculated, are generally easier to obtain than are absolute counts, but they have to be used with care (see Chapter 3).

2.1.2 Monitoring

By undertaking repeated surveys or counts, one can build up a picture of the population trend of individual species on sites or across entire countries. This process is known as 'surveillance', and is part of a larger programme of work known as 'monitoring'. Monitoring is a process for adaptively managing populations, sites or habitats, i.e. changing the way they are managed in the light of increasing knowledge (Greenwood and Robinson 2006b). The monitoring process has four key elements:

1. Setting targets: for example, what population size, site status or habitat state does one wish to achieve?
2. Surveillance: observing how the size of the population (or other elements) varies over time, and determining whether the target is being met or not.
3. If the target has not been met, understanding why: this can either be done by analysing the surveillance data, often in combination with other information, or by undertaking additional research.
4. Action: making changes to management based on this knowledge to ensure that the target is met.



Note that surveillance must be continued whether or not the target has been met, in order to determine whether the management changes have been successful, and to ensure that targets continue to be met even if the environment changes.

Surveillance and monitoring of bird populations, are, once again, principally used to aid species and site conservation. Population trend data are central to setting species conservation priorities; all other things being equal, a species whose population is declining will be of a higher conservation priority than one that is not. Bird population trend data are also used to produce indicators of environmental health (Gregory *et al.* 2005, www.ebcc.info/pecbm.html). Experience shows that habitats in which bird numbers and diversity are declining tend also to be losing other species as well (e.g. Robinson and Sutherland 2002 - reptiles, amphibians, plants, invertebrates, van Strien *et al.* 2004 – butterflies). Given that bird population monitoring, especially at the national level, is easier than for most other species, it is perhaps not surprising that so much importance is now attached to monitoring bird populations.

Monitoring has a range of further purposes. Well-designed monitoring schemes can be research tools in their own right, providing that suitable environmental data are collected or are available. Analyses comparing temporal or spatial changes in bird numbers with changes in environmental variables, such as habitat and food supply, can provide early pointers towards the underlying causes of changes in bird populations. Monitoring also plays an important role in measuring the success of conservation actions, such as species recovery programmes or the adoption of new management practices (see Chapter 5).

2.2 What information should be gathered?

2.2.1 Detailed planning and resources

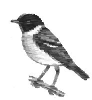
Having clarified why you want to count birds, either once (status assessment) or repeatedly (surveillance), you need to think about exactly what information should be gathered. This requires careful thought. First, ask what would be the best information to gather; second, what methods are available for gathering that information; third, what resources are available. This is not a simple linear process. Having thought about the methods, you may realise that there is no way of obtaining the information that you had decided you needed, so you have to revise your plans and identify what is the best information that you can gather, given the methods available. Even more significantly, having thought about the resources, you may realise that you are unable to apply the best methods, simply because you have insufficient resources.

There are three ways of responding to the reality of insufficient resources. The first is to increase them. If the limit is financial support for, for example, paying professionals, you may be able to persuade funders to provide more, or you may be able to find alternative sources of funds. If the limit is the number of volunteers prepared to assist with the work, you may be able to persuade more people to volunteer. The second response is to choose alternative methods requiring less resource, and to accept less perfect information than you had originally identified as necessary. The third response is to give up the whole endeavour. For example, in a mountainous country of steep slopes, and with fierce rivers and wide lakes dividing the landscape, it may be quite impossible to adopt a strictly random – and resource hungry - distribution of sample sites (even with stratification) (see Chapter 3.2.6 and 3.2.7). However, we strongly suggest that this should not lead you to abandon the enterprise. Rather, you should consider what sort of distribution of samples is achievable given the resource, and whether this will provide information that, even if not perfect, will help to identify environmental problems and their solution. The deep impacts of the EU's Common Agricultural Policy on wildlife in the 1980s and 90s were, after all, largely detected by national census schemes that were not based on perfect statistical designs; and these same schemes provided many of the insights into the exact reasons why many farmland birds were declining. Only narrow-minded pedants insist that if one cannot do the perfect thing, then one should do nothing. Science would never have advanced if they had been in charge.

2.2.2 Information to be gathered

For some purposes, it may be obvious which species are to be counted. For others, it may not be and requires careful thought. For example, if the objective is to monitor the condition of a habitat, it is not wise to concentrate on iconic, rare species because these have special requirements that may not be typical of the birds of that habitat (that is why they are rare!). In addition, they may be subject to special management that helps them, but which may not be helpful to the more ordinary birds of that habitat. The species to concentrate on are the common species typical of that habitat; fortunately, these are also generally easier to survey because sample sizes are larger.

One must also consider what section of the population is to be surveyed. Breeding birds may be relatively easy to count, immatures and other non-breeders relatively difficult. While it is probably better to concentrate resources on getting a good count of breeders than to devote a lot of effort to trying to include non-breeders, if you do so you will inevitably remain ignorant of the non-breeding part of the population. The time of year is also important. Some issues are fundamental: if your country is mainly important for waterbirds in the winter, then that is when you should count them. Others are technical: are the dates that you are setting for the counting of breeding birds so early that you miss



some of the summer visitors in late years, confounding variations in the time of arrival with genuine population changes?

Whether you should aim to count absolute numbers or just get an index of the population is another key decision, and is covered in Chapter 3.

The area to be covered also needs thought. Is it better to cover 70% of the country properly and to ignore the other 30% or to cover the whole country less than perfectly? The answer will depend on the objectives, the available resources and the exact circumstances.

A final important question is what ancillary information to gather. This is important because, as outlined above, such information may help to explain changes in bird numbers. Nowadays, huge amounts of environmental information, much of it gathered by Earth Observation (remote sensing from satellites), is available on national or international databases. Nonetheless, details such as the presence of small patches of bushes in open habitats, or clearings in woodlands, small ponds and ditches will often be worth gathering in the field. This sort of information is not well-recorded on the databases, yet they are often important for birds, and may be extensively removed (or, sometimes, replaced) without any record being made other than in the notebooks of birdwatchers.

2.2.3 What methods to use?

Field methods and survey design are considered in Chapter 3. Thinking about the former is easy for experienced field ornithologists. Perhaps it is too easy: one needs to think carefully about exactly what information is being delivered by each method – and perhaps even more about what information is not. The design of surveys is a matter to which much attention has been paid by many people over the years, and it is important to understand the general principles that have been arrived at if one is to achieve the design that will best deliver the required objectives.

One also needs to consider how the data are to be managed. How will they be gathered? How will they be checked (validated)? How will they be stored? How will they be archived? The last is particularly important. Data should be archived in a way that guarantees that they will be available indefinitely into the future, which means multiple copies in multiple locations, and with the archives being accompanied by the relevant 'metadata', describing exactly how they were obtained (see Chapter 4). In addition, knowing what statistical analyses will be used is essential while planning the programme, otherwise you may find that you have gathered data that cannot be analysed in a way that will provide the information you need (see Chapter 4).

Finally, it is sensible to think about how you will communicate the results. To whom do you wish to communicate them – fellow scientists, the fieldworkers involved in the project, conservation NGOs, government officials, the general public? The answer to this question will influence what methods of communication you will use, and needs to be considered at the planning stage, for it may influence how you manage the data and even exactly what data you gather (see Chapter 5).

2.2.4 Consultation

There is a wealth of experience to draw on when planning bird census and surveillance work. We have tried to collect as much of this as possible in this book, but do not hesitate to contact countries that have experience of doing such work, especially those that are culturally or ecologically similar to you own. Most people are happy to share their experiences about what has worked well, and even what has not worked well (which may be even more important!). Of course, things that work well in one country may not work in another, so you need to think carefully about such advice. In particular, we suggest that it is important not to reject a method that works well elsewhere, simply because you feel that it will not work for you. Be open-minded and ask yourself whether your country really is so different from the one providing the advice.

It is also important to consult widely within one's own country. Funders and users of the data are obvious people to draw in; there is no point in producing information that is not exactly what they need. Furthermore, you may need to convince them that what they need is not what they have actually asked for. This is always easier to do at the planning stage than when you produce what they consider to be the wrong information. Other professional ornithologists will be able to provide technical advice. So will experienced fieldworkers, professional or amateur: it is no use planning to employ a field method or survey design that does not work well in the particular circumstances faced by the fieldworkers. Consulting them will also enable you to take the human factor into account: one method may be better than another in principle, but if the fieldworkers do not like it, then they may refuse to participate or fail to stick to your field protocols. People who have organised other surveys in your country (not necessarily of birds) will be able to give advice on both technical and human issues. Finally, it is essential to consult statisticians, too, preferably ones who are also birdwatchers and who will thus know what you are talking about, not just the general principles.

2.2.5 Pilot work

Pilot work is always to be recommended before you introduce a new monitoring scheme. This could take two different forms; pilot years of a full scheme, and pilots to test field methods.

If you have little experience of running large-scale monitoring programmes, you may find it useful to work out the best possible methods that seem to be relevant to your objectives and launch a scheme, treating the first year or two as a pilot.

That is to say, you analyse the results to determine whether they provide the sort of information that is needed; and you get feedback from those involved – organisers, analysts and, above all, the fieldworkers. Taking this information into account, you must then decide whether to stick with the same methods, in which case your pilot year(s) become part of the long-term data set, or to modify them, in which case your pilot year(s) have to be set aside. There is a temptation at this stage to modify the methods just slightly, on the grounds that this will improve them, but still allow the pilot year(s) to be included in the long-term dataset. This is not sensible: if the changes result in significant improvements, then the data from the pilot year(s) will not be comparable with later data. It is better to make all the changes necessary to improve the scheme and set the data from the pilot year(s) aside (see Chapter 3.2.6).

Even if you do have experience of running large-scale monitoring programmes (perhaps especially if you have such experience), specific questions may arise at the planning stage about field methods and sampling design. For example, is it better to use point-transects or line-transects for your work, and is it better to survey many small areas or fewer larger ones? Such questions can be answered by running pilot projects specifically designed for the purpose. This will delay the start of the main scheme but it will probably be worth it in order to work out the best possible method for the long term.

2.2.6 Avoid planning paralysis

Planning is a time-consuming process – though less time-consuming if carefully thought about before you start. This means that you need to allow enough time for it. Even more importantly, do not become so tied up with planning that you suffer from 'planning paralysis' – never getting round to doing something because you are thinking so much about the best approach. Especially with surveillance programmes, the best time to start is now. In fact, the best time to start usually turns out to be 10, 50 or 200 years ago: if we had the data for all those earlier years, we would be able to illuminate current problems so much better than is possible without them. But, unlike palynologists and dendrochronologists, we cannot step back into the past. That is why we should begin surveillance schemes as soon as possible – tomorrow is too late (though better than not starting at all).

2.3 Resources: fieldworkers and infrastructure

The financial resources needed for a project vary greatly, depending on the project itself, and the country in which it is taking place. Perhaps the only general advice to be given is that when estimating the funding required one should make sure that all costs are included – organization, fieldwork, data processing, management and archiving, curation, analysis, communication and publicity.

The other key resources are the fieldworkers and the organizational infrastructure. These are considered in detail by Greenwood (2007), but we summarize the key points here.

2.3.1 Fieldworkers

Large-scale schemes require large numbers of fieldworkers, more than can usually be found among the ranks of professional ornithologists; so, amateurs have to be recruited.

The recruitment process demands skills as great as any involved in operating large-scale programmes. It is not just a matter of getting many people to volunteer: one has to ensure that they are competent, that they actually do the survey work they have agreed to, that they stick to the agreed protocols, that they submit the data in the agreed form and on time, and that they continue to do the work in future years.

Some ill-informed people think that amateurs cannot be as competent as professionals. In fact, there is great variation in competence within both amateur and professional communities, so there is broad overlap. Assessing competence must be done on an individual basis. Volunteers should not be excluded because they do not belong to some particular society, or do not have any paper qualifications. On the other hand, they should not be included just because they are friends of a well-known ornithologist, nor simply because they do have paper qualifications. The competence of new volunteers is often best attested by people who have been in the field with them, so long as those people are known to be competent themselves. Frequently, people will exclude themselves after the necessary level of field skills is explained to them, or they have been asked "Are you capable of doing X and identifying Y?".

If someone is not competent to do a particular survey, he or she should not just be turned away but should be directed towards a simpler piece of work or training. The latter, whether it is formal training or just through accompanying an experienced fieldworker on a few surveys, is always helpful in raising standards. Such training could be, for example, in general identification skills (especially using calls and songs) or in particular survey techniques, and will serve to raise the confidence of those who may have mistakenly thought that a particular survey was too difficult for them (see Chapter 3.2.5).

Clear instructions make it more likely that fieldworkers will both take part and stick to the proper methods. Because it is increasingly possible to produce maps of particular areas by accessing national cartographic databases on the web, it is easier to provide surveyors with maps of their individual areas; this both helps to encourage them and reduces the chances of them going to the wrong place.

Maintaining peoples' enthusiasm for long-term projects depends, above all, on prompt and continued feedback about the results and how they are being used. It is also important to make the submission of data as easy as possible.

Should amateur fieldworkers be paid or not? Some countries manage large programmes of amateur-based surveys without even paying the volunteers' travel expenses. There is no evidence that not being paid (or even having to pay to take part in a survey, in order to help defray running costs) seriously weakens peoples' commitment to the work. Given that any money that is not used to pay volunteers can be used for better organisation, analysis or communication, it is therefore usually better not to pay them.

When starting a new programme it may be tempting to offer payment in order to boost the number of participants. What needs to be borne in mind, however, is that it will then be difficult to stop paying in future, which makes the work particularly vulnerable to the withdrawal of funding. Furthermore, it sets a precedent: people start to expect payment for any similar work. An alternative might be to allow fieldworkers the chance of winning a prize as an incentive, for example an identification guide, a distribution atlas, or pair of binoculars.

2.3.2 Organisational infrastructure

In some countries, there is no pre-existing organisation conducting bird censuses or similar work. One is thus free to establish whatever institutional arrangements are appropriate within the culture of one's country, and within any constraints imposed by those funding the work. There are broadly three sorts of institution conducting ornithological census work; universities, government bodies and independent research institutes.

A university base has the advantage that the university (often unwittingly!) may provide considerable support free of charge or at low rates – staff time, computing facilities, postage, etc. Students may be keen to help with some of the organisational work. But a university base is vulnerable should the key member of staff retire or move to another institution, since the work usually depends on the interests of individuals rather than on some strategic commitment by the university.

Government institutions can provide a secure base for running surveillance programmes – until the government decides to cut funding, perhaps on no more than a political whim. In some countries, they may also come under pressure to present the results in an unduly favourable light, rather than an entirely objective one, and this is ultimately in nobody's best interests. Furthermore, volunteers may not be prepared to provide information, even about wildlife, to government agencies – especially if they are not paid.

Independent institutes may be even more vulnerable to changes in government funding, as contracts come up for renewal at intervals. However, if an institute has been careful to keep a high profile and a positive image within the general population, especially among conservationists, public reaction to cuts in funding may persuade the government to change its mind. Furthermore, independent institutes are free to raise money from any source they please, thus making them less vulnerable to reductions in any one source. The governance structure of the institute may also be important to some volunteers. If it is governed by a Board elected by fieldworkers, this deepens the commitment of at least some of the latter: they can feel that they have a say in the policies of the organization, in the work that it does and in the way in which the results are used. They may even provide significant financial support if asked.

2.4 The long term

Monitoring programmes in principle run forever. This does not, however, mean that they should use the same methods forever. The methods should be regularly reviewed, to ensure that they remain appropriate and that developments in thinking, technology or resources have not caused them to become out-of-date. Some changes may simply make things easier, such as being able to submit data online rather than on paper, or being able to supply fieldworkers with maps. These changes can be introduced without raising concerns about their effects on the comparability of future with past data, though the change should always be recorded for the benefit of future interpreters of the data. Other changes happen without any intervention from the organisers, such as improvements in binoculars, the use of range-finders to estimate distance, or the introduction of new field guides. These changes may influence the results, but there is little that the organisers can do about it.

Sometimes, however, it may be considered sensible to introduce significant changes deliberately, such as a change in survey design or field methods. This should only be done with the greatest of care, so that continuity of results is maintained despite a change in methods. The best way to do this is to have a period of overlap, when a scheme based on the new methods is run alongside a scheme based on the old methods. Towards the end of the planned overlap, the data need to be analysed to determine whether the two schemes are telling essentially the same story. If they are, it is a simple matter to link the two data sets statistically, so that the long-term continuity is unbroken when the old scheme is terminated. If the two schemes turn out to tell different stories, deep thought is needed. Is it better to continue with the old scheme, to maintain long-term continuity, or to move to the improved scheme to provide better information in future? There is no general answer to this question.

The most likely breaks in continuity are due to the withdrawal of funding. If you or others can persuade your government to sign up to agreements that require it to produce regular reports on its bird populations, it will then come under

pressure to provide at least some funding. Unfortunately, governments can sometimes get away with providing data that are so crude as to be useless or even misleading. Thus, it is useful to find multiple sources of funding. If several 'partners' fund a programme, it is difficult in public-relations terms for one of them to drop out. Furthermore, if one does, then the work can still go on, even if at a reduced scale. If funding totally disappears, do not allow the scheme to stop. At the very least, people must be found to organise the work in their spare time and some of the fieldwork must be undertaken. It does not matter so much if the data are not analysed for a few years: provided they have been gathered, they can be analysed in future. It does not matter if the quantity of field data is reduced: any data are better than no data at all. The key requirement is that there should be some continuity, so that long-term data analyses remain possible.

Chapter 3

COUNTING COMMON BIRDS

Richard D. Gregory and Jeremy J. D. Greenwood

3.1 General principles of good survey design

3.1.1 Introduction

We saw in the previous chapter why counting birds is so important and how careful planning is the key to success. In this chapter, we first look at the general principles and considerations around good survey design, then at how these principles have been applied in a series of European case studies. Our focus in this guide is multi-species surveys of commoner land birds across whole landscapes, but here we also consider wider design questions relating to single or small groups of species, or special habitats, as they help to clarify key design principles.

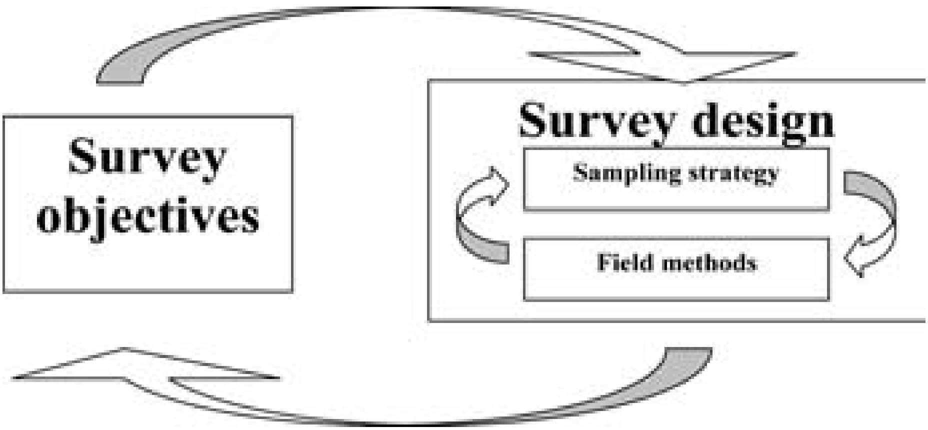
Whatever the exact survey aims, scope or locality there are seven guiding principles:

1) Keep it simple.
2) Aim high (but not too high!).
3) Listen and communicate with your key ornithologists (counters, regional organisers, advisors, other experts).
4) Listen to the people who might be using the information.
5) It's an ongoing process – plan to continue monitoring work indefinitely and have contingencies in place to maintain the data-gathering even if funding is cut.
6) Design a survey that can be expanded in size or scope if more resources become available.
7) Archive the data effectively.

Before rushing in to undertake a survey or set up a monitoring programme, you first need to clarify your objectives and review your resources, as described above. This is a key stage in planning and any uncertainty at this point might limit the usefulness of the results and waste valuable time and money. It is not just that the objectives should determine the survey design, but that the practical limits on what can be done (which should be clear when the design is being planned) may cause you to modify the objectives (Fig 3.1). It is better to have less ambitious but achievable objectives than to stick with over-ambitious objectives that one fails to achieve.

The temptation is to be overly ambitious at this point and try to collect more information than is strictly required, sometimes to the point where this compromises the overall quality of the survey. A useful technique here is to list your

Figure 3.1. Feedback loops operating in survey design between the survey objectives, sampling strategy and field methods.



main goals, the data required to fulfil them, and the approximate time required to collect these data; then revisit and prioritise your aims once again. It is tempting to ask a whole range of interesting scientific questions but the absolute priority is to be confident that you will be able to answer the key ones and, if possible, anticipate emerging ones. This section outlines how to go about planning a rigorous survey.

Some the key considerations for common bird monitoring are:

- where will we undertake the survey? Should we cover the whole area of interest, or only sample part of it?
- if we plan to sample, how should we select the study sites?
- what geographical sampling units will we use? Mapped grid squares, forest blocks, or other parcels of land?
- what field method will we use? Line or point transects, territory/spot mapping, or some combination of methods?
- what are the recording units for the birds? Individuals, singing males, breeding pairs, nests, territories etc?
- do we want to estimate population size accurately, or more likely, will a population index meet our needs? In other words, are we mostly interested in relative or absolute abundance?
- what traditions and experiences of bird monitoring already exist, both within country and how can they be used effectively?
- can the experience of other countries be useful in designing the programme of work?

- how will the subsequent data analysis be carried out? What kind of expertise and software will be needed for this task? A key product will be national population indices for individual species and multi-species indices (=indicators); are we clear as to how these will be derived from the data that we obtain?
- if a new national scheme is to be introduced, then has contact has been made with the EBCC's Pan-European Common Bird Monitoring Scheme?
- how will the national/sub-national results be reported and used? Who will be the key targets for different reporting e.g. the volunteer counters, statutory conservation agencies, policy and decision makers in government, politicians, and the general public?

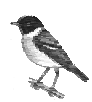
A useful way of planning a survey is to visualise some of the finished products, even down to the details of what summaries of data you wish to include in your reports. This will help to clarify the various stages that you need to go through to collect, analyse and present these data.

3.1.2 What population is being studied?

The first step in planning is to be clear as to what population you are studying. That is, the geographical area to be covered and the sort of birds to be included. The former may be an administrative unit, such as a whole country, a province or a nature reserve; it may be a geographical entity, such as an island; it may be an ecological unit, such as a lake; or it may be a set of such units, such as all the lakes in a country or all the islands in a region. In this chapter, we refer to the geographical area to be covered as the *study area*.

Defining study areas may seem easy but care is always needed. For example, you may wish to estimate the population of a species in an entire country and you may conduct surveys that lead you to think that you have done so. But if there were areas that you could not survey, such as military training areas, then you have not estimated the entire population but only the population living outside such inaccessible places.

Defining the birds to be included is easy enough at the species level (unless you are dealing with species that are difficult to distinguish) but within the species it is more difficult. Do you wish to estimate the whole population (or its trends) or just those of the breeding birds? And, if the latter, how do you define 'breeding'-holding territory, laying eggs, producing independent young, etc., etc.? It is often difficult to count a whole population: birds that do not hold territory may be too secretive, for example. In such circumstances, ornithologists commonly opt for counting those elements of the population that are easy, such as the territory-holders. If one is interested in knowing the total number of individuals of the species, this means that one must know the likely relationship between the number of territorial birds and the total population. Even if one is merely interested in trends, it is not safe to assume that a 23% increase in the number of



territories over 10 years means that there has been a 23% increase in the total population. That will only be true if the proportion of non-territorial birds has remained constant. If one does not know this (and one rarely does), then one has to admit that all one knows for sure is how the number of territories has changed and that one's knowledge of the birds not holding territories is limited.

3.1.3 Population size or index?

For some purposes, we need to have a reliable estimate of the total size of a population. This is more difficult than it may seem. Even if we are counting birds on a lake from a good vantage point, some of the birds that are there may be hidden behind others or in fringing vegetation. In technical terms, *detectability* is not perfect. Some fieldwork methods (Chapter 3.3) are designed to measure detectability, so that one‘s counts can be corrected but these all depend on whether the assumptions underlying the methods are correct. It is always important to think carefully about any assumptions that one makes when making population estimates, whether they are simple assumptions such as “I could see all the birds that were present” or the less obvious assumptions underlying the measurement of detectability.

Fortunately, we may only need to know about proportional changes in the population – that is, so many percent increase or decrease per year. Such changes are rather easier to measure than are absolute numbers. For example, rather than trying to count every bird nesting in an area, we may make counts of the numbers seen or heard during highly standardized survey walks. If the number of birds observed declines over a period of years, we may infer that the population of birds in the survey area has similarly changed. The number of birds detected during the standard surveys is thus used as an *index* of the population, its changes reflecting the changes of the whole population.

Various such indices are in use, contributing greatly to the monitoring of bird populations. However, they have a fundamental weakness: they all rest on the assumption of a constant relationship between the index and the population. If the detectability of birds changes over the years, perhaps because song frequency changes as populations increase or because habitat changes make birds more difficult to see, then this assumption is wrong and the index is unreliable. For this reason, some people advocate that we should only use fieldwork methods that allow detectability to be estimated (we cover such methods in Chapter 3.3). Others argue that the magnitude of population changes in which we are interested in terms of conservation science are commonly of the order of a few percent a year, substantially larger than are the likely changes in detectability, making the latter largely irrelevant. We agree with the latter view, though accept that it is better to use methods that allow for changes in detectability wherever possible.

3.1.4 Census or sample?

If a species occurs in relatively few places, and particularly if the birds or their nests are conspicuous and if they use traditional breeding sites (so that knowledge of these can be built up over the years), it may be possible to count every individual in the population by surveying its entire range. Such complete *censuses* are not easy. They require strong organization, to ensure that all potential sites for the species have been included in the survey. Many censuses are marred because it is not clear whether areas from which no birds have been reported have been surveyed or not; if they have not been surveyed, one cannot assume that they hold no birds, unless the habitat is known to be definitely unsuitable.

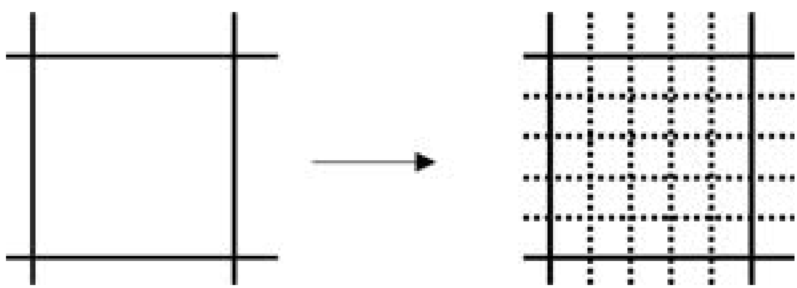
For most species, it is impossible to arrange full coverage of the entire study area, especially if the latter is an entire country. The solution is to count the birds in representative *sample* areas, extrapolating from them to the whole country. For example, if the study area is 5327km^2 in extent and a total of 76km^2 has been surveyed and found to contain 142 birds, the best estimate of the total population in the study area is 142 x 5327/76 = 9953 birds – providing the samples are truly representative of the study area as a whole (Fig. 3.2).

Note that it is possible to mix censuses and samples. One may census those parts of the study area that are easiest to survey or hold the greatest numbers of birds and then just sample the rest of the study area.

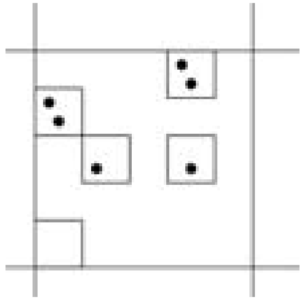
3.1.5 Reliability: accuracy and precision

The reliability of a sample-based estimate of numbers (or of change in numbers over time) is a matter of both *accuracy* and *precision*. Accurate estimates are ones that are not consistently too low or two high; that is they are not *biased*. An obvious source of bias is under- or over-counting during fieldwork, so it is important to use well-tried methods that are appropriate to the species and habitats being studied. Useful methods are considered in Chapter 3.3. Bias will

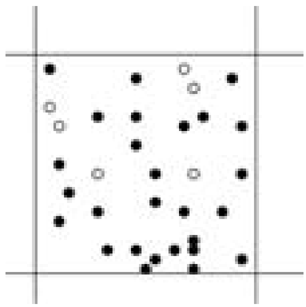
Figure 3.2. *Choosing the right sampling units to count from a grid.*
(a) *First, break the whole area down into bits that can be counted - these are sampling units. In this example, we have the resources to count five of the 25 sampling units.*



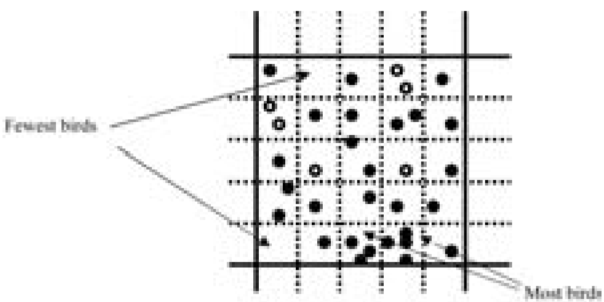
***(b)** Next select your squares randomly (see text), count the birds (filled symbols) in these specially selected sampling units (and no others), and estimate the population. The estimate = number of birds counted divided by number of squares counted (= average density of birds per square) multiplied by total squares e.g. Population estimate = 6/5 x 25 = 30, Or, more correctly, add your census count to an estimate of the number of birds in the remaining un-surveyed squares = 6 + (6/5 x 20) = 30. This extrapolates data from areas where we count (our sample) to those we do not count.*



***(c)** Random selection of sampling units always provides a good estimate of the true population. In this hypothetical example, our estimate was 30 and the 'real' population was 33. Here, open circles represent birds that were counted and filled circles those that were not.*



***(d)** It may seem odd that our random sample has missed both the 'best' areas for birds, i.e. with most birds in them, and actually counted one of only two squares without any birds at all, but this does not matter. As we have seen above, the information we collect from our random sample allows us to estimate the population accurately. Had we based our counts on the best areas, our overall estimate would be a hopeless over-estimate.*



also arise if the samples are not truly representative of the whole study area: for example, if remote regions, steep mountains, or urban areas are underrepresented in the sample compared with the whole study area.

It is never possible to know for sure that one's estimates are unbiased. All one can do is to adopt practices that are likely to minimise the bias. Strategies to ensure that samples are truly representative, and thus unbiased, are presented in Chapter 3.2.

Even if an estimate is unbiased it may not be close to the true population size (or trend); that is, it may not be precise. Poor fieldwork may produce counts that, even though they are not consistently biased, are sometimes much too high and sometimes much too low. Even if the fieldwork is perfect, population densities and trends always vary from place to place, so getting a precise estimate for the study area as a whole depends on taking enough samples to 'average out' these variations. How many is 'enough' is considered below.

Box 3.1 Measuring precision of an estimate

Suppose that one were to repeat a survey many times simultaneously, taking an independent set of samples each time (but always taking the same number of samples and sticking to the same methods). One would then get a set of many estimates of the size of the population. For example, if the true size of a population were 1030, ten estimates might be: 793, 846, 902, 950, 967, 1011, 1089, 1154, 1232, 1364

These vary considerably from each other and none is particularly close to the true value. These estimates are not precise.

But suppose that the 10 estimates were: 1007, 1012, 1018, 1023, 1024, 1029, 1037, 1043, 1051, 1064

These are similar and all are within a few percent of the true value. They are precise estimates.

The variation between the estimates in such sets can be measured, so that a numerical value can be used instead of 'not precise' or 'precise'. In real life, of course, we do not know the true population size nor do we conduct simultaneous repeat surveys. Fortunately, the likely variation between the estimates from repeat surveys (were we to conduct them) can be estimated from just one survey, from what we do know: the variation between the counts obtained in the samples within that survey and the number of samples. This measure is the standard error.

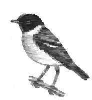
From the standard error, we can calculate confidence limits, which many find easier to interpret. If one reads that a population estimate is "5943 with 95% confidence limits of 5491 and 6395", this means: (1) that one's best estimate (from the data one has gathered) is 5943 and (2) that, if the true population really were 5943 and one was to repeat the sampling many times (as above) then in 95% of the repeats one's estimate would lie between 5491 and 6395. (It does not mean that the chances are 95% that the true population size lies between 5491 and 6395 – though interpreting it in this way will not usually lead you far astray).

Methods for calculating standard errors and confidence limits for most of the sampling designs in this chapter are provided in Greenwood & Robinson (2006a).

Most of the standard methods of calculating confidence limits assume that the counts made in one's samples follow an approximately Normal distribution. This is frequently not the case and it is generally good practice to use a more robust method, such as bootstrapping, to estimate the confidence limits (Box 3.2).

Box 3.2 Bootstrapping confidence limits

Bootstrapping assumes that the distribution of counts observed in the samples is the same as in the whole set of units from which the sample was drawn (as does any valid statistical analysis of the data). If that assumption is correct, then one can take the distribution of counts and randomly sample from it, not in real



life but in one's computer. (Computer packages such as Excel provide simple means of drawing samples randomly from a given distribution). One can then use that theoretical sample to provide another estimate of the total population. The exercise is repeated many times.

Here is an example, referring to a study area comprising 1205 potential sample plots, of which 10 were surveyed. The original counts are in the first column below, together with their total and the national population estimate derived from them (simply the total multiplied by 120.5). In the next 6 columns are 6 sets of 'counts' derived by randomly sampling from the distribution of the original counts, together with their totals and the estimates of the national population that would have been derived from them were they actual counts. Note that in the simulated data some of the original counts appear more than once: this is because drawing a number from the original data distribution does not prevent it being drawn again ('sampling with replacement').

		Theoretical samples					
	Counts	*1*	*2*	*3*	*4*	*5*	*6*
	19	19	48	19	64	48	32
	48	32	48	38	38	64	37
	92	49	49	19	38	32	58
	49	49	19	48	64	32	19
	32	32	38	49	92	32	92
	58	19	19	49	92	38	58
	38	32	48	19	37	37	32
	75	19	32	38	75	48	38
	64	48	64	75	64	38	19
	37	38	48	19	48	58	75
total	512	337	413	373	612	427	460
estimate	61696	40609	49767	44947	73746	51454	55430

In practice, one draws far more than 6 replicates: the minimum is usually recommended to be 999. The 999 theoretical estimates plus the actual estimate are then placed in order, lowest to highest. The 25 smallest estimates thus comprise the lower 2.5% of the distribution and the 25 largest comprise the upper 2.5%; or, to put it differently, 95% of the estimates lie between the 25th from the bottom and the 25th from the top. These values can thus be taken as the 95% confidence limits of one's estimates. (If you generated 9999 theoretical samples, the limits would be the 250th smallest and largest).

When a full set of 999 was generated from the above distribution, the limits obtained were 46634 and 78205. These are clearly approximate: it would be appropriate to round off the numbers, stating that the estimated population was 61700, with 95% confidence limits of 46600 and 78200.

For a stratified sampling design, one conducts the random sampling process within each of the strata once and analyses the simulated data set as though it were real to get estimates of the stratum populations and the total population. Then one repeats the whole thing many times (see Sutherland et al. 2004).

For two-stage sampling, each new set of simulated data is produced by first drawing randomly from the set of major units, then randomly within each.

Unlike bias, the extent of which is never definitely known, precision can be measured, as either the standard error of the estimate or its confidence limits (Box 3.1 & 3.2). When quoting a population estimate (or trend), one should always state the sample size on which it is based and its confidence limits (or standard error).

Note that some authors use the term 'accuracy' for what we have called reliability, rather than just to mean unbiased.

3.2 Sampling strategies

3.2.1 Defining the potential sample areas

It is essential to define the areas to be sampled with care. If one wishes to sample the entire landscape, then the most effective way to define sample units is to superimpose a grid over the whole study area and define the potential sample units as equal-sized sections of the grid – for example as squares of 2x2km or as rectangles of 2' of latitude by 5'of longitude (Fig. 3.2). Useful grids are often printed on national maps.

Observations of birds at the edge of sampling units lead to uncertainties of interpretation, such as judging whether a territory that is only partly within the defined sample area should be included or not. For this reason, it is sensible to use squares rather than rectangles, to minimize the ratio of edge to included area.

It may seem more appropriate to divide the landscape into 'ecological' units, defined by such things as habitat and physiography, and to take a sample of these. However, this will lead to bias because it will over-represent the boundary zones between habitat units – and boundary zones often hold lower or higher numbers of birds than other parts. In farmland habitats, it may seem appropriate to use individual fields as the sample units but this will over-represent field boundaries, which are usually ecologically different from the fields themselves. Even using ownership or administrative units will lead to bias, for their boundaries commonly run along waterways, mountain ridges, or other ecologically relevant elements of the landscape, which will thus be over-represented. Such potential biases must be carefully considered if such sampling units are adopted for reasons of practical convenience.

For species that are confined to patchy habitats that make up only a small proportion of the landscape, such as lakes, it may be sensible to use the individual patches as the sample units, provided that their boundaries are clear or can be consistently defined.

Particular consideration needs to be given to the analysis of data derived from sample units of different sizes (Box 3.3).

Box 3.3 Sample units of different sizes

Suppose that a country has 1750 lakes (covering a total of 54 250 hectares) and that 10 of these are sampled at random, yielding the following population counts of a bird species:

											Total	*Mean*
Count	68	1008	34	106	164	54	50	107	160	49	1800	180
Size of lake (ha)	13.1	150.4	12.2	5.6	34.2	6.3	15.6	19.9	22.6	11.7	291.6	
Birds per hectare	5.19	6.70	2.79	18.93	4.80	8.57	3.21	5.38	7.08	4.19		6.68

There are two different ways of estimating the national population:

1. Estimate unweighted by size of sample unit

One simply multiplies the mean count per lake by the national number of lakes:
Estimate of national population = 180x1750 = 315 000 birds.

2. Estimate weighted by size of sample unit
   One multiplies the totals of the counts by the ratio of the national area of lakes to the area sampled:
   Estimate of national population = 1800x(54250/291.6) = 335 000 birds.
   Given that the larger lakes are likely to hold more birds, the weighted estimate is generally better than the unweighted estimate for the purposes of surveillance of national populations.
3. Measures of precision
   Methods of calculating standard errors and confidence limits of both sorts of estimate are provided by Greenwood and Robinson (2006a)

The treatment of sample units that extend over the border of the study area needs careful thought. If the border is a simple political border but one that can be crossed, so that the part of the sample unit beyond the border can be surveyed, the best approach is to include the whole of the unit (including the part across the border) if more than 50% of it lies within the study area but to exclude the whole of it if less than 50% does so.

If the political border cannot be crossed, one may exclude such border units from one‘s sample so long as they do not differ ecologically from the rest of the study area or only make up an insignificant proportion of the total study area. Alternatively, one can just include those parts of the border units that can be surveyed, allowing in the analysis for the fact that these units then differ in size from the standard units that are not on the border.

If the border of the study area is the sea (and one is studying land birds), then one must allow for the fact that the coastal samples each cover smaller areas than do the inland sites. The same applies if the study area is an ecological unit, such as a forest surrounded by open country; one surveys only the parts of the sample units that are within the forest and allows for their differences in size in the analysis.

3.2.2 How many sampling units need one take and how big should each be?

The answer to this question depends on the details of the individual investigation but there are general principles that can be used when planning a survey to try to ensure that it achieves its aims.

The precision of one‘s population estimate will depend both the differences in counts (or trends) between the various sample units and the number of units sampled. The investigator has some control over the former, through using good fieldwork techniques, though even with the best techniques there will still be differences between counts because of actual differences in population density (or trends) between the sample units. Increasing the size of the sample is an effective way of increasing precision of the estimate. However, the width of the confidence limits is inversely proportional not to the number of samples but to the

square root of the number of samples. This means that there are diminishing returns as one increases sample number: thus increasing the sample size fourfold will only halve the width of the confidence band and one then needs another fourfold increase – 16-fold in all – to halve the confidence width again.

If one has some idea of the variation in counts between sample units (perhaps from pilot work), then one can estimate how many samples one needs to attain a desired level of precision. It is important to do this when planning new work, to ensure that resources are not wasted by taking fewer samples than are necessary.

Note that, contrary to what one might think, the proportion of the study area that is sampled (the 'sampling intensity') has little effect on the precision of one's estimate, unless it is well above 50%. It is the absolute number of samples that is important.

If one has limited man-power, one way of increasing the number of samples is to make each sample smaller and thus less time-consuming. But there are balances to be struck. Most fundamentally, the differences in population between smaller sample units will be proportionally greater than those between larger units, which cancels some of what is gained by increasing the number of units. Furthermore, in fieldwork terms, the smaller the units, the more difficulty there will be in deciding whether to include birds seen close to the edge of the sample areas, which is a source of imprecision. In addition, travel time has to be considered. A simple example illustrates the problem. Suppose that it takes 2 hours to travel between sample sites and one spends 2 hours to cover sample areas of 4 km^2: hence, each site takes 4 hours in total, meaning that one can cover two sites (totalling 8 km^2) in 8 hours. Sites half the size only take half as long to survey but still entail the same travel time per site, so it takes 9 hours in total to cover three sites (totalling only 6 km^2).

3.2.3 How to ensure samples are representative: random sampling

Random sampling is the only way to ensure that samples are unbiased (Fig. 3.2). Furthermore, if samples are not random then the confidence limits that one calculates for one's estimate will not be correct, so one will also be misled about the precision of the estimate.

How does one take samples at random? Haphazard choices, such as stabbing a pin 'randomly' in a map are never truly random; one needs to use more formal methods. Here is an example. There are 497 lakes in the study area; one wishes to sample 20 of these at random. One numbers them 1-497. From tables of random numbers or using a random number generator on a calculating machine or computer, one gets a three-digit random number: the lake with that number is included in the sample. One repeats the process until 20 lakes have been chosen. Numbers larger than 497 are ignored; if the same number comes up more than once it is sampled only once and extra numbers generated until 20 lakes have been

chosen. Here is another example. One is studying a river 25 km long. One wishes to survey random 100m stretches. One generates a random number between 0 and 249, as before, and multiplies it by 100; that is the starting point of a sample unit, in metres from one end of the river. A third example: a grid 300km x 500km has been superimposed on a map of the country, from which one wishes to sample 1x1km squares. One numbers the rows of the grid 1-299 and the columns of the grid 1-499. One then generates random numbers in pairs, the first of the pair being the row and the second of the column, to determine which square to sample. If a chosen square falls in the sea or a neighbouring country, one ignores it. Notice that in all these cases, because the tables and the computer generator are designed not to favour any number over any other, each potential sample unit (lake, 100m stretch of river, 1x1km square) has exactly the same chance of being included in the sample as each of the others.

The generation of random numbers need not involve tables or calculators. One can simply cut a number of pieces of paper as close to identical in size as possible and number them. Then shake them up in a box and draw them out blindly. This can be tedious if there are many potential sample units but it can be made less so. For example, to generate three-digit numbers: write the numbers 0-9 on 10 pieces of paper; draw a piece blind – its number is the first digit in one‘s number; return the paper to the container, mix and draw again; the new number is the second digit; return, mix and draw again to get the third digit; repeat the whole sequence as often as necessary to get a full set of three-digit numbers.

It is not always easy to decide how to sample at random; or, to be strictly accurate, it is easy to believe that one has designed a random-sampling protocol, but to be quite mistaken. This is particularly true if the sample units are of different sizes or are irregularly distributed, such as lakes or other patches of habitat that may be used as sample units. There is no problem if they can all be identified and numbered in advance of the fieldwork, as above, but sometimes such places are too numerous for this to be practical – they may not all have been mapped. Consider the possibility of selecting a set of random points across the study area and sampling the nearest lake to each point. This would favour the larger lakes because they occupy more of the landscape and so are more likely to be close to a random point than smaller lakes. It would also favour lakes that are isolated. (Consider a lake near to a random point: if it has no neighbours, it will be the closest lake to the point; but a lake with neighbours might not be as close to the point as is at least one of the neighbours).

One way of getting an unbiased sample of lakes is as follows. Lay down a grid that is markedly larger than most of the lakes and choose a random sample of grid squares. Within each sample square, survey all or just a proportion of the lakes in the square, choosing which to sample at random; sample the same proportion of the lakes in each square, not the same number – so, if you decide to sample 25% of the lakes in each square and three squares have 8, 13 and 23 lakes in them, one should sample 2, 4 and 6 lakes. Some of the lakes may not fall wholly in the grid square: include any that have a higher proportion in that square than in any other and exclude the rest. If one includes all the lakes that have any part in the square, this is biased to larger lakes. If one surveys a fixed number of lakes in each square, rather than a fixed proportion, this is biased towards more isolated lakes.

Linear features, such as rivers or coastlines, are also difficult to sample randomly when they are so extensive that the approach suggested above is impractical. One method is to take a random sample of grid squares as with the lakes. Lay down one or more lines randomly across each of the chosen squares and take all or a proportion of the places where these intersect rivers as the starting points of surveys.

(Note that the lakes and river-intersections within each square are not statistically independent because of their proximity to each other, so it is inappropriate to treat them as independent samples for the purpose of analysis. One way of analysing the data is to combine all the counts from the same square into a single sample; one is then dealing with samples of different sizes, which should be thought about in the analysis (Box 3.3). Alternatively, one can treat this design as two-stage sampling, discussed in section 3.2.9).

Bias can occur at every stage of the design. For example, if one always surveyed upstream of the starting point for river samples the sample would be subtly biased towards the higher parts of the rivers. (The solution is to choose to survey up- or downstream at random in each case – by generating a random number and going upstream if it is odd and down if it is even).

Sometimes people use a regular distribution of samples, for example to take 100m surveys at 1km intervals up a river or to survey the most north-westerly 1x1km square in each 10x10km square of a grid. This is not advisable because it will generally lead to the confidence limits that one calculates being wrong, so one has a false idea of the precision of one‘s sample. Furthermore, if there is any environmental regularity in the study are, regular samples can produce bias. People naively think that regular sampling will be more representative than random sampling, because there is even geographical coverage. But if one is worried about getting even geographical coverage the appropriate method to use is stratification (below), not regular sampling.

3.2.4 Deliberate bias towards larger sampling units

One could argue that biasing the sampling towards the larger units is desirable. For example, if larger lakes are likely to hold more birds then one finds out more about the total population by concentrating the sampling on the larger lakes. Such an approach requires special design and analysis, beyond the scope of this book.

3.2.5 What is wrong with letting observers choose sample sites

Observers generally prefer to choose their own sample sites rather than being directed to randomly chosen places. In single-species surveys, they almost invariably choose to visit places that they expect to have plenty of the species in question, thus biasing the estimate of the total population in the study area and probably also the estimate of the overall trend in numbers. Limited evidence suggests that such biases are less marked in multi-species surveys (because most places are good for at least some species) but we should still guard against them. Biases will also arise if people choose to sample some habitats rather than others or to choose survey sites that are convenient to get to. The only way to avoid such biases is to determine the sample locations at random, allowing no observer choice.

Concern has often been expressed about potential biases arising in long-term studies because of observers choosing to stop surveying sites where birds are declining. Again, the limited evidence suggests that this is not a great problem but it is something that should be guarded against. Some survey designs guard against this effect by surveying the same fixed set of sites through time, replacing suitably skilled observers when the need arises.

One cannot guard against biases resulting from the choice of observers by asking them to choose ‘representative’ areas. Experience shows quite clearly that people’s idea of a ‘typical oakwood’, for example, is an idealized oakwood, not typical of most oakwoods in the study area.

Given that random sampling is the ideal, how can observers be persuaded to go to randomly-selected sites. Sustained education of the fieldworkers as to the importance of random sampling will pay off over the years. In single-species surveys, one can raise the interest in visiting squares that have few or none of the focal species by adding other things – e.g. by asking them to record all buntings even though the Corn Bunting is the species of key interest for example, so that fewer of them encounter completely blank squares.

3.2.6 Making samples even more representative: stratification

Stratification is an extension of simple random sampling, which has advantages in some situations. For example, simple random sampling may, just by chance, result in more samples being taken in some parts of the study area than in others; one may want to ensure a more even distribution of samples. To do so, one simply divides the study area into smaller areas, technically termed ‘strata’, and samples randomly within each of them. While it is generally best to have strata of uniform size, this is not essential; it is often administratively convenient, for example, to use political subdivisions of a country as the strata when studying national populations.

The analysis of stratified samples is a little more complicated than that of simple random sampling. It allows one to produce estimates of population (or trends) for each of the strata separately, as well as for the study area as a whole. Where the strata are political subdivisions, this may be useful.

If birds are relatively evenly distributed, one‘s results will be more precise if the sampling intensity is the same in all strata than if it is different. But other considerations may supervene. For example, if some parts of the country have few observers available or are expensive to get to, these can be sampled at lower intensity. The results are not biased towards the better-sampled strata because the statistical analysis automatically corrects for differences in sampling intensity.

One common form of stratification is to define different habitats, ecological or altitudinal zones as the strata. In this case, each stratum may not be a physically continuous unit. For example, woodland, arable farmland, pastures and wetlands may be taken as the four strata into which a country is divided; none of these is usually distributed in a single physical block but all the blocks of each habitat form a single statistical stratum. Stratification by habitat allows separate estimates to be obtained for each habitat, which allows one to study differences between habitats in population size. It also increases precision of the overall estimates because it ensures that all habitats are properly represented in the sample.

Two simple examples illustrate how stratification can be used. In the first, our area of interest is known to comprise two distinct habitats, which we expect to hold different densities of the species of interest (Fig. 3.3). We can get a more precise estimate by using stratification than by simple random sampling, by allocating a predetermined 50% of our samples to each habitat. (It may be more efficient to use a proportion other than 50% in each – see below). In the second example, there is prior information from a bird atlas that the species is largely absent, or at least very rare, in the southern part of the region. Randomly sampling across the whole region might, quite by chance, result in us selecting a high proportion of our samples in the area where the species is largely absent (Fig. 3.4). This would lead to an imprecise and inaccurate estimate and might lead to other problems, such as reluctance by fieldworkers to visit these areas because they expect to see so little. As an alternative, we could predetermine that, for example, 80% of our samples are drawn at random from the area we think is largely occupied, and only 20% of our samples from that thought to be largely unoccupied. Selection of strata clearly depends upon some knowledge or well-founded assumptions about the distribution of the study species.

We can stratify by habitat, climate, altitude, land use, bird abundance, accessibility of survey sites, administrative or geopolitical boundaries, and so forth. From what we know about the ecology of birds, it will often make sense to stratify

Figure 3.3. *Stratification by habitat. Imagine our study area comprises two distinct habitats of roughly equal area, within which our chosen study species lives but perhaps at different densities. A random sample across the whole area is quite likely to result in an uneven split of survey squares between the two habitats. If 70% of the squares happen to fall in one habitat (a) then the population estimate for the whole area based on the ten squares would inevitably be dominated, or biased, by that habitat. The solution to this problem is to stratify (b), taking a number of samples proportional to the size of the stratum. (Other distributions of sampling intensity may be more efficient – see text). The data are then analysed by strata and the results combined to give an unbiased estimate of population size (see text for further information on sampling within strata).*

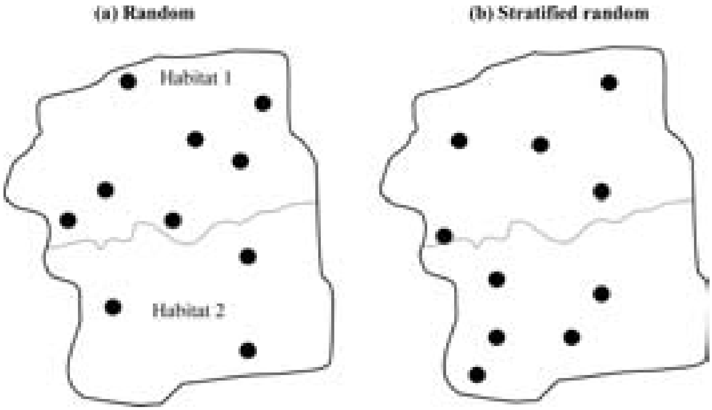
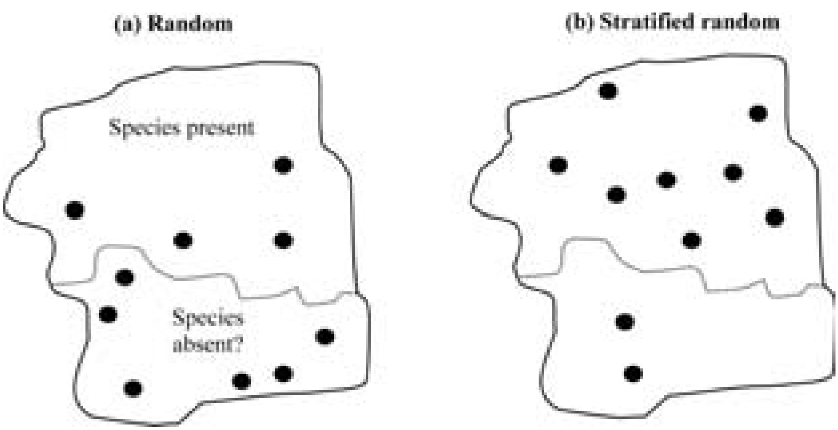


Figure 3.4. *Stratification into well-occupied and poorly-occupied areas. Imagine we are surveying a bird in an area divided into two distinct habitats. A pure random sample (a) of the whole area could, quite by chance, result in 60% of our samples falling in the southern habitat - which we have reason to believe has very few, if any birds. The filled circles represent survey plots. This would be wasteful of time and resources. Far better would be to use prior knowledge to stratify our sample (b) and, say, take 80% of our random samples from the occupied habitat, and 20% from the habitat that is likely to be unoccupied (see text for further details). Note that although the sample is smaller in the unoccupied area, it is still vital that it is surveyed.*



our sample by obvious factors, such as habitat and altitude. Where surveys rely on local observers, it might also make sense to stratify by their availability. Stratification by observer density might seem odd at first sight but it provides an efficient way of maximising the use of skilled volunteers when their distribution is uneven, as it often is. Stratification is recommended because it can improve both precision and accuracy, and it ensures proper habitat coverage. Thankfully, there are simple rules that help us choose the most appropriate strata – and it turns out that even when our prior assumptions about strata prove to be wrong there is no detrimental effect.

If one has little idea about the population of the study area in advance, it is best to sample all the strata with equal intensity – that is, to take a number of samples in each stratum that is proportional to its size (Fig 3.3, Box 3.4). However, a great increase in precision is obtained if one samples in proportion to the variation in population size (or trend) within the strata, taking more samples in the strata in which populations are more spatially variable (Box 3.4). If one has conducted enough pilot work to have properly measured the variation within each stratum, then the differences in sampling intensity that maximize precision can be worked out exactly; but even a rough guess may provide substantial gains in precision over simple random sampling. Note that in this context one is concerned with absolute variation rather than relative variation. In general, absolute variation within a stratum is likely to be greater where mean densities are greater, so even if one does not know the variation as such one can use density as a rough guide as to how to distribute sampling intensity – higher where there are more birds. Again, even an approximate idea of the differences in density will increase precision.

Box 3.4 Choice of sample sizes within strata

Let:

N_T = total number of units available for sampling in the whole study area
N_h = total number of units available for sampling in the hth stratum
S_h = standard deviation of counts in the hth stratum
C_h= cost of sampling per sampling unit in the hth stratum
n_T = total number of samples to be taken

We wish to know what sample sizes to take within each stratum so as to maximize the precision of the estimate of total population for a given amount of fieldwork effort.

That is:

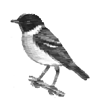
n_h = sample size to be chosen in the hth stratum

1. If neither S_h values nor population densities are known: proportional allocation
Samples are allocated according to the size of strata:

$$n_h = (N_h / N_T)\, n_T$$

2. If S_h values (or population densities) are known
The optimum is to allocate more samples to the strata with the greater variation in counts between its units. For each stratum, calculate $N_h S_h$.

Let the sum of these values be Σ_1.



Then:

$$n_h = (N_h\, S_h / \Sigma_1)\, n_T$$

If S_h values are not known, then estimates of average population density may be substituted for them in this calculation.

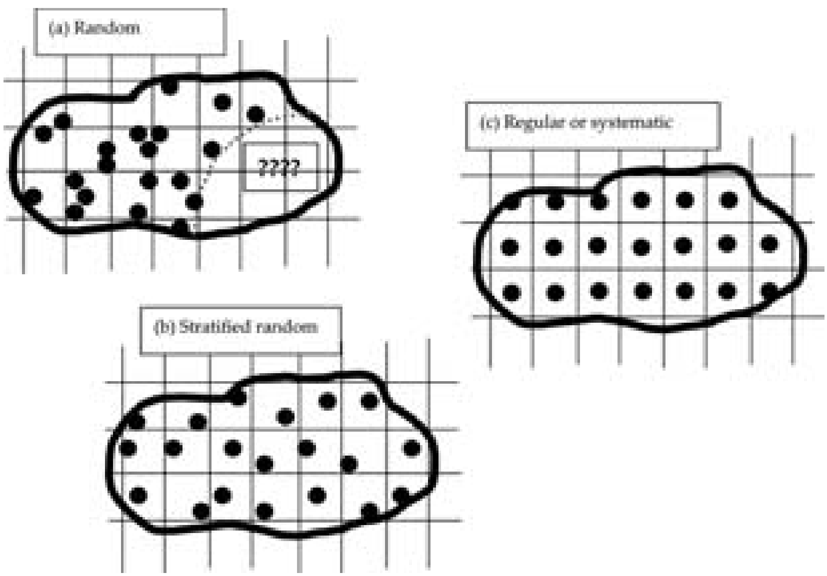
3. If relative costs of sampling in different strata (C_h) are also known
Sampling is now weighted towards the less costly strata.
For each stratum, calculate $N_h\, S_h / C_h \cdot \sqrt{C_h}$
Let the sum of these values be Σ_2.
Then:

$$n_h = [(N_h\, S_h / \sqrt{C_h}) / \Sigma_2]\, n_T$$

Not infrequently, the effort involved in sampling varies in different strata. This also influences the optimum distribution of sampling across strata – that is, the distribution that maximizes the precision of the results for a given level of resources available for the work (Box 3.4).

A potential problem with random sampling, particularly when sample sizes are low, is that, just by chance, our samples might be concentrated in one part of the

Figure 3.5. *There are certain situations, in which a pure random sample can, quite by chance, miss an important part of the study area, which could lead to serious under- or over-estimation of a population depending on its distribution. In this example, a random sample (a) under-samples the southeast corner of the study area. A stratified random approach (b) could alleviate this problem by requiring a survey point in every grid square in the study area. Similarly, a regular sample (c) overcomes this problem because survey points are located in the centre of every grid square. Here the filled circles represent sampling units (n=20) within a large area of interest defined by the bold border.*



survey area that is particularly good for a species, or might miss an area in which we were particularly interested (Fig. 3.5). If we are using stratification, this is less of a problem; we can, for example, stipulate that every grid square, or every strata, contains a fixed number of sampling units (Fig. 3.5). An alternative to random sampling that gets around this problem is *regular sampling*. This involves selecting the sampling units by choosing them in a regular pattern, but as noted above, there is a concern regarding bias and precision. We can again use random numbers to generate a regular pattern. If we want a 10% sample from 100 squares, we can select a random number, say 7, then take every 10th square; 7, 17, 27, 37…97. Alternatively, we could simply decide to sample every 1-km square in the northeast corner of every 10- km square and so forth to achieve a predetermined sample size.

Stratification can be used alongside regular sampling. For example, we could take every seventh square from a stratum where a bird is thought to be common, but every fourteenth square from a stratum where it is thought to be rare.

There are some advantages to regular sampling compared to a random design. Most importantly, maps and distribution atlases can readily be produced from data that are regularly distributed. In addition, regular sampling may be easier to organise and to explain to co-workers than random sampling. It is also true that regular sampling ensures that all parts of the study area are included in the sample; however, such coverage can also be obtained by stratification.

Unfortunately, there is a fundamental disadvantage to regular sampling, which is that the confidence limits that one calculates for one‘s population estimate (even if based on bootstrapping – Box 3.2) are incorrect, unless birds are randomly distributed across the landscape, which they never are. In addition, regular sampling may over- or under-sample features that are regularly distributed in the landscape: for example, it might be that roads are the same distance apart as one‘s of samples, areas near roads will be over- or under-sampled. Nonetheless, if one is not too concerned about one‘s confidence limits being exactly correct and one is happy that one‘s sampling pattern does not coincide with environmental regularities, then regular sampling may be acceptable.

One way of combining the advantages of regular sampling with those of randomization is to divide the study area into a regular grid and sample randomly within each grid square. The squares are thus strata, so one can make proper population estimates for the whole study are abut one can also combine the data from the samples within each grid square into a single data set that can be used for mapping purposes. To apply the usual methods for estimating total populations from stratified samples, one must have at least two random samples within each square. There are methods that can be applied when there is only one sample per square but these are not straightforward (Cochran 1977).

3.2.7 Areas that are impossible to access

It may be impossible to access some areas, such as military bases or very steep mountains. If one simply fails to include such areas but analyses the data without taking this into account, then one's results are likely to be biased because the bird populations of the inaccessible areas differ from those in the rest of the country. What one must do is to measure the extent of such areas, either from maps or from knowing the proportion of the sites chosen for sampling that turned out to be inaccessible, and restrict one's formal population estimate to the accessible parts of the study area. One is justified in making an informal estimate of the population in the inaccessible areas but this must be reported separately from the formal estimate. Thus, a report on the work might read: "Urban areas were impossible to survey. The estimated population in the rest of the country was 242,500 pairs (95% confidence limits: 239,300-245,00). Informal evidence suggests that the population in the urban areas (7.4% of the country) is around 300 pairs."

Some people have attempted to deal with the problem of inaccessible areas by substituting each inaccessible sample site with the nearest accessible area similar in habitat. This may not be satisfactory because inaccessible areas are likely to be different from accessible ones: those too steep to survey will be steeper, military training areas are likely to be managed differently from other areas, etc. The proper procedure is to separate the analysis for the accessible areas from that of the inaccessible areas. The former is based on the original sample (that is, excluding the substitute sites), as in the last paragraph. The analysis for the inaccessible areas is then made as though the data for the substitute sites were real data for samples taken from inaccessible areas. The two analyses should be reported separately, with a commentary as to the reliability of the estimate for the inaccessible areas. This procedure may be an improvement on making an informal estimate for the inaccessible areas, as above, but one should be careful not to be led into a false sense of its reliability because of the more formal methodology.

3.2.8 Areas with few fieldworkers available

Sometimes, especially in single-species surveys, some sample sites are very unlikely to hold birds because they hold no suitable habitat. Despite one's best efforts of persuasion (section 3.2.4), fieldworkers may be so reluctant to visit them that even if asked to do so, they don't. If may be tempting to ignore this problem, simply analysing the results from the sites that were visited as though they formed the whole sample. But one's estimate of total population will obviously be biased, perhaps markedly so. A better approach is to treat such sites as inaccessible, as in the previous section.

Usually, some people are prepared to visit sites that are likely to hold no birds, being persuaded that we need to be sure what is there, even if it is nothing. This being so, the best approach is to divide the study area into strata defined according to the number of birds they are likely to hold and accept a lower sampling intensity for the places that few people are prepared to survey. This has the advantage of providing a valid formal estimate of the total population (or trend), through the usual analysis of stratified random samples. Furthermore, it allows one to detect any expansion of the population into areas in which it is thought not to occur.

Similarly, if some parts of the study area have many observers available and others have few, one can define strata according to the number of observers and accept less intensive sampling in the strata with fewer observers. This depends on the observers in each of the strata being prepared to visit random sites within that stratum. A different approach is needed if people are reluctant to go to sites more than a certain distance from their homes. In this case, one has to start by mapping the distribution of observers and assessing how far they are prepared to travel. One uses this information to divide the country into strata according to distance from observers. The more distant zones can then be sampled less intensively. The key thing is that, as always, sampling within zones must be random.

One sometimes has to accept that so few people are able to visit areas distant from their homes that such areas cannot be covered. One then asks each to visit randomly selected sites within, say, 50km of their homes, accepting that those parts of the country further than 50km from anyone's home are not covered. The formal population estimates should then be restricted to those parts within 50km of observers' homes; any extension of the results to the whole country depend on an assessment of how representative of the whole country are the sampled areas. This is not as good as having stratified random sampling over the whole country but it is better than attempting the latter only to find that many of the chosen sites are not covered because they are too far away.

3.2.9 Two-stage sampling

If one is studying a large sparsely-inhabited area, it is likely that fieldworkers will spend much of their available time getting to the sample sites, rather than actually surveying them. Two-stage sampling is a way of increasing the proportion of time spent surveying. It is most easily explained by example. One divides the survey area not only into basic sample units but also into larger areas; for example, one might use monads (1x1km sqaures) as the basic sampling unit and hectads (10x10km squares) as the larger units. One then takes a random sample of hectads and, within each, surveys a random sample of monads. Suppose that it takes 3 hours (on average) to get to a new hectad but only a further 1-hour to reach a random monad within it, plus another 1.5 hours to survey it. If one visits three monads within a hectad, that will take 10.5 hours. If, in contrast, one visits only 1 monad within each hectad and then moves on to another hectad, it will take 15.5

hours to cover 3 monads – because of the extra time taken up in moving over the long distances between the hectads.

Two-stage sampling is also appropriate if one is studying species that occur in relatively few large patches – such as seabirds on islands or the birds in major wetlands. In such situations, it may take much time and expense to get to the patches but relatively little to move within each of them. An appropriate strategy is to choose a random sample of the patches and then take a number of random sample within each of these.

Analysis of two-stage samples is slightly more complex than that of simple random sampling, especially if the number of basic units is not the same in all major units; but the gain in efficiency of fieldwork justifies it. The most efficient balance between the number of larger units and the number of basic units depends on the magnitude of the differences between larger units in average population relative to the differences between basic units within larger units. One can use a pilot survey to assess this.

3.2.10 Improving efficiency of data gathering in remote regions

Travel time is particularly important in remote regions. This may mean that, within a single study, it is appropriate to use two-stage sampling in remote parts of the study area, but simple random sampling in well-inhabited regions. The data for the remote regions then have to be analysed separately from the rest but the total population estimate is just the sum of the two individual estimates. Trend analysis would have to follow the same logic.

A simpler method of dealing with remote regions is simply to survey larger areas in them than in the rest – for example, if the basic design is to use tetrads (2x2km squares) as the sample units, one might survey two adjacent tetrads when sampling in remote areas. Note that in this case, the two adjacent tetrads are not independent, so it is wrong to separate their data in the analysis. Rather, they have to be combined, being treated as a single sample unit but twice the size of the units in the less remote regions. As with all cases where the sample units within a survey are not all the same size, the analysis needs to take this into account.

3.2.11 'Correcting' free-choice methods

Practicalities sometimes dictate that fieldworkers are allowed to choose their sample sites rather than being directed towards random sites. It is possible to reduce the resultant biases (section 3.2.4) in various ways. One may simply encourage people to visit areas that are typical of the local landscape – though, as we have seen, this is unlikely to eliminate bias totally.

A more formal method can be applied if people's choices seem to be related to obvious factors, such as habitat (people prove reluctant to survey certain habitats). In this case, one stratifies the sample by that factor *after* the survey has

taken place (when one can see how surveyors have biased their sampling) and analyses the data as a stratified survey. Such post-stratification reduces bias in the overall population (trend) estimate but only to the extent that it successfully captures the biases of the surveyors' choices.

An alternative approach is to ask observers to measure habitat variables at each sample site. One can then build models relating bird numbers (trends) to those variables. If one measures the same variables at random sites across the survey area, one can then make national population (trend) estimates from the characteristics of these random sites and the model. This approach only works, of course, if the model includes the main causes of the spatial pattern in numbers (trends).

3.2.12 Surveillance: the need to maintain sample sites

For long-term surveillance, it is invariably better to continue to survey the same sites every year rather than to use new sites. Of course, some sites may become inaccessible and some observers may drop out. Methods for analysing surveillance data allow for such gradual change in the composition of the sample but it is good to try to keep changes to a minimum. If an observer drops out, it is generally advisable to get a new observer to take it over, even though the site has to be treated as though it was a different sample site from before (because the new observer may have different abilities from the old one).

Special measures may be needed when one is keeping a limited number of special sites under surveillance but the number is too great for all of them to be surveyed every year. For example, one may wish to monitor populations on all 40 of the major wetlands in a country but be unable to arrange for more than 10 of them to be surveyed in any one year. If one chooses 10 at random and surveys them every year, one will not detect changes at the other 30, some of which may be important. The solution is to adopt a rolling programme of surveys.

A simple rolling programme, using the above numbers, would be to take a random 10 in the first year, a random 10 out of the remaining 30 in year 2, a random 10 out of the remaining 20 in year 3; the remaining 10 in year 4; the original 10 again in year 5; the second 10 again in year 6, etc. The problem with this approach is that any overall changes will only be measured at intervals of 4 years. A more complex design would be to have only some of the sites changing each year, each site staying in the sample a few years before dropping out. This allows changes in the national population to be estimated every year and each site to be kept under long-term surveillance. For ease of analysis, the programme should be regular: the pattern with which sites are in or out of the survey should be the same for all sites and the number of sites surveyed should be the same every year.

One argument against maintaining the same set of sample sites through time is the increasing use of count data to map and model bird distributions. If mapping

distributions is one of the main objectives of a monitoring scheme, then it may make sense to sample a higher proportion of new sites each year, or an entirely new selection each year, as long as one recognises the cost in terms of having more uncertain trend estimates.

3.3 Field Methods

3.3.1 Introduction

The choice of field methods is as important as the choice of sampling strategy. As we have pointed out above, these choices are not independent: what field method is possible may influence one's decisions about sampling strategy and *vice versa* (Fig. 3.1). The decisions must all be made in the light of the objectives of the monitoring programme. For example, one method may provide more precise data at each individual sampling site than another, but require so much effort that fewer sites can be covered than can be covered by the other method. Since the precision of the overall estimate of population depends both on the precision at individual sample sites and the square root of number of sites, both of these have to be considered when deciding which method to use.

By way of illustration, land bird monitoring in the UK has changed considerably in the last fifteen years with these considerations in mind (Gregory 2000, Gregory and Baillie 2004, Gregory *et al.* 2004a, see also section 3.5.1). The UK has moved from an intensive national count scheme based on territory mapping at a relatively small number of sites, to an extensive count scheme based on line transects at a very large number of sites (http://www.bto.org/bbs/index.htm). The obvious benefits are better geographical coverage of many more habitats and bird species, and a more efficient design involving many more enthusiastic volunteers.

Of course, there is no uniformly best method, as what is best depends on the species under study, the habitat, and the resources available – particularly the fieldworkers. The three most common field methods in bird monitoring are mapping, line transects and point transects; each of these is covered in below. These and other methods are covered by Bibby *et al.* (2000), Sutherland *et al.*

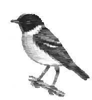
(2004), Greenwood and Robinson (2006b) and Gibbons and Gregory (2006). Wherever possible, it is best to use a method that allows detectability to be estimated or in which an assumption that detectability is perfect is reasonable.

Whatever the method chosen, it is important to standardize the fieldwork as much as possible, in order to ensure comparability between observers and, even more important, comparability over time (and over space). It is important to give fieldworkers exact instructions as to how to conduct their surveys. This is not easy: if the instructions are too detailed, fieldworkers may not bother to read them properly.

There are some general issues to consider in planning fieldwork:

- The season of the year the survey is to be carried out. If one is monitoring breeding populations, for example, visits that are too early will encounter birds that are still migrating through the area and those that are too late will miss birds that have stopped singing.
- The time of day the survey is to be carried out, which should be the best time for detecting birds. This may not be the time when singing is at its peak, when the observer may be overwhelmed by the level of song.
- The recording units and behaviour of the birds to be noted (ages, sexes, nests, singing, calling males etc).
- The size of the survey plots. If they are too small, they will yield only imprecise data; if they are too large, observers may be reluctant to undertake the work or may carry it out with insufficient care.
- The number of visits to be made to each sample plot site. This is commonly around 10 visits for mapping, in order to generate enough data to map territories reliably. For transects, 2-4 visits is the norm, spaced out over the breeding season, so that early breeding species are detected on the early visits and late breeders on the late visits).
- The recommended search effort. This covers not only walking speed (particularly important for line transects) or count duration (for point counts) but such things as frequency of scanning with binoculars, stopping to identify the origin of distant calls, etc.
- Consider pilot work and training requirements in the lead up to bird surveys. Pilot work can be used to assess different field methods, assess the clarity of survey instructions, and uncover practical issues. Training can be tailored to specific field methods, or components of the field methods, such as line or point transect recording, habitat recording, or distance estimation for example.

Different observers will often differ in their ability to record birds and other data. If more than one observer is available, efficiency can be improved by matching observers to particular tasks they suit (e.g. one spotting and identifying birds, one estimating distances or positions, one acting as a data recorder), and by in-



corporating training as described above. By comparing results from individual observers over time, survey organizers can assess whether their effectiveness changes as they become more experienced. The results of such monitoring of performance may indicate, for example, that it would be wise to exclude the first (days, month, year) of an observer's work from the analysis in particular instances.

3.3.2 Territory mapping

Also known as spot mapping, this is based on the idea that it is possible, by accumulating observations of birds' locations and activities throughout the breeding season, that one can work out the boundaries of territories and thus estimate the number of territorial birds. Each sample plot is visited on several occasions and the locations of all birds seen or heard (and of nests found) are carefully mapped. Plot sizes of 10-20 ha in closed habitats and 50-100 ha in open habitats have been found satisfactory. An essential component of this method is the use of activity codes to describe bird behaviour in the field. These allow observers to record simultaneous observations of territory-holding birds, different forms of territorial behaviour and other factors that later allow an analyst to approximate the boundaries between adjacent bird territories. Examples of these codes, and of the way that maps can be analysed, are given in Marchant *et al.* (1990), Bibby *et al.* (2000), and Gibbons and Gregory (2006).

At first sight, this would appear to be an accurate and precise method. Furthermore, because it produces a detailed map of the distribution and size of territories at each sample site, one can link bird distribution with habitats (so long as these are also mapped carefully). For certain purposes, for example habitat management on a nature reserve, such information can be invaluable.

The method does, however, have a number of disadvantages:

- It rests on the assumption that all territories are detected, which detailed studies have shown is often not true. This does not matter if we are prepared to accept an index rather than a true population (or trend) estimate.
- The fieldwork is very time-consuming, requiring up to ten visits to each site to be able to identify territories (though fewer visits may be made if only one species is being surveyed – a minimum is around four).
- Surveyors have to spend several hours transferring data from multi-species, single-visit maps to single-species, multi-visit maps, ready for analysis.
- Interpretation of the results can be difficult and subjective, particularly when territory densities are high. It requires the application of consistent rules by all analysts – and the consistency must be maintained over time.
- Territories at the edge of a plot are troublesome and require arbitrary rules.

- It is difficult to compare results across studies unless common standards of territory analysis have been applied.
- It is difficult to use in featureless habitats, such as open grasslands or deserts, because it is difficult to plot positions on a map when there are no landmarks.
- It is an inefficient method for recording non-territorial species, semi-colonial species, those that sing for brief periods, or those that are not monagamous. (A reason why mapping has seldom been used in the tropics, where many species do not maintain clear breeding territories).
- It is difficult to use in places where breeding is not highly seasonal and synchronous. (Another reason why it has not been much used in the tropics).
- It requires that high quality maps of the study area are available. (1:2500 is a generally suitable scale).

Despite these limitations, territory mapping has proved a very useful method of monitoring birds in temperate regions. Because the observations are mapped, the results have proved a valuable data source for ecological research, particularly when careful maps are also made of the habitat in the survey areas. In those situations where it is critical to map individual territories, and sufficient resources exist to do this, it is the method of choice. When used appropriately, it allows fine-scale habitat associations to be studied and probably provides relatively reliable estimates of population size (with the proviso that not all territories may be detected). Mapping methods can also be usefully combined with nest finding, radio telemetry, mist nesting etc. in research projects.

3.3.3 Introduction to transects and distance sampling

Both *line transects* and *point transects* (sometimes called point counts) are based on recording birds along a predefined route within a predefined survey unit. In line transects, birds are recorded continually along the route; in point transects, they are recorded at points at regular intervals along the route, for a given duration at each point. While there are important differences between the line and point transects, and choosing between them will be an important decision in survey design, there are also many practical and theoretical similarities. They can be combined within the same survey.

There are a number of variations on the basic theme. At the simplest, one simply counts all the birds seen or heard; sometimes birds beyond a certain distance away are not included. Such methods can provide no more than an index because they do not allow one to measure detectability, which cannot reasonably be assumed to be perfect. Nowadays, most users of transects record the distances that the birds are from the line or point when they are first detected - either exact distances or within fixed bands (such as 0-25m, 25-100m, beyond 100m). We definitely recommend doing this because such data can be used to estimate detectability in the habitat concerned and thus allows true densities to be esti-

mated, using the method of *distance sampling* (see *Detection probabilities,* below). A key decision when designing transect surveys is how precisely to record the distances from the line or point to the bird. It is best to record exact distances, which may be practical for single, or a small number of species, but this is laborious (though becoming less so, as range-finders become more widely available). If one simply records in bands, then the more bands the better (but also the more laborious). The minimum requirement is two fixed-width bands. An extra band for observations beyond the outermost fixed-width band is desirable: though the data from that are usually not included in the estimation of detectability, they can be used for the indexing of species that are conspicuous but occur at low densities. (Furthermore, fieldworkers generally prefer to record all that they observe rather than being told to ignore some and may be tempted to include birds they observe in a category rather than ignore them altogether.) 'Binning', as it is called, creates problems for analysis and should be avoided if possible.

Whether one uses exact distances or bands, it is important that these are measured accurately. Otherwise, the estimation of detectability (and thus of density) will be biased.

All birds identified by sight or sound should be recorded. Silent and calling birds have different detectabilities. These can be separately estimated if observers record whether sight or sound was used to detect each bird. This allows much better estimates of population than if the aural and visual detections are not distinguished but adds to fieldwork complexity. Birds that are seen flying over the census area should be recorded separately because they cannot be included in standard density estimation.

Birds that fly away should be recorded as coming from the point where they are first observed. Try to avoid double-counting the same individual birds at a point count or within a transect section. It is, however, correct to record what are likely to be the same individual birds when they are detected from subsequent points or sections of the route. (In principle, individuals that, because they have moved, are present not only at point A when you are there but also at point B when you are there will be balanced out by birds that were at B while you were at A and at A while you were at B).

It is useful to record habitat consistently along lines or at points, in order that habitat-specific detectabilities can be measured. Such habitat data also allow bird-habitat relationships to be studied. Recording such data using simple hierarchical habitat codes allows detailed information to be summarised, input and analysed efficiently. For example, the system used in the UK follows Crick (1992). Here observers are able to record the *primary* and *secondary* habitat characteristics within survey sites; a system common across a range of BTO monitoring schemes. Where habitat is systematically recorded as part of the

survey, it is often useful if the habitat of the 'ideal' transect route is recorded as well as that of the 'actual' route followed. At the least this allows the extent of any habitat bias to be assessed; it may even be possible to correct for any bias.

When studying breeding birds in temperate latitudes, it is usual to survey each sample site 2-4 times each breeding season, to provide adequate coverage of both early and late breeders. We recommend this number, both as having proved satisfactory and because it allows comparability across different surveys.

Because they can be used to derive relative and absolute measures of bird abundance, line and point transects are the preferred survey methods in many situations. They are highly adaptable methods and can be used in terrestrial and marine systems. They can be used to survey individual species, or groups of species. They are efficient in terms of the quantity of data collected per unit of effort expended, and for this reason they are particularly suited to monitoring projects. Transects can be usefully supplemented and, to some degree, verified in combination with other count methods such as sound recording, mist netting, and tape playback (Sutherland *et al.* 2004).

Some thought needs to be given to surveying birds that are non-territorial, semi-colonial species, those that sing for brief periods, and those that have unusual mating systems; but this is less of a concern than in territory mapping. In such cases, we might wish to record additionally roost counts, numbers of nests, birds at leks etc., or add additional components of monitoring.

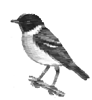
A disadvantage of transect methods is that, whatever is the ideal route or layout of points, actual routes tend to follow paths, tracks or roads, and so may not be representative of the area as a whole. A practical way around this using point counts is to establish counting stations at right angles to the transect line and say 30 or 50m into the habitat. Deviations may also occur because water-courses block the route, access is denied etc. In some cases, it might be necessary to substitute a section of the route that cannot be covered with an equivalent but accessible route. Similar accessible points may substitute for those that are inaccessible. An advantage of points over lines is that it is often easier to substitute positions of single points than those of lines.

3.3.4 Line transects

At its simplest, a line transect involves travelling a predetermined route and recording birds on either side of the observer. Distances should be estimated perpendicular to the transect line (rather than the distance from the bird to the observer).

Perpendicular distances can be estimated in a number of ways:

1. Distance may be estimated by eye from the line, given practice and periodic checking against known distances. (Fixed distances can be marked in the field using marker posts or coloured tape to aid recording).



2. Bird observations can be plotted on to high quality maps and the distance measured subsequently. This requires good mapping skills. It is helped by having fixed markers around the survey route.
3. Observers can use a sighting compass to estimate the angle (Θ) between the transect line and a line from the observer to the bird and a tape or range finder to measure the distance (d) from that point to the bird. The perpendicular distance from the transect line is then calculated as $d \cos \Theta$
4. Observers may be able to visually mark the position of a bird when detected and then use a tape or range finder to measure the distance when they are perpendicular to where the bird was recorded. This is not recommended, as visual marks are not easy to retain as one moves.

The sampling strategy chosen for a particular survey will have determined the sample site to be surveyed. It is still necessary to choose the line transect route within this site. There are several options and some flexibility is advisable. For example, a regular or systematic approach may be used, with parallel transects orientated north to south at fixed positions within each sample site (e.g. two lines 250m inside the west and east edges of a 1x1km square), or a series of transects oriented along the long axis of the study area. A random approach, for example with starting points and directions of transects selected randomly, may be used, though this has no advantage over a systematic method (because the random choice of the sample site has dealt with the statistical problems associated with a regular pattern of sampling). In large sites, one may use a stratified approach, placing routes either systematically or randomly within particular habitat patches. If more than one line is used within a sample area, it is important that their outer bands do not overlap; we recommend that lines are at least 200m apart. The optimum length of the transect lines depends on the conditions; they need to be long enough to ensure that the number of birds recorded is not very small but not so long that a single line is likely to cross markedly different habitats. In temperate Europe, 1-2 km is a satisfactory length.

The survey design of the Breeding Bird Survey in the UK, which uses a line transect approach, provides a useful model that can be adopted elsewhere for breeding birds (Gregory 2000; Gregory and Baillie 1998, http://www.bto.org/survey/bbs.htm, see also section 3.5.1). This survey is based on two counting visits to a square each breeding season, with one visit to set up a route, and uses three distance bands, 0-25m, 25-100m and over 100m. Two parallel lines, each 1km long, are surveyed.

Line transects are highly adaptable. They have, for example, been used to survey seabirds from ships and both waterbirds and seabirds from the air. These are specialised and expensive applications but, especially with the application of refined distance-sampling methods, they can provide information of immensely better quality than traditional land-based surveys of such birds.

3.3.5 Point transects

Point transects differ from line transects in that observers do not record along a route but at predefined spots. Arriving at a spot, they allow the birds time to settle, and then record all the birds seen or heard for a predetermined time. We recommend a 1-minute settling period and a 5- or 10-minute count. (People have counted for as little as 2 minutes and as much as 20: the first may result in rather small numbers of detections, the second in double-counting, as birds move about). For 10-minute counts, we suggest that birds recorded in the first and second five minutes are noted separately (allowing some check on double counting, on whether birds are attracted to the observer, and allowing comparison with 5-minute counts). We recommend a minimum of two fixed-distance bands of 0-30m and 30-100m, with birds beyond 100m also recorded (see Sutherland *et al.* 2004, Gibbons and Gregory 2006). We recommend that birds flushed as you approach a stop should be recorded and included in the totals for that point. This must be made plain in the report of your work, because some workers do not include such birds.

Distances are easier to measure from points because one does not have to bother about whether they are perpendicular to the line and one can easily establish markers around stopping points. This is useful because it is more important to be accurate in one‘s estimates of distances with point transects, for which population estimates using distance sampling depend on the square of the distance to each bird rather than on the distance itself.

Within the sample site, points may be placed on a regular grid, or randomly or stratified randomly, though, as with line transects, random has no benefit over regular: all the points within a sample site represent a single sample. We suggest a minimum of 200m between counting stations. The number of points within each sample site depends on the size of the site but 20 per site is probably a minimum – 25 can easily be fitted into a 1x1km square, at intervals of 200m.

As with transects, it is useful to score habitat at each point and to score that at inaccessible points as well as accessible ones, to allow habitat-specific detectabilities and habitat biases to be estimated and bird-habitat relationships to be studied.

The North American Breeding Bird Survey, which is a continent-wide survey, involves point counts along randomly selected road transects
(Sauer et al. 2006; http://www.mbr-pwrc.usgs.gov/bbs).

3.3.6 Choosing between line and point transects

There is often little to choose between line and point transects because they so are adaptable to species and habitats, but each is better suited to particular

situations (Table 3.1). The strengths and weaknesses of the methods needs to be matched against your survey objectives:

Table 3.1. *A comparison of line and point transects.*

Line transects	***Point transects***
Suits extensive, open and uniform habitats	Suits dense habitats such as forest and scrub
Suits mobile, large or conspicuous species and those that easily flush	Suits cryptic, shy and skulking species
Suits populations at lower density and more species poor	Suits populations at higher density and more species rich
Covers the ground quickly and efficiently recording many birds	Time is lost moving between points, but counts give time to spot and identify shy birds
Double counting of birds is a minor issue, as the observer is continually on the move	Double counting of birds is a concern within the count period - especially for longer counts
Birds are less likely to be attracted to the observer	Birds may be attracted to the presence of observers at counting stations
Suited to situations where access is quite good	Suited to situations where access is restricted
Can be used for bird-habitat studies	Better suited to bird-habitat studies
Errors in distance estimation have a smaller influence on density estimates (because the area sampled increases linearly from the transect line)	Errors in distance estimation can have a larger influence on density estimates (because the area sampled increases geometrically from the transect point)

3.3.7 Detection probabilities

As discussed above, while indices may be used for the purposes of population monitoring, they rest on the core assumption that detectability does not change systematically over the years. If it does, changes in the index are not a reliable indication of changes in the population. Similarly, one may wish to compare the results of surveys in different areas. Even if the methods used are identical, differences between habitats or the behaviour of the birds may cause detectabilities to differ. Unless one can allow for differences in detectability, comparisons between different habitats surveyed at the same time (i.e. densities) and between the same places surveyed at different times (i.e. trends) rest on foundations that are in principle insecure. Buckland *et al*. (2001, 2004), Thomas *et al*. (2005) and others have argued that this is unsatisfactory.

The solution is to adjust counts to take account of detectability. Various methods have been proposed. For example, the 'double-observer' approach uses counts from primary and secondary observers, who alternate roles, to model detection probabilities and adjust the counts. The 'double-sampling' approach

uses the findings from an intensive census at a sub-sample of sites to correct the unadjusted counts from a larger sample of sites. The 'removal model' assesses the detection probabilities of different species during the period of a point count and adjusts the counts accordingly. 'Distance sampling' underlies modern transect me- thods presented above (Buckland *et al.* 2001, 2004; Thomas *et al.* 2005). It takes account of the fact that the number of birds one sees or hears declines with distance from the observer. The shape of this decline, the distance function, differs among species, among observers and, importantly, among habitats – birds within open grassland are detectable over greater distances than those within dense forest - even when they occur at the same densities. Distance sampling models the 'distance function' and estimates density taking into account both the birds that were observed, plus those that were likely to be present but were not detected. Fortunately, not only has the method been well-worked out both theoretically and practically, but the software and further information to analyse one's data are freely available at: http://www.creem.st-and.ac.uk/software.php?fromruwpa=yes. Density estimates improve with the number of birds recorded - a minimum of about 80 records is recommended.

As do all methods, this one relies on a number of assumptions and these have been the matter of considerable debate. They need to be evaluated carefully in the field and steps taken to lessen and understand their effects. The key assumptions of distance methods are:

- that all the birds actually on the transect line or at the counting station are recorded;
- that birds do not move away from the line or point in response to the observer prior to being detected;
- that the birds are uniformly distributed across the landscape or, at least, that the transect lines (or points) are randomly distributed with respect to variations in bird density.

These assumptions are not completely realistic. Cryptic and shy birds that are right on the line may be missed; birds are likely to move before the observer detects them; and transect routes may tend to follow tracks, waterways, etc. - features that birds are commonly attracted to or avoid. Thus, the estimates of density derived from distance sampling may not be as accurate as we would wish. Nonetheless, because they have been consistently corrected for detectability, they are probably more reliable for monitoring purposes than indices that are not so corrected.

The other methods available for dealing with problems of detectability rest on assumptions that are just as unlikely to be strictly valid. Furthermore, none of them has been widely used and all are somewhat labour-intensive in the field and in analysis. For these reasons, we strongly recommend distance sampling. It is the most efficient and simple method of estimating bird density from field data that

has so far been devised, allowing in principle for differences between habitats and species in conspicuousness, enabling comparisons to be made between and within species, across different habitats and over spans of time. Even those who are wary of its assumptions and therefore doubtful as to the absolute reliability of the density estimates derived from it, allow that it provides a good index of population.

3.3.8 Mixing methods

Though it is not common, there is some merit in being prepared to use more than one method. Different methods may be best suited to different landscapes or favoured by different observers. Thus, it may be appropriate to run two parallel monitoring methods alongside each other, even though this will involve additional organization and resources. If one does so, then one obtains two different estimates for each population and trend. It is easy to combine these into a single estimate (Box 3.5).

Box 3.5 Combining two different estimates

They can be estimates of population size or trend.
Let the estimates be $\hat{Y}_1$ and $\hat{Y}_2$.
Let their standard errors be S_1 and S_2.
The best overall estimate is then:

$$\hat{Y}^* = (\hat{Y}_1/S_1^2 + \hat{Y}_2/S_2^2)\, S_1^2\, S_2^2 /(S_1^2 + S_2^2)$$

This has a standard error of:

$$S_{\hat{Y}^*} = \sqrt{[(S_1^2 + S_2^2)/ S_1^2\, S_2^2]}$$

3.4 Summary

When you embark on a new bird survey the first thing to do is to carefully define your objectives. Then decide whether a reliable measure of population size is needed to meet your aims or whether they could be met merely by a reliable index of population size. You also need to decide whether your aims would be better met by carrying out a complete census or by sampling the area of interest and its bird population(s). There are various approaches to sampling: we recommend random sampling with stratification as being generally the best, though other designs may be appropriate to particular situations. Similarly, various field methods are available: most perform well in certain situations but in general, we recommend point and line transects because of their overall performance, efficiency and adaptability. Due attention must be paid to the detection probabilities of birds in survey design and we recommend that distance to birds is estimated, in order to estimate these. Understanding the detectability of birds in different places, in different habitats and at different times is important in understanding how populations might be changing.

There are a few guiding principles to good survey design. It always makes sense to keep things as simple as possible. That does not mean your survey designs (sampling strategies and field methods) and analyses will always be simple, but at each stage of the planning process try to choose options that are simple and efficient. Complex methods are not necessarily better and often prove to be costly in time and effort. It is good to be ambitious in your aims, but keep your feet firmly on the ground and be realistic about what can be achieved. Talk and listen to the key people who will be a part of your project, the fieldworkers who will organise and collect the raw data, the analysts who will lead the data analyses, and the land managers, policy- and decision-makers who will ultimately use the information. (It is very important to understand how the information you collect might be used by conservation agencies and what are their information needs). Finally, in nearly all respects monitoring is an ongoing process, so counting, dialogue, and feedback must continue: and you must keep all aspects under careful review.

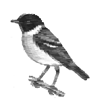
3.5 Case studies

3.5.1 Breeding Bird Survey in the UK

David Noble

At the start of the 1990s most common terrestrial breeding birds in the UK were monitored by the BTO/JNCC Common Birds Census (CBC). The CBC had been running since the early 1960s, originally to address concerns about agricultural intensification and the effects of pesticides, and was a volunteer territory mapping scheme that required participants to make seven to ten visits per year to their chosen site and record on a detailed map the positions of all birds detected and their activity (singing, nesting, flying, etc) using standard codes. The maps were then returned to the BTO for the territory mapping analysis to provide an estimate of the number of territories of each species at each site. Despite its popularity and effectiveness in being the first source of information on serious declines in farmland birds in the UK, the CBC has always had some limitations. Firstly, because observers selected their own plots, traditionally targeted at and classified as farmland or woodland, coverage was biased to these two habitats and to the regions inhabited by most participants, in southern England. Secondly, because of the time commitment required to carry out up to ten visits year after year, the number of participants seldom exceeded 300 per year and it would have been difficult to expand on this.

To address the limitations of the CBC, a new survey of breeding birds was proposed, with the aim of providing sufficient data to generate representative national population trends for as many species as possible. Pilot fieldwork to determine the best survey method was undertaken in 1992 and 1993, considering



only line transects and point counts because of their perceived suitability for volunteers with a broad range in levels of experience. Using these results and other available data, analyses were carried out to determine the most effective sampling design, measured as the capacity to detect a significant 50% inter-annual change in as many species as possible. This work suggested that random sampling stratified by observer density would be most effective and that further stratification - by habitat - added nothing.

The new survey, named the BTO/JNCC/RSPB Breeding Bird Survey (BBS), was introduced in 1994. The key features of the scheme are its stratified random design and its simplicity. The random element is essential for avoiding bias towards particular types of site, and it is therefore important for regional organisers to allocate squares to volunteers without leaving any gaps. The regional stratification allows survey effort to vary between regions without affecting the resulting trends, and means that the national survey can encompass high intensity local effort where that is feasible. However, there should be a minimum level of coverage in all regions. In practice, the country was divided up into 83 regions using local government boundaries and the stratification by observer density was achieved by allocating squares in proportion to BTO membership within the region.

The simplicity refers to the field recording methods. Only two counting visits per season are required, one in the first half of the season (April to mid-May) to get the best measures of numbers of early breeding species (mainly residents); the second during the latter half of the breeding season (late May to early July) to get the best measure of numbers of later breeding species (mainly migrants). Observers spend relatively little time in the square during each visit, walking at a normal pace along two roughly parallel transects that traverse the 1-km square – therefore 2 km in total. This reduction in effort (approximately four hours of surveying, plus travel time) has been successful in encouraging many more observers to participate, and its coverage in 2007 exceeded 3500 squares. For practical reasons, observers are forced to deviate from a straight transect across the square and select their own route, often following paths and public rights of way. Although this may introduce some habitat bias, subsequent analyses suggest this is minimal and the important point is that the same route is done year after year, usually by the same observer. We test this about every five years by comparing habitat details along the ideal route of two parallel lines 500m apart with the habitat along the actual route.

Volunteers are asked to begin their counts between 06.00 and 07.00 hours so that they coincide with maximum bird activity, but avoid concentrated song activity at dawn. Volunteers record all the birds they see or hear as they walk methodically along their transect routes. However, only counts of adult birds are included in the analysis of population trends. Although not necessary for most of the indexing programmes, BBS surveyors assign all bird detections to one of three distance bands (0-25m, 25-100m, and >100m) and to one of ten 200m sections along the transect route. The distance bands allow subsequent calculations of absolute density (given certain assumptions) and the recording by 200m sections allows detections to be related to habitat information also collected at that resolution. The important point is that these elements add very little to the effort required by the surveyor and provide valuable additional information that can be related to the calculated population trends. Possibly slightly less enthusiastically than for bird counts, BBS volunteers also record basic habitat information using codes from an established hierarchical system common to a range of BTO schemes (Crick 1992), for each 200m transect section.

See Appendix for example of instructions for fieldworkers and field recording sheet, Forms for BBS coworkers are also available at http://www.bto.org/bbs/take_part/download-forms.htm.

The BBS has been a great success in the UK but not without considerable overall effort. Although coordinated by the BTO, funding is through a three-way partnership between two NGOs - the BTO, and the RSPB - and a government department (JNCC). There is a National Organiser who works almost fulltime on the operational side of the BBS, to promote the survey, organise data collation and report to volunteers, funding bodies and to the general public. The network of volunteer regional organisers is also critical to its success, as they have the responsibility for finding suitable surveyors for the squares allocated within their region. Their approaches to finding volunteers are as varied as the individuals themselves but most have strong links to local bird clubs. In theory, BBS surveyors should be able to accurately identify all birds in their region by sight and sound, but it is recognised that some individuals take a year or two to get up to speed. An important feature of the survey design is that ideally the same individual surveys the square each year, although some changeover inevitably occurs. Nevertheless, any other observer effects (due to changeover or increased experience) can be later corrected for with analyses.

The BBS went online in 2003, with the development of a system for volunteer surveyors to submit and edit their records online, and view data for their sites from previous years. BBS Online also proved a very effective way of presenting results without the limitations of the printed report. Plots of population trends for all species, by region, by country, as well as maps of species coverage, maps of relative abundance, and tables of coverage by region are all now readily available.

The BBS started in 1994 and the CBC was finally ended in 2000. The six years of overlap were invaluable in developing methods of linking the historical population changes that had occurred since the 1960s to those currently revealed by the BBS. There was generally good correspondence between trends for farmland and woodland birds, at least in the parts of England well covered by the CBC.

However, trends for species in other habitats (for example urban and upland) showed differences and highlight the value of introducing the BBS with its representative coverage in the first place.

3.5.2 How to choose where to count

Hans Schmid

In Switzerland, we established our new ‘Common Bird Monitoring’ scheme, called MHB (Monitoring Häufige Brutvögel), in 1999. At an early stage, the question arose of how the survey plots should be selected in order to be representative of the whole country. The question was of great importance for us because Switzerland is a highly diverse country with a multitude of different habitats within a small range. However, extreme topographical conditions cause major difficulties for surveys; for example, many squares located in the Alps are quite remote and often difficult to reach. In some areas there are only a few paths and moving in rugged and steep terrain would consequently be difficult. Furthermore, there are often steep and slippery slopes, snowfields, landslides, and bridges that had been washed away during winter; all posing different and often unexpected risks for fieldworkers.

About the same time as the MHB began, the Swiss government launched a national biodiversity monitoring programme BDM (www.biodiversitymonitoring.ch). The intention was to co-operate on the ornithological part of this programme from the start in order to achieve the greatest possible collaboration and to reduce expenditure. The biodiversity monitoring programme is based on a grid (horizontal distance: 12km, vertical distance: 8km) with 534 kilometre-squares that are spread regularly over the country (Fig. 3.6), and which are the basis for different surveys carried out every 5 years. Based on the experience from the Swiss Breeding Bird Atlas, it was estimated that ca 250 squares would be sufficient for annual surveys of abundance and that a long-term survey in that order of magnitude could be guaranteed.

For the scheme, 267 squares were eventually chosen, which ensured a representative selection covering all the Swiss regions, the altitudinal ranges, aspect and the main habitats. Also, the squares needed to be reasonably accessible and it needed to be possible for more than 50% of the square to be mapped without any major problems. It soon became evident that it would not be possible to find enough squares within that basic grid to meet all these conditions.

First in the selection process, the number of squares within each of the biogeographical regions was defined, proportional to the areas of these ten regions. Then, the altitudinal distribution of the squares was defined. For example, if 30 squares had to be selected within a particular biogeographical region where

Figure 3.6. *Selection of the MHB-plots with yearly counts (black crosses, n=267) in Switzerland.*

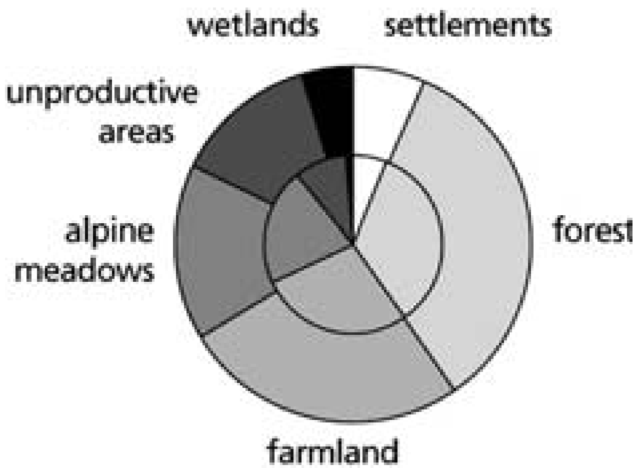
20% of the area is located between 1000 and 1200m asl, then we attempted to find six squares with a median altitude within that altitudinal range. After the initial selection of 30 squares, they were checked to ensure that the main habitats were represented according to the proportion of the habitats in the whole region. If not, single squares were exchanged, by selecting one from the same altitudinal range, which also had to be reasonably accessible. In cases where no plots from the regular grid matched these criteria, we had to select one as close as possible to the regular grid.

So the correction proportion of habitats and altitudinal zones, plus the accessibility, were our most important criteria. As the topography in the alpine areas of Switzerland is extreme, some compromises had to be made with the spatial distribution. Thus, there are zones where four squares in a row had to be selected, followed by five squares which had to be dropped. Nevertheless, the general distribution of the survey squares is adequate, with all important altitudinal zones and main habitats being represented in correct proportions.

Finally, only 197 kilometre squares could be selected from the basic grid. A further 37 were selected from a denser grid which the BDM uses in two alpine areas. Another 20 squares were selected by shifting the squares within the basic grid (by a maximum of 5 kilometres). Through this procedure, suitable plots could be found from the same region, which were a bit easier to survey but which were more or less identical with reference to habitats, altitudinal range and aspect. Finally, in Ticino, the southernmost region of Switzerland and, from the biogeographical perspective, very different to the rest of the country, a special selection of 13 additional squares were surveyed. Here, political considerations played a role in this extra coverage.

This monitoring scheme can thus be summarised as one with a regular grid where punctual adjustments were made. It covers the whole country, and the main habitats are well represented (Fig. 3.7). However, special habitat types which are more or less linearly arranged, tend to be under-represented. If it was not necessary to make compromises with the national biodiversity monitoring programme, we would probably have been somewhat more generous in shifting the squares, to select those with better accessibility, thus making fieldwork a little bit easier.

Figure 3.7. *Coverage of the main habitats by MHB. Inner circle: selected squares (n=267 squares), outer circle: whole country. Wetlands are underrepresented because squares from the regular grid falling on large lakes and hereby including any shore habitats were omitted.*



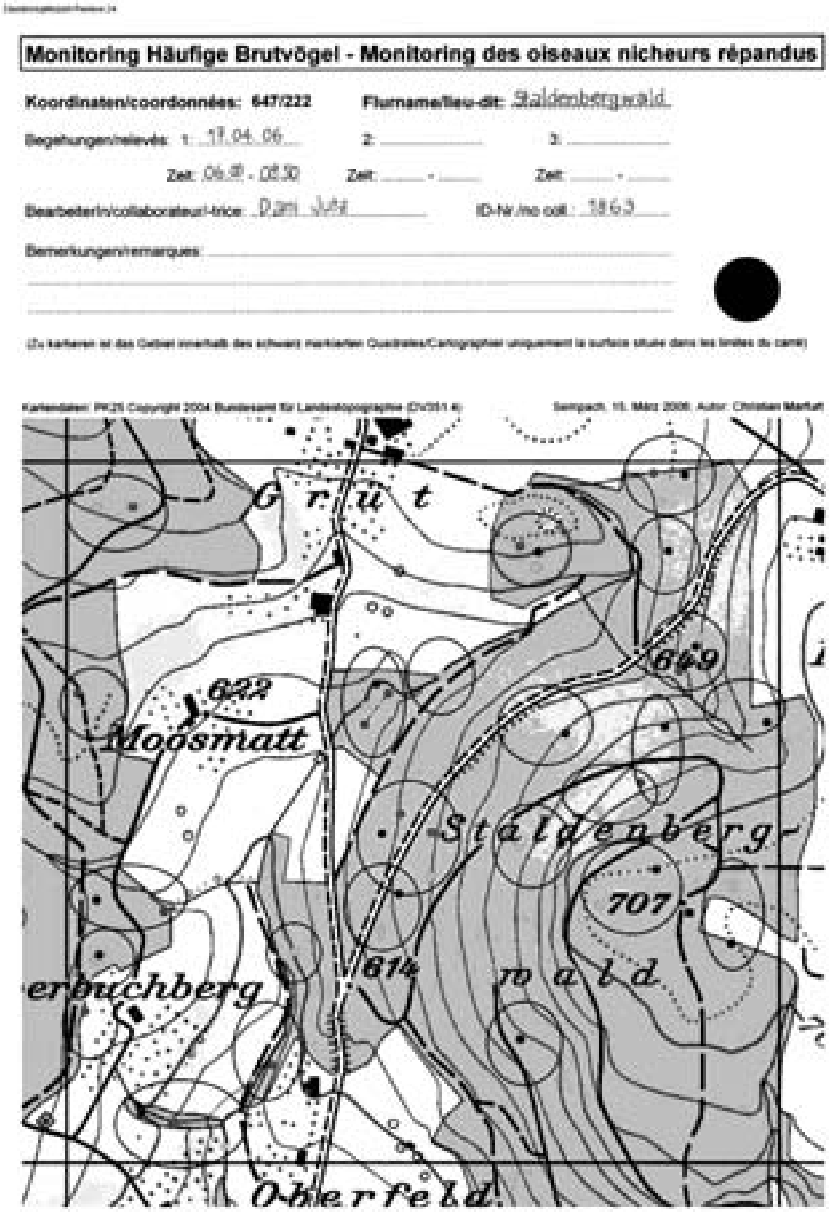
3.5.3 How to count birds in the field?

Hans Schmid

In Switzerland, so far, most surveys have been undertaken using the territory mapping method. The ‘Common Bird Monitoring’ (MHB) scheme, our key scheme for documenting long-term trends, is based on this method. There are a number of reasons for using this method: for example, Switzerland is a very varied country with small-scale habitats. Many of the areas that are particularly interesting from the ornithological point of view, including many wetlands, are only small and are quite simple to survey. In Switzerland, the territory mapping survey method was already in use by the late 1940s. The key early reference on breeding birds in Switzerland (Glutz von Blotzheim 1962) presented this method extensively and recommended it; thus, territory mapping became the standard survey method for ornithologists. For the second Swiss breeding bird Atlas (1993–1996; Schmid *et al.* 1998) territory mapping was also successfully used, although in a somewhat simplified version. As the scheme volunteers readily accepted this simplified version, and as they were already familiar with it, we opted again for it when in 1999 we started the MHB. One of the main advantages is the fact that this method is quite easy to understand, meeting the fieldworkers' ideas about the spatial distribution of the breeding pairs and thus producing results which seem convincing to them. For the controlling work it has the advantage that the procedure can be reconstructed step by step. Its drawback lies in the rather time-consuming office work, which in our case has to be done by the fieldworkers. Also, we probably have to invest more time for checking results at our institute than we would have to with other methods. We tried to compensate for this by developing software, so-called TerriMap (download over www.vogelwarte.ch/id), which is easy to understand and which helps the fieldworkers to digitalise their observations and to add up their territories (Fig. 3.8). This software promotes data transfer and makes the controls by the coordinators easier. Additionally, we get numerous precise localizations of the breeding birds, opening new possibilities for more detailed habitat analyses.

How do we collect the data in the field? The MHB is based on annual counts in 267 kilometre squares, with three visits to each square from mid April onwards. Squares that are situated above the timberline are only visited twice, as there are far fewer species at this altitude, the open habitats are quite simple to survey and the breeding season periods of the species here are more synchronous. Our fieldworkers were equipped with coloured and black and white 1:6000 scale maps, with a map indicating the survey route and a map showing the approach route. Fieldworkers also receive a manual which contains the detailed survey methodology, species lists and the times of first light during the survey period (www.vogelwarte.ch/id). Periodically we also organize one-day-courses for new fieldworkers. For each species, minimum criteria are defined, which must be met, otherwise an observation is not registered. Thus there are seasonal limits for the later arriving migratory birds (e.g., Pied Flycatcher *Ficedula hypoleuca*: 25 April, Garden Warbler *Sylvia borin*: 10 May, Red-backed Shrike *Lanius collurio*: 15 May, etc.). Through this system many conflicts can be avoided as probable migrants are suppressed automatically. Off the seasonal limits, birds must be observed in their potential breeding habitats. For some species, such as Lesser Redpolls

Figure 3.8. *Example of a territory-map of the Winter Wren, produced with TerriMap. The observations made during the 3 visits are produced with different colours.*



Carduelis cabaret in the lowlands, the stricter criteria as defined for the breeding Atlas must be fulfilled.

The survey squares are located at altitudes between 200 and 2500 m asl. Since the breeding period in the higher zones starts later than in the lowlands, there are recommendations concerning the survey period, there are no fixed time limits. As the thaw in the mountains can fluctuate markedly from year to year, a strict limitation on the survey period would be unreasonable. In squares below 1200m ASL, visits should be made between 15th April and mid June at the latest. Between 1200m ASL and the timberline we recommend that fieldwork is conducted between 25th April and 1st July. Above the timberline, the first visit should take place when a large proportion of the square is free of snow and the second by 10th July. It is one of our aims to keep survey effort comparable from year to year. Thus, the survey route (average length: 4-6 km) must remain the same and the time spent in the square should not vary too much. For this reason, new surveyors are told how much time their predecessor had spent in a square. On average, it takes fieldworkers about 45 minutes to cover one kilometre-square.

On the field maps all visual and sound records of potential breeding birds are noted. Compared with the traditional territory mapping method, the number of potential symbols for the observations is reduced. Thus, for example, there are not different symbols to say a bird has been heard or seen. However, surveyors are recommended to mark simultaneous observations because this helps to define the territories later on. To register a territory, a single observation is sufficient. This is a simplification compared to the genuine territory mapping method. This can be justified by the fact that there are only three visits to each survey square. From a sample coverage of additional visits, this finds method approximately 90% of the effectively existing species and about 85% of all territories. Once fieldwork has ended, the volunteers analyse their survey results themselves and complete a standardized recording form. Now, the majority of surveyors uses TerriMap, and produces a CD-ROM, which contains all the maps and data files. Subsequently, they send all field maps and the CD-ROM to our institute. Here we make a thorough check and give individual feedback to each volunteer.

3.5.4 When to count: a case study in the Mediterranean Basin

Sergi Herrando and Lluís Brotons

The objective of most census methodologies is to obtain information on bird abundance as precisely and accurately as possible. To achieve that, there are many important aspects related to the timing of the census. Here we present some considerations on this topic in the framework of the Catalan Common Bird Survey and other ongoing schemes from the Mediterranean countries.

Which season?

Most common bird census schemes focus on breeding populations. Consequently, we should ascertain when the main period that identifies the breeding population in the region is. Monitoring projects in southern European countries might require slightly different seasonal designs than their northern counterparts.

Due to strong climate constraints, the great majority of the species that live in northern latitudes concentrate their breeding periods in narrow time-windows at the end of spring. However, this pattern progressively changes as we move towards southern Europe. In Mediterranean regions, some resident passerines start breeding very early, in February or March or even earlier, whereas some Trans-Saharan migrants only arrive at the beginning of May. Nevertheless, the time-window available for censussing breeding birds in the Mediterranean region may not be as extensive as these patterns suggest. This can partially be explained by the results of studies showing that some populations of both resident and migratory species breed later than populations further north (Blondel and Aronson 1999, Shirihai *et al.* 2001, Moreno 2004) and that the duration of the breeding season may be constrained by hot and dry summers as well (Moreno 2004).

Therefore, in the Mediterranean region, the optimal census period can differ greatly, depending on the particular species. Another important point to be considered, is that breeding birds often overlap in space and time with wintering and migrant individuals of the same species, which may even sing very actively during this period. As we cannot easily distinguish the former from the latter, confusing results may arise if the census period starts too early. Consequently, monitoring schemes tend to set conservative initial censusing dates, in order to enhance the confidence on the census results as reliable estimators of breeding population numbers.

Two main counting strategies are applicable: 1) to concentrate efforts when all species can, at least to some extent, be detected, or 2) to split the sampling strategy into at least two counting periods, a first one for early breeders and a second one for late breeders. The Italian MITO2000 follows the first approach, while the French and the Iberian schemes follow the second one (Table 3.2). However, the definition of precise time intervals is not a trivial task and differences of more than one month are found even among the Mediterranean breeding bird schemes (Table 3.2).

Table 3.2. *Seasonal time schedules applied in 2006 for the existing national and regional census schemes that are located in the Mediterranean region.*

Scheme	***Location***	***1^{st} period***	***2^{nd} period***	***Info source***
MITO2000	Italy	1^{st} May - 30^{th} June		www.mito2000.it/downloads/istruzioni_mito.pdf
STOC-EPS	France	1^{st} April - 8^{th} May	9^{th} May-15^{th} June	http://www2.mnhn.fr/vigie-nature/spip.php?rubrique2
SOCA	Andorra	15^{th} April -15^{th} May	16^{th} May-15^{th} June	http://www.adn-andorra.org/index.php?option=com_wrapper&Itemid=43
	Catalonia & Balearic Islands	15^{th} April -15^{th} May	16^{th} May-15^{th} June	www.ornitologia.org/monitoratge/soccinstruccions.pdf and www.gobmallorca.com/ornit/sac/index.htm
SACRE	Spain	15^{th} April -15^{th} May	16^{th} May-15^{th} June	www.seo.org/media/docs/Instrucciones%20sacre06.pdf
CAC	Portugal	1^{st} April - 30^{th} April	1^{st} May-31^{st} May	www.spea.pt/conteudos/CACInstrucoes_Mar2007.pdf

Similar principles should be taken into consideration to develop a bird monitoring project in the winter season. The Mediterranean zone has a shorter winter time-window than that of the Boreal zone. Designs of winter schemes also need to minimise the influence of bird movements, something that may be impossible to some extent in a season in which unpredictable resource availability and/or weather conditions may induce erratic movements from one area to another. The wintering censuses of the Catalan Common Bird Survey start on 1^{st} December and finish on 31^{st} January, but further research would probably be required in order to determine the influences of the time-window on the estimation of winter populations.

Finally, it is worth raising the issue of another particular characteristic of the Mediterranean region with respect to many other regions in Europe: the altitudinal gradient. When designing a monitoring project in any Mediterranean country, as well as in many other European countries, one should take into account its complex topography. Altitudinal changes of more than 2,000 m asl are common all around the basin, which could be equivalent to latitudinal effects of moving thousands of kilometres to the north or south. A first obvious solution to this problem could be to allow flexibility in censusing date, in order to allow matching the sampling to local differences in bird detectability associated with altitude. In the Catalan case, breeding censuses carried out in subalpine and alpine belts are allowed to be delayed from one to four weeks depending on the altitude (the higher the altitude, the greater the delay). However, at present, there is not a standardised rule, since factors other than altitude itself, such as slope,

orientation and winter snowfall, can play a determining role in the snow melting, and each observer has to select the best days for conducting the censuses. The Italian MITO2000 is another example in which the census period is also adjusted, according to both altitude and latitude.

What time of day?

Detectability is a crucial aspect to determine the duration of a particular census and the precise time of day in which it should be carried out. If detectability does not vary through the day, censuses could potentially be conducted at any time, be very long and accumulate many field records. Obviously, this is not the case. It is well-known that breeding passerines are much more detectable early in the morning than in the middle of the day, and have a second but shorter peak close to dusk (Robbins 1981); however this pattern may also depend on the latitude. Probably, daily changes in detectability are more marked in southern Europe, where high temperatures around the middle of the day sharply reduce bird detection. Breeding bird monitoring schemes in northern European countries allow up to 5-6 consecutive hours of field work (e.g. Koskimies and Väisänen 1991), but a time-window of 3-4 hours is commonly advised in the Mediterranean region.

Daily patterns of detectability have been less studied in the winter. Again, differences between the Boreal and Mediterranean regions are clear. In the northern countries, all daylight hours may be needed to conduct a single census in winter (e.g. Koskimies and Väisänen 1991). In the Mediterranean region, where there would be time to conduct more than one count per day, morning and afternoon censuses may show significant differences in bird richness and abundance (Herrando *et al.* 2007).

3.5.5 Detectability and distance sampling: principles of bird surveys

Marc Kéry

Surveys and censuses

Bird *censuses*, i.e. complete enumerations (counts of all individuals in an area), hardly exist in practice, instead we usually deal with population *surveys*, i.e. incomplete enumerations (counts of a proportion of individuals in an area). Fundamentally, 'counting' birds means sampling a population. Two kinds of sampling processes can be distinguished in surveys, a spatial sample and a sample of individuals (Williams *et al.* 2002). Surveys must be designed and analysed in a way that permits unambiguous interpretation of the resulting data.

The first principle: Bird surveys as spatial samples

Typically, the area of interest is much bigger than the area that can be surveyed; for instance, when inference about an entire country is desired. Usually, only a number of sampling units (e.g. $1km^2$ quadrats) can be surveyed. To be able to apply the laws of probability to the problem of formally scaling up from the sampled quadrats to the entire 'population' of quadrats, e.g. the whole country, the only valid method of selecting the individual sample quadrats is some sort of random selection, with stratification and, with small limitations, regular sampling along a grid, being equally valid procedures.

Even when no formal extrapolation from the sampled quadrats to the entire country is required and one just wants to say that what is observed in the sampled quadrats tells us something about the entire country, we still need some random mechanism to select our sample as a guarantee that our sample is representative of the entire country. Deviations from this ideal may be unavoidable in many cases. However, it is important to realize that this creates a risk of losing the ability to generalize to the entire area about which inference is desired.

The second principle: Bird surveys yield only samples of individuals

Even within sampled quadrats, we typically cannot count all individuals present. Instead, we only observe a fraction or a *sample* of the entire population size in a quadrat. This is formalized by the Most Important Formula (MIF) of monitoring. Ignoring double-counts, we can write

$$E(C)=N*p$$

where E denotes the expectation (long term average) of a count C, which is related to local population size N by a proportionality constant p, detection probability (=detectability). As an example, assume that 16 greenfinches are present in a quadrat (N=16) and that each has some probability of being seen or heard by the surveyor, say, p=0.6. The MIF then tells us that on average, 9.6 greenfinches are detected on any survey.

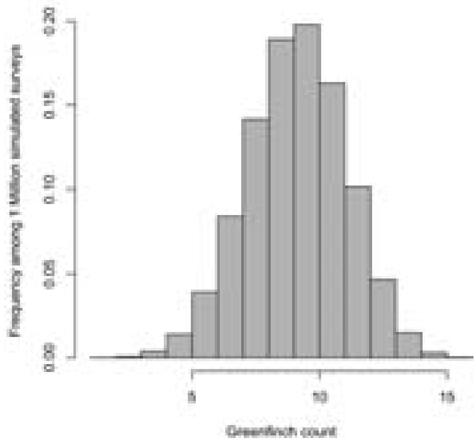
Technically, C is random variable: even under 'identical' conditions, repeated counts conducted in the same quadrat will vary one from another whenever detectability is not perfect (p=1). From statistical theory, this variation is known to be well described by a Binomial distribution, $Bin(N, p)$, that is, each count can be assumed to be a draw from a binomial distribution with 'trial size' N, the number of birds present, and parameter p, the per-bird detection probability.

Fig. 3.9 plots the results of 1 million simulated surveys in a quadrat with 16 greenfinches with detectability equal to 0.6. Counts in individual surveys were (very rarely) as low as 0 or as high as 16, and most clustered around the average of the distribution, which is given theoretically as 9.6, fairly close to the observed mean of 9.597.

A widespread waste of information

An important consequence of the view of bird counts as random variables is that the widespread practice of discarding the lower of, say, two repeated counts represents a waste of information. Excluding any unusual effects, such as thick fog, strong wind, or the timing of counts in relation to the arrival of migrants, both

Figure 3.9. *Plot of 1 million realisations of a Binomial distribution with N = 16 and p = 0.6. In our example, this shows how frequently each possible count appears in a quadrat where there are 16 greenfinches with each of them having a 60% chance of being detected.*



counts are equally valid indices of abundance. Only retaining the higher amounts to throwing out 50% of the available information about relative abundance. The only sensible approach to such replicated counts is to use averages (or equivalently, totals) as measures for relative abundance or use a binomial mixture model to estimate absolute abundance, see below.

Importance of detectability

The situation encapsulated by the MIF creates a dilemma because what we want in monitoring is population size *N*, but what we observe is a contaminated (by detectability *p*) version of *N*. Hence, bird counts are just *indices* of true population size *N* and, without additional information, we have no idea how close these indices are to true abundance.

Worse yet, the 'proportionality constant' *p* is far from constant, instead it is influenced by any number of factors, some of which have to do with the birds, some with the observers, and some with the environment (e.g. Bibby and Buckland, 1987, Diefenbach *et al.* 2003, Norvell *et al.* 2003, Kéry *et al.* 2005, Alldredge *et al.* 2007b, Amrhein *et al.* 2007). Factors potentially affecting detectability of a bird include species, sex, age, mating status, stage in the breeding cycle, social rank or distance of its territory to the observer. Further, identity, experience, age, number of hours slept during the preceding night will typically vary among observers and affect the detectability of a bird. Finally, population density, habitat type, weather, season, and time of day have all effects on detectability, too.

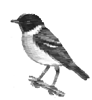
The implications of the MIF are two-fold; first, abundance is typically *under-estimated* by raw counts and second, patterns in detectability are confounded with patterns in abundance. For instance, like many other songbirds, unmated nightingales sing at higher rates than mated ones and therefore their detectability is much higher. If for some reason the adult sex ratio in a population changes towards more males, more of them will remain singles which will automatically entail higher rather than lower *counts* (Amrhein *et al.* 2007). Similarly, if everything else is constant, a study of bird populations on a restocked clearfell will automatically find declining *counts*, because increasingly dense vegetation reduces the maximum distance to which individuals can be detected (Bibby and Buckland 1987). Finally, climate change, with its associated changing weather patterns such as earlier springs, has a large potential for introducing spurious effects into *counts* of birds, for example by producing an increasing mismatch between the timing when surveys are conducted and the time of optimal species detectability.

In the view of some (e.g. Buckland 2006), detectability is therefore a central issue in bird surveys. There are different ways of dealing with detectability, depending on the interest in *relative* vs. *absolute* abundance, whether it is possible to sufficiently *standardize* counts and the availability or costs of gat hering *extra information* to formally estimate *p*.

Absolute abundance

Sometimes one is interested in absolute abundance. Examples may be surveys of rare and endangered species where the true number of individuals must be known to project population viability, or conversely, the number of a fish-eating species, where actual numbers of mouths need to be known in order to evaluate impacts on prey populations. In this situation, there is no way around formally estimating detectability *p* and therefore also *N*. There are many different protocols that can be used to estimate *N*, e.g. distance sampling (Buckland *et al.* 2001, 2004), various capture-recapture types of methods such as multiple-observer or time-at-detection methods (Alldredge *et al.* 2007a, b) or binomial mixture models (Kéry *et al.* 2005, Royle *et al.* 2005). The first obtains information about *p* from detection distances, while the two latter examples use repeated surveys of a closed population.

In essence, all these methods boil down to rearranging the MIF to $\hat{N} = C / \hat{p}$ (hats denote estimates). Hence conceptually, abundance *N* is estimated by dividing the observed count *C* by an estimate of the probability with which an individual in the population appears in the count (detectability). Different methods of abundance estimation differ by the way how the estimate of *p* is obtained. In the last few years, research on abundance estimation has increased, and Buckland et al. (2001, 2004), Williams et al. (2002) and Nichols et al. (in review) represent valuable syntheses.



Relative abundance and the index assumption

Most people would claim that they are not interested in absolute abundance but rather in relative abundance. They want to be able to detect population changes or say which regions or habitats are better than others in terms of abundance of a species. In this case, raw counts may be enough, provided that counts have a constant relationship with true population size. Thus the average detectability must be constant across desired dimensions of comparison. If one is interested in population trends, trends in counts are only valid indices of true population trends in the absence of any temporal trends in detectability. If interest is on spatial comparisons only, e.g. of regions or habitats, temporal trends in detectability are usually irrelevant. Instead, the absence of differences among regions or habitats in detectability is essential to make valid inference based on the raw counts.

Legitimate interpretation of raw count data in monitoring programs therefore requires that the index assumption be met: average detectability must be constant across dimensions of comparison. As an insurance against detection of spurious patterns, it is therefore imperative to monitor detectability to test this essential assumption. To produce scientifically defensible ‘numbers’, monitoring schemes should provide quantitative evidence showing that the index assumption is met adequately. This requires that distance or capture-recapture-type information be collected in at least a subsample of quadrats.

Standardization

Conceptually, the variation in counts e.g. over time or across space is the sum of the variation of true population size and the variation of detectability. When interest is on relative abundance, it is therefore important to *standardize* which aims to reduce variation in the latter. In theory, if standardization was perfect, variation in detectability would be zero and all variation in counts would be due to variation in abundance. Monitoring schemes should therefore have a strong interest in standardization.

There are three ways to standardize a monitoring scheme: in the design, analysis and by directly estimating detectability. All schemes usually contain some elements of standardization by design, for instance sampling area (e.g. 1 km^2), effort (e.g. 3–4 hours), daytime (e.g. first daylight hours) or timing of surveys (e.g. 15th April–15th July) may be prescribed. This will directly eliminate some nuisance variation in the counts due to different sampling areas and different detectability over a morning, across the season or owing to variation of effort. This sort of standardization is well understood by most scheme organisers.

The second kind of standardization is covariate modelling. Factors that cannot be or have not been made constant *during* the surveys may be quantified and their effect removed *afterwards*. Such factors can be introduced as covariates into the

analysis of counts using some plausible model of the functional form of their relationship (e.g. Link and Sauer 2007). This sort of standardization is not yet sufficiently used in many monitoring schemes. There are a host of readily available factors that are known or suspected to affect detectability and therefore counts, such as observer identity, experience, survey duration, timing and daytime. Introducing them as covariates into a trend analysis, e.g. in TRIM, should greatly reduce the bias and increase the precision of estimated trends from counts.

Third, formal estimation of abundance is the ultimate standardization of counts. Provided that the model to estimate p and N is adequate, all counts are made fully comparable because any distorting effects of detectability are entirely eliminated.

In practice, except for formal abundance estimation, standardization can never be perfect, since many factors relevant to detectability cannot be standardized, e.g. climate, traffic noise or observer identity, or because they have not been measured or even recognized. An important issue with covariate modelling is to standardize for nuisance effects on counts but only covariates that are *uncorrelated with abundance* itself must be used; this may restrict this option in many cases (e.g. habitat effects may be relevant to both abundance and detection). Therefore, even in strongly standardized monitoring schemes, formal estimation of detectability, perhaps in a random subsample, as a test of the vital index assumption is highly desirable.

3.5.6 How to work with volunteer counters: Czech Society for Ornithology "Members to Members" training course

Steven O´Connor

Introduction

This week-long course aims to provide members of the Czech Society for Ornithology (CSO) with intensive practical and theoretical training in key aspects of ornithology. The objectives are to recruit new fieldworkers for monitoring schemes and improve the standards of those already participating in schemes either organised by the CSO or in their own amateur based research projects, through improving skills and knowledge of CSO members.

The principles of the course are to: build up a scientific approach to ornithology, share experiences, work in a team, and learning from practical experiences.

This case study refers to the course run from 26th May to 2nd June 2007.

Location

The course took place in the village of Jizerka located on the upland plain in the Jizera Mountains, Northern Bohemia. The altitude is between 800 and 1000 metres asl. The area was heavily damaged in 1970s and 1980s by acid rain and ensuing extensive loss of tree cover, but has since been replanted with conifers and, to a lesser extent, indigenous broad-leaved species. A number of peat bogs are also found in this area. Notable bird species here include Black Grouse *Tetrao tetrix*, Meadow Pipit *Anthus pratensis*, Whinchat *Saxicola rubetra* and Common Snipe *Gallinago gallinago*.

Participants

The twelve participants were all CSO members who had been selected by the programme organisers from a wider pool of applicants. Selection was based on questionaires which all applicants were requested to complete in advance. The organisers took into account the applicant's knowledge and experience of ornithology as well as their motivation for taking part in the course. Each participant paid a €50 fee to cover basic overheads associated with the course – (rental of training centre, accommodation, training materials). The group was mixed in terms of age (from high-school students through to pensioners) and experience (several participants were seasoned bird surveyors and were or had been students of zoology, others were birding 'enthusiasts' with little or no formal grounding in ornithology), although only two of the trainees were women.

Structure

The course comprised two elements – **lectures** on theoretical aspects of the science of ornithology, and **fieldwork** that allowed the participants to put some of the theory learnt into practice. Fieldwork was allocated mainly to the morning sections of the course, while lectures and related discussions followed in the afternoon and evening.

The lectures covered a range of themes that included:

- Methods used when conducting ornithological field research;
- Analysis of research data including basic statistics;
- Interpretation of research results;
- Bird identification and some ringing training;
- Trends in breeding birds in the Czech Republic;
- Bird ecology and ethology.

The course was led and coordinated by two CSO personnel. The lecturers were CSO staff and academics working professionally in the field of ornithology. They were supported by leading amateur ornithologists who provided practical insights on the skills needed for effective and reliable bird identification. All the lecturers, as well as the CSO staff leading the course gave their time free-of-charge and covered their own travel costs, hence the title of the programme "Members to Members".

The fieldwork element was structured around a research project that the participants were required to conduct throughout the course. The objective of the research was to establish the ornithological value of two selected localities within the Jizera Mountains. The participants were split into two groups (each a combination of experienced and novice trainees) and given a locality in which to conduct their surveys. The groups then selected the methods to be used in the research and set up the plan and design of the research. The planning process was largely done by the groups, but with some supervision from the course coordinators. Field methods included the use of Timed Species Counts, MacKinnon lists and point counts for estimating relative species abundance and species composition, accompanied by searching for nests, and some small scale ringing. Field research was carried out on five of the seven days of the course.

Outputs & results

Each group had to manage and analyse the data collected and to produce a report. At the end of the training course, a representative of each group gave an oral presentation to the other participants on their group's research findings. Also, a joint article on the results was published on the internet. The wider result of the course was that a core of CSO members have been trained in the basic principles of ornithology and are now able to support CSO in its future research projects. The participants have been encouraged to submit their collective research results for publication in a national ornithological journal.

Observations

The relevance and usefulness of the course largely depended on the level of competence of the individual participants – the emphasis on the 'scientific' aspect of ornithology suited the needs of the more experienced trainees, whereas those less experienced found the course significantly more challenging.

The course structure and timetable was physically demanding on all the trainees. The daily programme involved an early start (5am) to conduct field research. The counting methods selected by the groups meant a daily 8-12km walk across hilly terrain which usually took some 6 hours to complete. Following a break around midday for lunch, and recuperation, the participants then had two blocks of lectures, plus a free discussion session that ran into the late evening hours. Inevitably this had an impact on trainees' powers of concentration, particularly in those lengthier afternoon lecture sessions.

The efforts invested by the CSO in organising the course were significant. The costs of running the programme were kept neutral by the CSO only due to the willingness of CSO personnel and lecturers to provide their inputs free-of-charge and because the training facilities were owned by a local environmental NGO who were willing to provide them at a preferential rate. While the organisers were ultimately satisfied with the results of the course, there was also a recognition that

such an undertaking could be demanding on the relatively limited capacities of the CSO.

The overall assessment from participants on the theoretical element of the programme was broadly positive; 58% rated it as positive, 34% as neutral, and 8% as negative. The relevance of the themes was rated 70% positively, although presentation of the themes was given a more mixed assessment. The learning value of the lectures largely reflected their relevance (again some 70% positive responses). Those lectures focussing on identification of specific species (particularly raptors) were rated most highly whilst those related to statistical methods and quantitative analyses were least positively assessed.

The CSO's overall assessment of this type of course (three such courses have been organised to date) has also been generally positive: some two thirds of participants started contributing as fieldworkers to some of the CSO monitoring schemes, whilst others have started or improved their own research, or have taken part in organisational work (e.g. CSO working groups). Participants have remained in contact with each other, thus creating new small volunteer-based ornithological teams throughout the country. Despite the relatively low number of participants it is expected that this type of training will improve the quality of monitoring schemes and other research and monitoring activities that involve the use of volunteers.

3.5.7 Pilot studies and preparatory work

Svetoslav Spasov

General Information

The idea of launching a national Common Bird Monitoring (CBM) scheme in Bulgaria emerged at the end of 2002 when a PECBMS workshop was held in Prague, and which a representative of the Bulgarian Society for the Protection of Birds (BSPB) attended.

In 2004, BSPB/BirdLife Bulgaria launched the pilot CBM scheme. This happened thanks to the methodological and financial support provided by the RSPB (BirdLife Partner in the United Kingdom).

Preparation and planning

The goals we would like to achieve by establishing a national CBM scheme are as follows:

- to develop a national biodiversity indicator based on common birds;
- to contribute to the Pan-European wild bird indicator;
- to develop and increase the capacity of BSPB.

The following points were taken into consideration when selecting the methodology and sampling design:

- the methodology should meet certain scientific criteria;
- the sampling design should guarantee the representative character of the covered habitats;
- the participation in the scheme should be entirely voluntary, i.e. the participants should not be reimbursed for travel expenses, etc.;
- the methodology should be as simple as possible allowing for the less experienced participants to apply it;
- the survey of sample plots should not take much time, i.e. the sample plots should not be too far away from the participants' places of residence so that they can have easy access and less travel expenses.

Out of all available methodologies, the line transect count was chosen as the most suitable for the following reasons:

- it is more suitable for open terrain (most of the sample plots are situated in open farmed areas);
- BSPB volunteers have experience in transect counts – the majority have used this methodology when surveying Important Bird Areas and prefer it to the point count method;
- this methodology has been successfully used in other European countries and experience is easily available from these countries.

The successful use of line transects in the UK and other European countries, as well as the methodological support of the RSPB, have also influenced our choice. The methodology of CBM in Bulgaria is based on the one used in the UK Breeding Bird Survey (BBS).

Sample plots are $1km^2$ in size, with two parallel transect lines divided into 200m sections. All birds are recorded in three distance categories (0-25, 20-100, over 100m), and birds in flight are recorded separately. The Bulgarian and UK schemes differ mainly in the types of habitats and the number of habitat levels. The Bulgarian scheme has adopted two habitat levels rather than four as in the UK. The CORINE Biotopes classification has been used – eight main categories and 42 subcategories of habitats on the territory of Bulgaria.

In order to ensure the CBM's sustainability, the choice of sample plots followed the basic rule that volunteers should have relatively easy access to their plots. This means that participants should not travel long distances to count their sample plots. This prerequisite is essential for the annual participation of volunteers since they are not reimbursed for travel expenses. The economic factor in volunteering in such activities has always been important for Bulgarians because the monthly per capita income is significantly below the European average. Thus, volunteers should not be required to travel long distances since this may place a significant financial burden on them and make them withdraw from the scheme.

This problem has been overcome by stratification by regions. Each observer chooses one 10x10km UTM square or region where they are able to count (usually near to where they live or another place which they may visit regularly). The 10x10km UTM squares or regions are divided by GIS into smaller (1x1km) squares and one of them is randomly selected.

A detailed map (1:25 000) of each sample plot is prepared using GIS. The map shows the relief, directions, scale, vegetation (open areas or forest), UTM square number and the fieldworker's name.

At the beginning of 2004, the first step in building a national network of participants in CBM was to assess the number of potential volunteers among BSPB members. Information collected by the regional coordinators of BSPB branches helped us to draw up a list of potential participants who had experience in similar activities and good skills in bird identification. Involving the people on this list was a priority in order to be able to launch the scheme in Bulgaria.

In addition, we made a second list of people who were not BSPB members but who were also potential participants in the scheme.

Materials for the volunteers

Apart from the maps of sample plots and the survey forms, all participants are provided with a CD containing the songs and calls of 72 common bird species and a field guide of widespread birds in Bulgaria. Both the CD and the field guide are made specially for the volunteers and are distributed to them for free. The field guide features pictures and descriptions of the species as well as a detailed description of the goals, methodology, basic habitat types and instructions on how to complete the CBM survey forms.

Establishing the network of volunteers

The recruitment of volunteers began before the 2004 breeding period, with a detailed description of the scheme featured in the BSPB magazine and on the BSPB website. This was an important step towards popularizing the scheme, especially when the information was provided by renowned people within the organization, such as the executive director, the conservation director and the most active members. Meetings in all regional BSPB offices and branches followed and were attended by the people on the list, as well as by other BSPB members interested in fieldwork. At the meetings, we presented the idea behind the CBM scheme, raised people's awareness about its importance to nature conservation and explained the methodology. At the end of each meeting, the people willing to volunteer in the scheme would choose a region where they were able to cover one or more sample plots. We held meetings in eleven towns within ten days. People from 13 other towns joined later after we had telephone conversations and exchanged emails with them. The website attracted new members and volunteers – some of them living in towns where the BSPB does not have branches. By the end of April 2004, 148 volunteers from 24 towns were recruited. It turned out that at the end of the field season, 75 participants had covered their sample plots, more than the expected 30 to 50 participants for the first pilot year. Despite the fact that almost half the number of people who were at first willing to participate had not covered their sample plots, the number of people who were genuinely interested in the scheme showed that the scheme certainly had the potential for growth.

In the spring of 2005 and 2006, we organized a series of meetings, lectures and workshops locally. In 2005, there were 129 volunteers and in 2006, 153.

Over 60 volunteers who participated in the pilot year (about 90%), have continued their participation in subsequent years.

Although the total number of volunteers is growing each year, the number of experienced volunteers has reached 70 and will probably remain steady for a long time. In order to expand the network of volunteers collecting quality data, it is essential to train the young participants, who are mostly biology students at university. Thus training is an important part of the coordinator's duties. The training involves lectures, discussions and field training that focus on bird identification and uses the survey methodology during the annual volunteer camps.

Feedback on the volunteers' work

Feedback is very important when working with volunteers. BSPB publishes a newsletter on the CBM scheme twice a year – before and after the field season. The newsletter features materials about the scheme and additional information about birds, their biology and identification. After all completed survey forms are collected, a thank you letter is sent to all participants who have covered their sample plots, together with the second newsletter.

Participation of other organizations

Although over 90% of CBM volunteers are BSPB members, other organizations also take part in the scheme. Our official partners within the scheme are the "Balkani" Wild Life Society, "Fund for the Wild Flora and Fauna","Central Balkan" National Park, "Rila monastery" Nature Park and UNDP/GEF "Rhodope" Project. Despite only small number of volunteers from these organizations participating, their involvement and support are of strategic importance to the popularization and official recognition of the CBM scheme.

Overcoming difficulties

During the short field season, there are other kinds of fieldwork under the BSPB's various nature conservation projects, as well as CBM fieldwork. As a result, there is competition among the nature conservation projects when it comes to engaging experienced volunteers in fieldwork. The CBM scheme is the only BSPB fieldwork activity which is carried out without reimbursing the participants for their expenses. Moreover, CBM volunteers work individually whereas teamwork

is more common with the other fieldwork activities. Some volunteers prefer to take part in paid activities, which are more attractive because they involve teamwork, and often they then do not have time to cover their sample plots. There is a complex solution to this problem, but one way to overcome it is by increasing the number of volunteers and improving the communications between the coordinators of the individual projects within the organization. In order to encourage volunteers' participation in the CBM scheme, we organize an annual raffle for those who have covered their sample plots in accordance with the methodology. The prizes are binoculars and field guides of the birds in Europe, and are awarded at the annual BSPB meeting at the beginning of August. By then, most of the participants have submitted their completed survey forms and can thus participate in the raffle. The annual meeting offers opportunities for some team building and discussions about the CBM scheme.

Working with volunteers – useful tips

- the regional coordinators and the national CBM coordinator should maintain regular contact with volunteers and discuss matters concerning the CBM scheme, as well as other issues;
- meetings with volunteers, workshops and presentations should be organized just before the beginning of the field season, i.e. in March and April;
- in the middle of May the coordinators should check how many volunteers have done the first count and remind those who have not to make at least the second visit;
- volunteers should be provided with thank you letters, newsletters, website link, etc, at the end of the field season;
- volunteers should be reminded that common birds are very important, agricultural habitats are as important to common birds as to some globally endangered species such as the Imperial Eagle *Aquila heliaca* and Red-breasted Goose *Branta ruficollis*, and that their participation in the CBM scheme contributes not only to conservation of common birds but to nature conservation in general, etc.

3.5.8 How to design data forms: the case of the Catalan Common Bird Survey (SOCC)

Gabriel Gargallo and Sergi Herrando

Data forms are completed by the participants of a given monitoring scheme with their field observations, before these are computerised. Here, we present some basic considerations that may help optimising their design. These are based on the experience that we have gained in the framework of the Catalan Common Bird Survey.

How will data be computerised?

Before designing a data form, one crucial question that should be taken into account is how the survey data is to be computerised. There are two main ways to carry this out:

1) using scanning and digitalisation systems that transfer the data of each form directly and automatically into a database. They require a very specific design to reduce interpretation errors and enable efficient data computerisation, which, on the other hand, limits its general use.
2) entering data manually using specific data-entry software

All our data forms belong to the latter class and, hereafter we focus on this particular case.

The use of online databases for entering field data is also becoming popular now (see Chapter 3.5.9 for a case study).

Field use

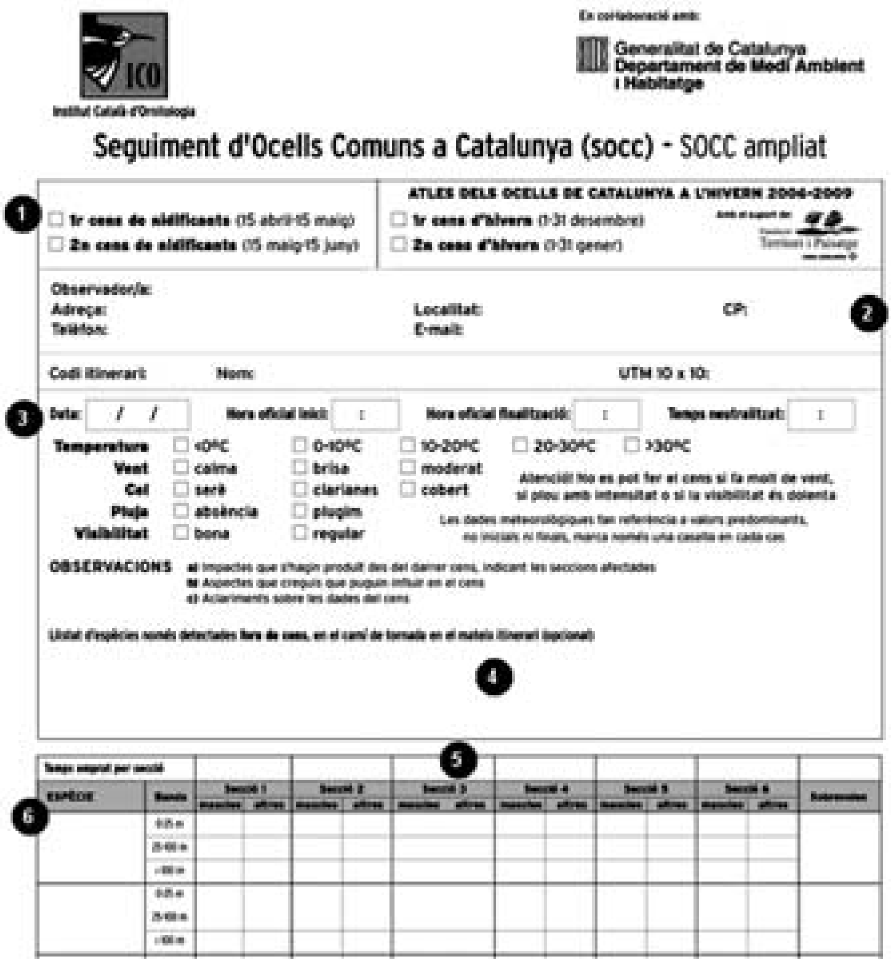
We strongly recommend using data forms that are to be directly completed in the field rather than as an intermediate step between field annotations and data entry. We can reduce the rate of errors and omissions by making the form user-friendly. There are two reasons for this: 1) the risk of forgetting to collect important data increases greatly if participants record field data in their own notebook; 2) data transfer from notebooks to the 'official' data form can lead to a number of transcribing mistakes, especially if this is done a long time after the fieldwork has finished.

Some participants simply do not want to use even the best well-suited data form in the field, or may find them impractical. However, the better the data form is designed for field use, the less likely it is that participants will use their own field notes.

Three main considerations should be taken into account to design more user-friendly data forms: 1) the width of each field should facilitate annotations (too often, forms are so dense that their field use is unfeasible); 2) print forms should allow the use of pencil which is much more water-proof than most pens; 3)

participants should understand that, by using data forms in the field, data quality benefits and they will save time to themselves and the project. For example of field data form used in SOCC see Fig. 3.10.

Figure 3.10. *Field data form used in the Catalan Common Bird Survey (SOCC). Numbers indicate main subdivisions: 1) Census period (breeding season/winter); 2) Observer details (name, address, email…); 3) Date, timing, neutralised time and meteorology (temperature, wind speed, sky conditions, rain, visibility; including a warning not to run the census in unfavourable conditions); 4) Observations on impacts detected in the area (sections affected) and list of species observed out of the census (when returning back); 5) Time employed to make each section (6 in total); 6) Census data (species, distance band, section (males/others), birds flying over).*


Institut Català d'Ornitologia
En col·laboració amb:
Generalitat de Catalunya
Departament de Medi Ambient i Habitatge

Seguiment d'Ocells Comuns a Catalunya (socc) - SOCC ampliat

1 ☐ 1r cens de nidificants (15 abril-15 maig)
☐ 2n cens de nidificants (15 maig-15 juny)

ATLES DELS OCELLS DE CATALUNYA A L'HIVERN 2006-2009
☐ 1r cens d'hivern (1-31 desembre)
☐ 2n cens d'hivern (1-31 gener)

Observador/a:
Adreça: Localitat: CP: 2
Telèfon: E-mail:

Codi itinerari: Nom: UTM 10 x 10:

3 Data: / / Hora oficial inici: : Hora oficial finalització: : Temps neutralitzat: :

Temperatura	☐ <0ºC	☐ 0-10ºC	☐ 10-20ºC	☐ 20-30ºC	☐ >30ºC
Vent	☐ calma	☐ brisa	☐ moderat		
Cel	☐ serè	☐ clarianes	☐ cobert		
Pluja	☐ absència	☐ plugim			
Visibilitat	☐ bona	☐ regular			

Atenció! No es pot fer el cens si fa molt de vent, si plou amb intensitat o si la visibilitat és dolenta

OBSERVACIONS

Llistat d'espècies només detectades fora de cens, en el camí de tornada en el mateix itinerari (opcional):

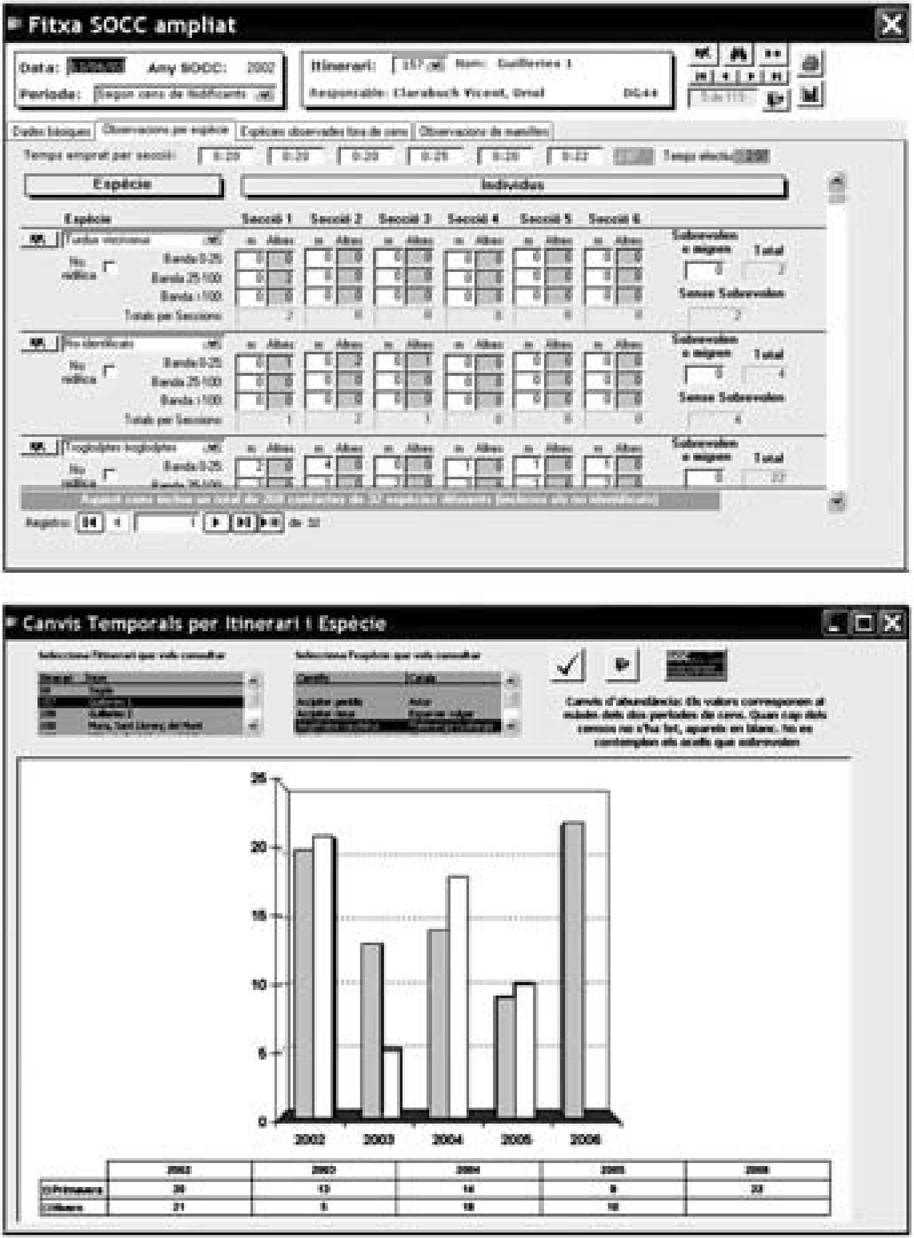
4

5

6

ESPÈCIE	Banda	Secció 1 mascles	Secció 1 altres	Secció 2 mascles	Secció 2 altres	Secció 3 mascles	Secció 3 altres	Secció 4 mascles	Secció 4 altres	Secció 5 mascles	Secció 5 altres	Secció 6 mascles	Secció 6 altres	Sobrevolen
	0-25 m													
	25-100 m													
	>100 m													
	0-25 m													
	25-100 m													
	>100 m													

Figure 3.11. *Two screenshots of the software used to computerise and visualise data from the Catalan Common Bird Survey (SOCC).*



Note that this overall recommendation in favour of the use of standardised data forms in the field may not make sense in some particular cases (e.g. more complex census techniques), but seems appropriate for most monitoring schemes.

From paper to computer

In the case of the Catalan Common Bird Survey, we encourage our collaborators to send their data already computerised and we ask them to keep their original paper form so that it is always possible to refer to them, if necessary. It would also seem useful to ask collaborators to send a paper copy of their forms together with their computerised data, however, this option adds postal, space and processing costs in exchange of a rather limited benefit (a paper copy that can be double checked).

In general terms, it seems better to invest in the implementation of good data entry software that allows basic data validation procedures and gives participants the option of preparing automatic summary tables and graphics before data are finally submitted (Figure 3.11). The latter are especially useful for detecting omitted species and count errors while automatic validation procedures built in to the software can highlight many mistakes related to species identification. For instance, when someone tries to enter data from a breeding bird census of a species that only mostly occurs in winter a pop-up window warns of the possible error. Depending on the nature of the possible error, the software allows the user to reconfirm the record or directly prevents them entering some combinations of species, season or region that are predefined as 'not allowed'.

In our case, the data entry software was developed using Microsoft Access. Each participant receives a personalised version with all his data. Currently, 70% of the volunteers use the software to enter the data and the remaining 30% send it on paper. Data arriving as paper forms are subsequently computerised by specifically trained staff members.

Data forms and data entry software

It does not matter if it is the surveyor or the project coordinators who computerise the field data, the forms should be designed to match the design of the data entry software. It is very important, therefore, to develop both designs in parallel. It is particularly important that the order in which the fields are arranged in the data form strictly match the order in which they appear in the data entry software. This allows a more efficient data entry process. For similar reasons, it is also important that field names, codes and abbreviations are exactly the same in both cases.

3.5.9 Development of an online system: online data management for Common bird monitoring in the Czech Republic

Tomáš Telenský and Zdeněk Vermouzek

The situation

The common bird monitoring scheme in the Czech Republic has been run by the Czech Society for Ornithology (CSO) since 1981. The scheme is based on a point count method with 20 points per transect, two distance categories and two counts per transect per year, and uses volunteer surveyors. The habitat is classified at each point, by recording the proportions of 10 defined habitat classes.

The data were originally collated on paper forms only, but in 2005, data collection on Excel spreadsheets was introduced. Finally, in 2006, it was decided to make a big change and switch to online data collection. Changes are always demanding on volunteers, and coordinators did not want to discourage them; the aim was to emphasise that the change is a positive one for the volunteers too. Setting up the online data collection was based on following principles:

- online data collection was made optional to surveyors, but was strongly recommended. Every surveyor is given the choice of one of three ways to submit data: paper form, Excel spreadsheet, and online;
- the user interface must be clear and friendly. Data entry must be easy and pleasant, as easy as or easier than filling in a normal paper form;
- the online system should produce simple summary statistics at a site level for each surveyor, to reward the data submission immediately;
- surveyors must be allowed to export their data from the web in a suitable form, so that they do not lose the sense of actually owning the data they have collected;
- selected surveyors should be involved in the development and testing of the software, so that they can comment on the system before it is introduced to all surveyors;
- online data submission should be motivated by small gifts to those who use the system.

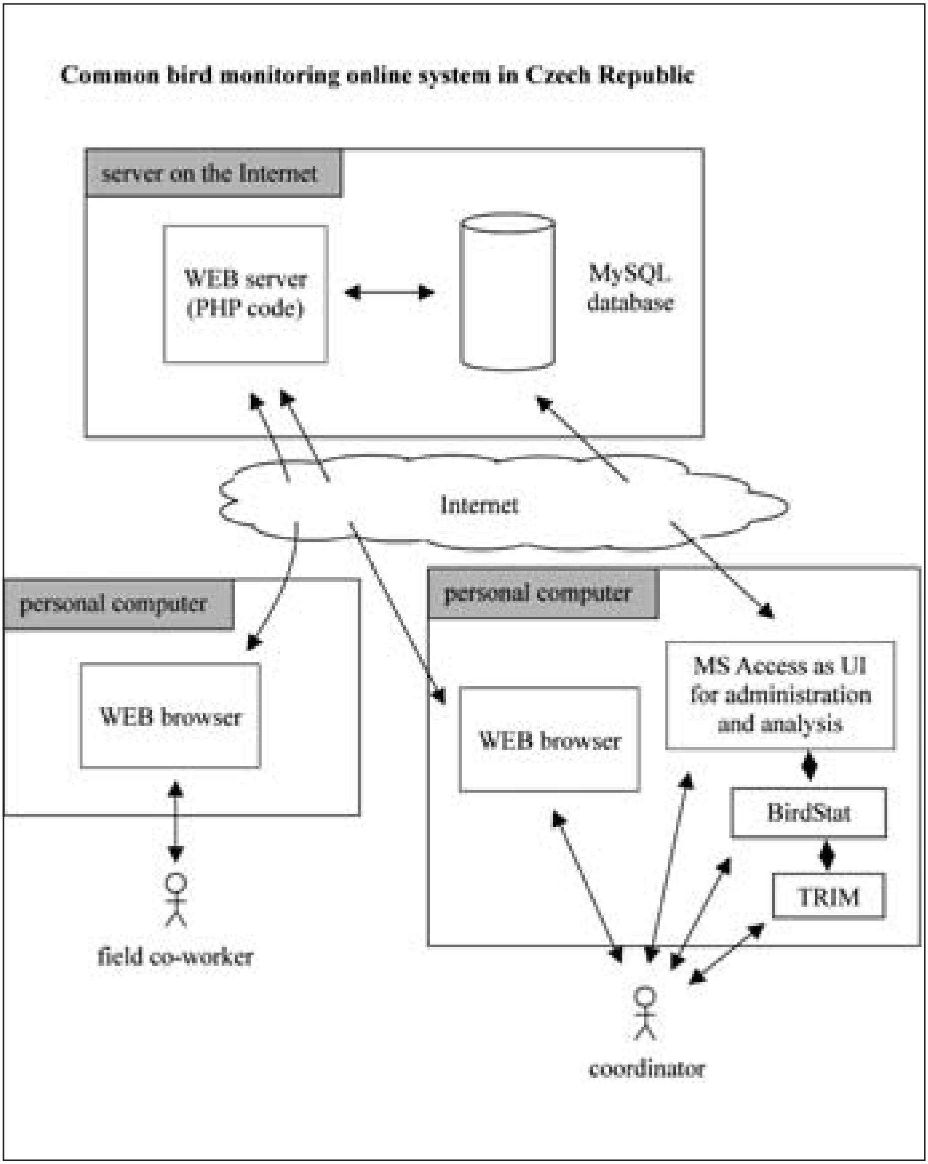
By submitting data online, the data then becomes the property of CSO. Further use of the data conforms to CSO's offical data access policy, but, of course, the surveyors have the right to use and publish their own data.

Architecture of the online system

Key features of the system are:

- we chose the 'slim client' architecture (see Chapter 4.2 'Setting up a database'), and the user interface is presented as a web page;

- the server (owned by a webhosting provider) runs a MySQL database which holds all the data, and a web server, Apache, which runs the PHP code;
- the MySQL database can be also accessed remotely by a database application using an ODBC connector (ODBC = Open DataBase Connectivity - standard



application interface used to communicate with databases). We use MS Access as a tool for administration and analysis by coordinators. Note that no data are stored in MS Access;

- surveyors submit and maintain their field data – information on transects, counts, habitat descriptions and personal information. Each surveyor only has access to his/her own data;
- the coordinator can use the web interface to read and modify the data of every surveyor;
- the coordinator does analysis and computes indices using database application (MS Access or OpenOffice Base) and BirdStats/TRIM (available freely at http://www.ebcc.info/).

Key features of the user interface are:

- **user friendly.** This is important, because:
  - the users are not necessarily computer-literate;
  - the system is new and the surveyors are volunteers and we are asking that they change the way they enter their data, we do not want to discourage them from taking part in the scheme;
- **error handling.** For example, when a field in a form is completed incorrectly, the form is returned with an appropriate error message while the information entered in the form is kept intact;
- **summary statistics for surveyors.** These are, at present:
  - an overview of the count per transect (e.g. either as the sum or maximum count of individuals) for each species and year;
  - an annual overview of the total number of species and total number of individuals counted along each transect;
- **lower risk of data entry errors.** The user interface was designed so that mistakes were less likely. This was achieved by being more precise than in a paper table and by introducing some automated checks.

Benefits of the online database include:

- **well organized data.** Fieldworkers can easily see all their data, for all years, in a summarised format. Compare this with the clumsy way that data are handled and stored in paper format and on Excel spreadsheets, and the amount of space needed to store paper forms. **This is a crucial point that is of great help to the coordinator!**
- **data immediately available at minimum cost.** The coordinator has immediate access to raw data and prepared queries in a form similar to a spreadsheet table without extra costs for data transcription;
- **swift feedback to fieldworkers.** When a fieldworker submits data online, the coordinator is notified by an automatic e-mail message and can thank the fieldworker immediately;

- **effective communication.** By guiding a fieldworker when entering data, the system can also reduce any emails or phone calls, which are usually needed between the coordinator and fieldworkers;
- **data quality control.** Fieldworkers help to detect mistakes, such as transcription errors, in historical data thanks to summary statistics and comparisons with their original data;
- **no more transcriptions = less chance of typing errors.** Data are transcribed only once, which reduces errors. When talking about transcription, we also mean copying and pasting cells in a spreadsheet – another possible source of errors!
- **overview.** At any one time, the coordinator knows exactly how many people have submitted their census data, and how many censuses on how many transects have been submitted;
- **summary statistics for coworkers.** Fieldworkers can generate summary outputs of their data, so every change in their results is immediately visible. This helps to motivate fieldworkers, and they appreciate it;
- **data from own counts available.** Every fieldworker has his or her data safely stored and accessible. If wanted, clear summaries (see above) are automatically derived and data can be exported, for example to an Excel spreadsheet.

Conclusions

The online system was released in April 2007. In 2007, 85 active surveyors cooperated in the scheme and 70 of them used the online system to submit their data.

The initial investment was high, but it seems to be starting to pay off now. There are, however, challenges for the near future. For instance, there are substantial costs linked to the long-term maintenance of the database, the development of further automation detection of input errors, input and checks of all old data submitted during the last 25 years on paper forms, etc. These issues need to be addressed by a scheme coordination team.

Further reading: http://jpsp.birds.cz/

Chapter 4

MANAGING AND ANALYSING DATA

4.1 Calculating indices and trends using TRIM

Arco Van Strien and Leo Soldaat

TRIM (Trends and Indices for Monitoring data) is currently the standard programme for the PECBMS partners to analyse count data obtained from bird monitoring schemes. It analyses time series of counts, using Poisson regression (or loglinear regression) and produces estimates of yearly indices and trends. TRIM is especially designed to cope with data containing missing observations and is freely available from Statistics Netherlands via www.ebcc.info (Pannekoek and Van Strien 2001).

Why Poisson regression?

One might consider applying ordinary linear regression to yearly count data. But that would not be a valid approach because linear regression assumes the data to be normally distributed. However, that assumption does not hold for most count data and log transformation to make the data more normally distributed does not work properly when there are many zero values in the data. Generalized Linear Models (GLM; McCullagh and Nelder 1989) offer a better alternative to analyse count data (Ter Braak *et al.* 1994). In GLM models, the normality assumption is replaced by the assumption of a distribution of the user's choice. For count data this distribution is often the Poisson distribution and this is implemented in TRIM. To apply the GLM models, transformation of raw data is no longer required.

For further information see the FAQ chapter about loglinear regression (under the main menu item "help" in TRIM). There is a powerpoint presentation for first-time users, which is available at www.cbs.nl (the easiest way to find it is via www.ebcc.info), and includes a basic explanation of TRIM.

Why use TRIM and when?

TRIM produces similar results to corresponding GLM models in statistical packages. But in general statistical packages are less easy to apply and some of them cannot handle large datasets with many sites. PECBMS-partners need to use TRIM in order to make it possible to produce supranational indices and trends per species.

TRIM is meant as a tool to produce yearly indices for many species on a routine basis, year after year. TRIM takes into account site effects in the calculation of year effects and takes into account the serial correlation between counts in consecutive years. TRIM also has options to incorporate covariates, changepoints and weight factors (see Table 4.1), but for more complex models one has to switch to other methods, such as GAM's (Generalized Additive Models) or Hierarchical models (Sauer and Link 2003). Also, TRIM is not able to take into account any changes in detection probability.

Smoothing of indices is possible by applying GAM's to the raw data (see for an example Siriwardena et al. 1998). An alternative way of smoothing is to apply the programme TrendSpotter to the TRIM results. TrendSpotter is currently used for smoothing the multispecies indicators and is based on structural time series analyses and the Kalman filter (Visser 2004; Soldaat *et al.* 2007).

How to use TRIM?

The TRIM manual shows the format of the input files required (see page 19 in the TRIM 3 Manual); these need to be ASCII files. There is an Access tool freely available for PECBMS partners to run TRIM in batch mode (called BirdSTATs and available at www.ebcc.info). See also the FAQ chapter "Preparing data and running TRIM" (under the main menu item "help" in TRIM).

A description of the use of TRIM is given in Chapter 4 in the TRIM 3 Manual. An important decision is the selection of the proper model. More details are available in the FAQ chapter "Choosing a model in TRIM" (under the main menu item "help" in TRIM).

What to look for in the TRIM output?

The following details in the output are most relevant:

- TRIM provides a summary of the data. Use the summary to check if TRIM has indeed recognized missing counts;
- TRIM highlights any sites with more that 10% of the total counts (across all years together), as such sites can be very influential to the results. It is important to understand that indices computed by TRIM are based on the sum of the counts of all sites per year and not based on the average trends per site. A few sites with high counts can thus make a difference;
- TRIM provides a list of the number of observations per year. Check if all years have observations, especially the first and last few years. If not, TRIM may extrapolate the indices beyond the years without data, with sometimes unexpectedly large changes. This happens only if the linear trend model is specified in TRIM;
- the most relevant things in the output are, of course, the indices and the overall trends. If the standard errors of the overall slope are large, say >0.02, then there is a problem (see Fig. 4.1). If this is the case, the statistical power to detect any trends is low and trends will be classified as "uncertain" (see the trend classification description under the main menu item "help" in TRIM). One may try to incorporate covariates to reduce the standard error. If this does not help,

there is not much more you can do, but the power will gradually improve as the time series get longer. See the FAQ chapters "Understanding indices and standard errors" and "Understanding overall trend slope";

The following details in the output are less important:

- information on model fit. TRIM constructs a model based on the observed data to estimate (impute) missing values. Please note that there is no problem if the model does not fit, because the lack of fit is already incorporated in the standard errors of indices and trends. See the FAQ chapter "Dealing with model fit";
- information on the percentage of missing counts. What counts is the amount of data for the model, not the amount of missing data. See the FAQ chapter "Dealing with model fit".

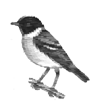
Examples of using TRIM and annotated output files are given in Chapter 4 in the TRIM 3 Manual.

Weighting in TRIM

If, for some reason, particular strata are oversampled or undersampled and the trends differ between strata, the indices will be biased. One may adjust for this bias by incorporating weight factors per site in TRIM. Strata may be geographical regions, habitat types, climate zones etc.

One may weight: (1) by surface areas, or (2) by population sizes. The idea of surface area weighting is as follows. Suppose a country has two regions, A and B, with surface areas of 50000 ha and 100000 ha respectively. Suppose that 100ha are sampled in region A and 50ha sampled in region B. If sampling intensity were similar, one expects 1/3 of the total that has been surveyed to be located in region A and 2/3 in region B. But 100 ha were surveyed in region A instead of the expected 50ha and 50ha in region B instead of 100ha. Thus, region A is oversampled and needs to be downweighted by a weight factor of 1/2. Region B is undersampled and needs to be upweighted by 2. These weights may be applied to all species in the sampling scheme. In other words, the weight factor for a particular stratum may be computed as the number of sites (or total area) *expected* if sampling was spread proportionally across strata surface areas divided by the number of sites *counted*. The number of sites here stands for all sites in the stratum, including sites where the species has never been found.

Instead of weighting by the total surface areas of strata, one may prefer to weight by the area where a species actually occurs, e.g. using the number of Atlas squares per species per stratum. The weight factors then should also be based on the number of sites within these Atlas squares and obviously, weight factors will differ between species. Van Swaay et al. (2002) applied this approach to the Dutch Butterfly Monitoring Scheme.



If population size information is available for each stratum, one may prefer to weight by population size or population share. Van Turnhout et al. (*in press*) applied this method to the Dutch Breeding Bird Monitoring Programme. One first has to identify the year or period in which information is available on both population sizes and scheme data. Consider the following example. Suppose a country has two regions, C and D, and the population sizes of species X are 75000 and 25000 breeding pairs respectively for year 1. The imputed scheme time totals produced by TRIM are as follows:

	Time totals in Year 1	***Time totals in Year 2***
Region C	100	50
Region D	100	200
Sum	200	250
Index	100	125

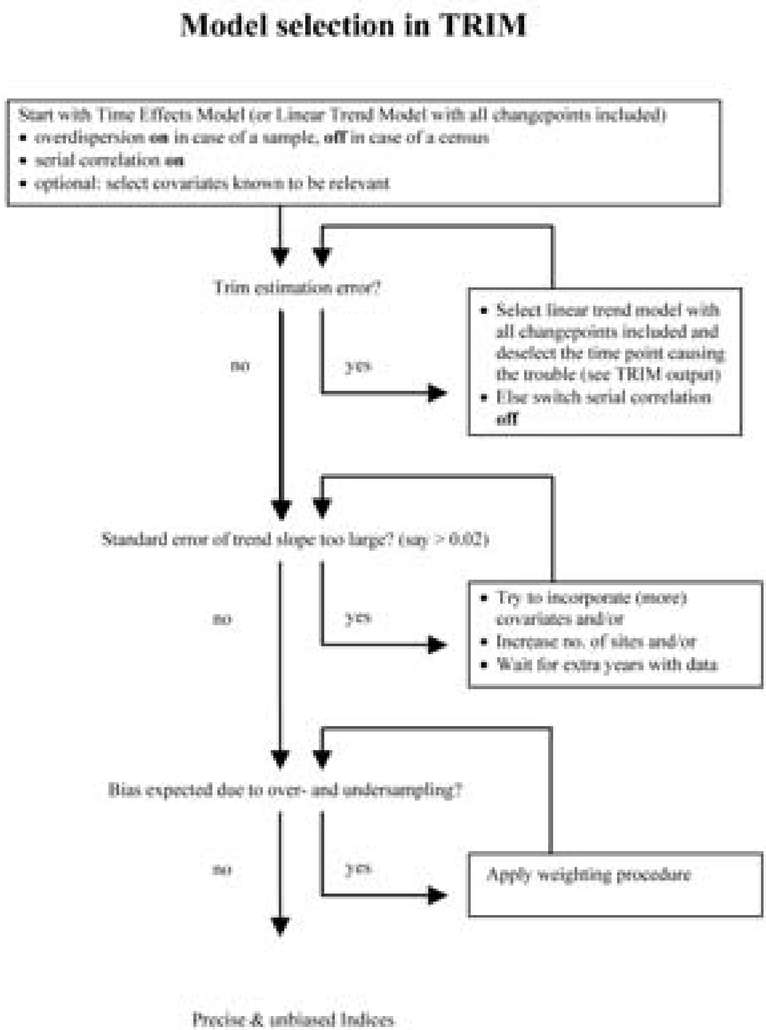
Taken both regions together, species X seems to increase. But the turning of time totals into population sizes indicates a decrease:

	Population totals in Year 1	***Population totals in Year 2***
Region C	75000	37500
Region D	25000	50000
Sum	100000	87500
Index	100	87.5

Thus, weight factors here are calculated by dividing the population number by the TRIM time total for the same year: weights for region C are 75000/100= 750 and for region D 25000/100= 250 for all years. Equivalently, this may be done for the average of a set of years rather than for one year only. Of course, after a number of years the population sizes in the two regions may be completely different from year 1. But assuming that these changes are properly captured by the changes in the scheme time totals, it is not necessary to adapt the weight factors. Only when better information on population sizes becomes available, is it sensible to adapt the weight factors.

The weight factors need to be incorporated in the TRIM input file for each year and site record (see p. 19 in the manual), although the weight factor is usually similar for each year per site and all sites of the same stratum have the same weight factor. The weights for records with missing values may have value “1” (= no weighting), but these records are ignored in the weighting procedure anyway. If all weights are multiplied by a constant, the indices will remain similar. So, weights may be reduced to keep time totals and other figures in the output small.

Figure 4.1. *Model selection in TRIM.*



Using surface area weighting, each year again the weight factors need to be updated because the total number of sites in the scheme may have changed. Using population weighting, a yearly update of weights may also be useful because TRIM time totals always change a little by adding the new years' data due to the modelling applied.

One has to indicate the availability of weight information in the input file (see p. 23 in the manual) and to choose weighting in the estimation options (p. 24). In addition one has to apply the strata used for the weight factors as covariate in the model (see also p. 45). TRIM then calculates weighted indices and their associated standard errors.

Final suggestions

- read FAQ's, where recommendations can also be found on, e.g., the choice of indices and multiplicative slope;
- check the EBCC website (www.ebcc.info) for the latest version of TRIM. We take care in solving any bugs in TRIM and from time to time some new features will be incorporated, but we are not planning major new developments in TRIM. Any new TRIM version should be compatible with the earlier versions.

Table 4.1*. Possibilities of TRIM and some other methods.*

Aim	*Method*
Assessing indices and trends using sampling data	TRIM time-effects model with overdispersion switched on
Assessing indices and trends for a complete census	TRIM time-effects model, but with overdispersion switched off
Testing change points	TRIM linear model with selected change points
Testing effects of factors on indices & improving uncertain trends and indices	TRIM with covariates
Smoothing yearly indices	GAM's or a combination of TRIM and TrendSpotter
Adjusting for oversampling of e.g. particular regions or habitat types	TRIM with weight factors per site
Taking into account observer differences, different sampling efforts, both date as well as year effects etc.	More complex models than available in TRIM, e.g. GLM's in statistical packages, GAM's or Hierarchical models

4.2 Setting up a database

Zdeněk Vermouzek and Tomáš Telenský

The main task of data management is to store and manage datasets over a long period of time. There are two main options for storing and managing data: paper

format ('paper' hereafter) and computer format ('database' hereafter). Each option is very different to each other (see table 4.2); both require different approaches.

***Table 4.2.** Differences between 'paper' and 'database' data management*

paper	*database*
data structure predefined by supposed use, easy to set up	data structure must reflect the described reality (could be difficult to set up; design flaws, e.g. unsuitable data structure, could limit future usage)
almost no preparation work and costs	need for careful analysis, design and development, demanding programming (usually by a specialist) before use
data handling is demanding (selecting or sorting usually need much time)	easy processing and querying (easy and quick selecting and sorting when needed)
almost no requirements on time and money when not in use	continual need for care (usually by a paid specialist or service)
relatively safe if on safe place	needs extra security care (authorized access, backups)
almost no possibility for unintentional changing of raw data	improper handling can produce unintentional changes in raw data, which are then hard to detect
every processing could produce errors by data transcription	only one transcription at the beginning – no more transcription errors during processing

Nowadays, the 'database' approach is usually assumed to be the more flexible and valuable, especially when considering the need for quick and easy use of data. However, only a well-structured and continually developed system meets the criteria of a suitable database, which costs money. Data stored in a database with proper security measures are safer than data stored on 'paper', but, on the other hand, a poorly constructed database is worse than none.

Database environment

When setting up a database, even a small personal one, it is vital to use a proper database software. The biggest mistake, committed by many people, is to use a spreadsheet (e.g. Microsoft Excel) for data storage. Spreadsheets are designed for data processing, not for safe data storage. The basic feature of every database is that related data remain related forever. For instance date, species and number of individuals entered into 'one row' remain in that row, whereas date, species and number of individuals entered into one row in a spreadsheet may be easily mixed with other rows, producing a useless data mixture. Such changes can be hard to detect and even harder to correct.

There is not one best all-purpose database solution. However, MySQL with PHP running on webserver (http://www.mysql.com, http://www.php.net) and Microsoft Access are probably the most widespread alternatives (see the comparison in Table 4.3).

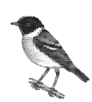


Table 4.3. *Comparison of the main features of MySQL and MS Access*

MySQL + PHP	***Microsoft Access***
open licence (database engine and updates for free)	licensed program (you have to pay for each installation and for each new version)
open community based (very low risk of being discontinued in future)	company based (seems secure now, but who knows about future?)
suitable also for large datasets (ie. point by point raw data)	not suitable for very large datasets (millions of rows)
suitable for remote and multi-user access ('online database')	suitable for smaller, one person operated bases on local PC
development needs educated programmer	development and administration possible by an experienced user
can be connected by MS Access (or other user-friendly application like Open Office) to manage data (e.g. by the coordinator for analyses)	

Databases for monitoring schemes are designed to be used over a long time at least tens of years. Current monitoring schemes are usually much older than any current database environment. Thus only the most solid environments and the strictest standards are suitable to use. It is best to avoid less usual and curious applications, as these don't guarantee future compatibility. It is wise to consult on the choice of database environment with someone experienced.

Data structure

Creating the right data structure is the crucial point in the process of setting up a database. A poor data structure limits future use of the data and can lead to further problems and extra costs. The data structure must accurately reflect described reality. There is no general data structure as it depends on the monitoring scheme. The analysis must be done either by a biologist with extensive computer skills or by an experienced programmer in conjunction with a biologist.

Security

All electronic data storage systems are prone to data losses due to equipment failure, misuse, abuse or other reasons. Security measures must be clear before putting data into the system and must be operated on a regular basis (manually or automatically) from the beginning. Main security measures comprise authorising all accesses (by usernames and passwords) and regular backups. The periodicity of backups depends on the intensity of data changes and the relative safety of the whole system (a small MS Access database on a personal computer should be backed-up after each use; databases on professional servers are usually backed-up automatically on-the-fly). It is wise to make a backup from time to time on to a medium like CD or DVD and store it at a separate location to the database (to avoid data loss, for example, by fire).

Online database

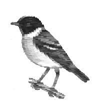
Databases that are directly accessible by individual volunteer surveyors via the Internet are a good way of collecting and managing data in the near future. This approach saves the scheme coordinator time and work, and allows for the direct control of their own raw data by surveyors and can thus ensure high quality data.

Online databases, however, are often interpreted only as a data collection and storage tool. In fact every online system must serve as a complex tool for collection, validation, storage, analysis, promotion and, also, motivation of volunteers. Only this complex approach can refund the high starting costs and ensure long-term viability. In this approach it is important to satisfy all the users, mainly by making the user-environment as friendly and error resistant as possible and by showing some results online (this means that every change in data is immediately visible – see case study in Chapter 3.5.9 for details). Every such system needs careful testing and checking for errors before it is released to the public. After a release, there should be as little change to the user interface as possible, so that users can become familiar with it. A clear manual is also necessary, and should be provided to all users.

The development of such a system takes a long time (for basic data collection and the simplest outputs, at least one year of preparation is needed), which is not possible without an experienced programmer and enough resources for future maintenance. This might be a reason for considering sharing capacities for development and maintenance with other institutions.

Table 4.4. *Comparison of big and slim client*

Big client	***Web browser as a slim client***
big client application must be developed besides the core database (more expensive)	only core database and web pages need to be developed (less expensive)
only operating systems, for which big clients exist, can be used	access to the database is independent on the user's operating system
the user interface possibilities are almost unlimited	the user interface is slightly confined by possibilities of web browser
users are bothered by installing and adjusting big client application	users don't install anything, they need only their username and password
users can work offline most of the time	users must be connected to Internet all the time
users have their data 'at home' which give a feeling of its ownership	all the data are only on the server – users can be motivated by automatically generated results
data exist in many copies at users' workstations and the server, need for synchronization. Induces non-trivial problems like conflict solving.	data are stored only at one place – the server. No conflicts occur.



Online database – big or slim client?

Users connect to an online database using so called clients or client applications. There are two main approaches – let us call them big and slim clients (e.g. when writing e-mails, MS Outlook is a big client, while a web browser connected to Google Mail is a slim client).

According to the comparison shown in Table 4.4, and according to our experience with various problematic big clients (none is completely trouble-free), we strongly discourage anyone from going for a big client design. Common bird census databases are too small and specialised to be suitable to develop as a big client application. Concurrently, Internet connections nowadays usually do not prevent the use of a slim client.

Things that must always be done:

- specify WHY you need a database (briefly and clearly describe the function of the database in a monitoring scheme);
- the database system must conform to the strictest standards to ensure future compatibility;
- the data structure must resemble the real data pattern. There is no place for compromises;
- set up security measures before starting any database;
- the online database must be user-friendly and must contain online outputs to motivate volunteers;
- consult specialists before the start of programming.

Things that must always be avoided:

- do not rush things!
- do not forget that every database (especially an online one) needs continuous care (and money) in the future;
- do not use spreadsheets (e.g. MS Excel) for long-term data storage, do not use non-standard technologies, and do not use a big client design;
- do not underestimate the risk of data loss by equipment failure, database misuse or abuse.

4.3 Case studies

4.3.1 How to check, organise and store data

Hans Schmid

The results of the territory mapping fieldwork for the Monitoring Häufige Brutvögel (MHB) have to be sent to the Swiss Ornithological Institute. Here the received data are registered, the files thoroughly checked, and the data entered and recorded. For more info on the MHB scheme, see http://www.vogelwarte.ch.

When a file is received, its arrival is noted and the following checks are made by a scheme coordinator:

- are all the requested documents included?
- does the file contain additional documents or further requests, which must be treated separately?
- is there a need for an immediate response or can regular processing take place later on?
- does the file need additional processing?

If anything is lacking, we contact the fieldworker immediately. Otherwise the file is processed routinely at a later time. When the more detailed check takes place, a set of criteria are examined:

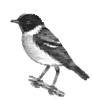
- is the general information correct and complete?
- is the species list complete, or are species which can be expected, missing?
- are there any species which seem rather unlikely for that particular area?

A more thorough examination of the maps then takes place:

- have all the entries on the field maps been transferred to the species maps correctly and completely?
- are there any observations which do not fulfil the criteria concerning the date or which were made at places which do not appear to be potential breeding habitat?
- are there other entries which are not clear and which require a further inquiry?
- do the size and the delimitations of the territories seem reasonable and understandable?
- have the numbers of territories been added up correctly?

The results from squares where a new fieldworker has taken over are inspected more thoroughly. In such cases we check whether the species lists are more or less comparable with those of the predecessors and also whether the number of territories is in the same order of magnitude. If this is not the case, a more detailed analysis is made, trying to find out what might be the reason for the discrepancies. When all these points have been clarified, the fieldworker receives personal feedback, with the corrections we made and possibly with suggestions on how to improve future surveys. Subsequently, the results are computerized by volunteers recruited specifically for this project. These volunteers get special software from us to allow rapid data entry.

The data are stored in a database, which is based on MS Access. The database consists primarily of two tables, one for the descriptions of the squares and one for the numbers of the territories per species. Various filters reduce the po-



ssibilities of false entries. A set of reports helps to produce routine inquiries. All documents, including correspondence, are suitably archived at our institute, so that they can be found immediately if another detailed check seems appropriate. For the examination of earlier entries it is useful to have the data within easy reach.

At the end of the year, when all files have been checked and stored, some routine checks are made on the whole dataset. Subsequently, for each kilometre square two identical lists are produced. They contain the general information concerning the square, the name and address of the responsible fieldworker, the dates of the visits and the number of territories per species for the last 10 years. We send these lists to the fieldworkers and ask them to make a thorough check. Thanks to this procedure, erroneous or missing entries can be detected. At the same time the fieldworker is asked whether he or she will be able to survey the square again the following year. The fieldworker signs one of these lists, sends it back to the institute and keeps the other one.

4.3.2 Bird monitoring and spatial modelling of species distribution: an example from the Catalan common bird monitoring scheme

Lluís Brotons and Sergi Herrando

Long-term bird monitoring schemes (LTM) provide us with a great deal of spatial data that have the potential to be used to create maps showing changes in species distribution and abundance. One possibility is to obtain distribution maps from sample locations, by using surrogate environmental data and estimating species habitat preferences in spatial terms. Recent developments in numerical methods, and the increasing availability of remote census data sources have boosted the application of habitat-based models in ecology. This approach is based on the hypothesis that if species environmental associations can be robustly established, one may use them to estimate species distributions through the identification of suitable habitat in areas from which faunal data has not been recorded, but where environmental information is available.

Habitat modelling is being progressively extended but has not yet been widely applied to LTM data. Here, we briefly describe how to use data from a bird LTM scheme to obtain species distribution maps. We use data from the Catalan common bird survey as an example to produce habitat based maps and assess its predictive accuracy using independent data from recently completed atlas work (Brotons *et al.* 2007).

How to conduct habitat based models: the bird data

We used LTM data from the Catalan common bird survey (SOCC, from the Catalan “Seguiment d’Ocells Comuns a Catalunya”). The SOCC scheme started in

2002 and is based on a line transect approach, in which observers record all individuals of all bird species seen or heard on a 3-km transect divided into three 1-km sections. We used these 1-km sections as sampling units for modelling and mapping purposes (see www.ornitologia.org).

At present, 226 SOCC transects have been conducted for at least one year during the period 2002-2005 (Fig. 4.2). The mean number of available years (maximum of 4 years) per transect during this period was 3.01. Since the SOCC scheme is essentially based on volunteer ob- servers, the survey is constrained by the number of available sampling transects and is prone to poor spatial cover of remote areas, resulting in a regionally biased sampling distribution. We took into account heterogeneity in sampling effort by weighting sample locations according to their abundance in different subregions.

In the end, we were able include 99 species that appeared in at least 10 different transects during the 2002-2005 period.

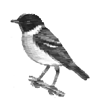
In order to evaluate the predictive ability of habitat models conducted using SOCC data, we used species occurrence from the Catalan Breeding Bird Atlas (CBBA, Estrada *et al.* 2004). The CBBA is a large-scale survey that covered the whole of the Catalonia between 1999 and 2002, using a grid based 10-km Universal Transverse Mercator (UTM) squares. A sub-sample of a total of 3,077 1-km squares (approximately 9% of the total area) was selected to conduct standardised intensive surveys of species presence in a stratified fashion to cover the main habitat types present within each of the 10-km UTM squares.

How to conduct habitat based models: the environmental data

We used 39 environmental variables to build the model, which were generated from available digital layers such as land use and climatic maps or digital elevation models. All environmental variables were generated for each 1-km UTM square in Catalonia and for 1-km square buffers around the central point of each SOCC section. If possible, the environmental variables (i.e. land use maps), were estimated from different data sources so that they better matched the sampling periods of each of the surveys.

How to conduct habitat based models: the model

We conducted occupancy models using presence/absence data over the 2002-2005 period from SOCC transect sections (SOCC models), by means of generalised linear modelling with binomial error distribution (GLM), including as potential predictors in the model all linear and quadratic terms, and selected the most parsimonious model using the Akaike Information Criteria (AIC). Other modelling methods are currently available and easily implemented in customised software, depending on the type of bird data available and the complexity of the database (Maxent, Phillips *et al.* 2006, BIOMOD, Thuiller 2003).



Long term monitoring programs and spatial modelling: perspectives and applications

Overall, the accuracy of models estimated with the SOCC data performed better than random for all the species analysed. Furthermore, the evaluation of their predictive accuracy on independent atlas (CBBA) field data provided acceptable to excellent results for most species and were, in general, highly comparable to the maps produced by the Catalan atlas (Figure 4.2).

Given the number of LTM schemes currently running in many countries, application of spatial modelling techniques to these data may prove a major contributor to conservation and land use planning in many areas. Spatial mapping of LTM data may substantially enhance the general efficiency of large-scale biodiversity assessments by adding a potentially useful spatially explicit component allowing accurate representation of species distributions. Furthermore, spatial mapping of LTM data may be integrated in current projects specifically aimed at mapping species distributions at large spatial scales. For instance, during Atlas work periods, spatial mapping derived from LTM data may become an integral part of Atlas methodology covering more common species.

Some limitations of habitat modelling, however, such as the difficulty of accounting for fine-scale habitat structure, should be kept in mind to enhance proper use of distributions maps derived from LTM data. For instance, many authors consider maps generated by habitat or niche modelling as equivalent to potential distribution maps. Although our models predicted the occurrence of most species with high accuracy, some additional steps may be added to ensure that final relative abundance maps corresponded as accurately as possible to real rather than potential distribution maps. A possibility is to filter out hypothetical occurrence areas for each species from the known distribution of the species, gathered either from expert knowledge or coarse resolution field atlas data.

How to improve monitoring schemes to obtain more reliable distribution maps?

We think that if used for mapping purposes based on habitat modelling, LTM schemes should benefit from an effort to increase sample size. Such an increase in sampling effort is also likely to benefit trend estimation, which is the main aim of most LTM schemes. There is, however, a trade-off between the number of locations that could potentially be sampled and the distance volunteer surveyor have to travel to cover them. We suggest that LTM data based on long transects, or possibly other methods (e.g. point counts), may be disaggregated into smaller sampling units (i.e. 1-km transect sections in the case of the SOCC), leading to significant increases in the predictive accuracy of habitat models. The optimal degree of disaggregation to develop accurate habitat models from LTM data should be further investigated and is likely to depend on factors such as minimum unit size, species ecology and spatial distribution of the sampling locations. The spatial coverage of the sampling scheme is also likely to be an important factor in many cases and therefore, improving this feature should be also favoured for mapping attempts.

Finally, we have shown that LTM data is ideally suited for occurrence data, which has been often found to be a good surrogate of abundance. However, since LTM schemes often collect count or density data, they have the potential to be used for more informative modelling of abundance data. It is expected that combining presence/absence modelling and abundance models will better fit the data when factors determining occurrence are different from those determining abundance.

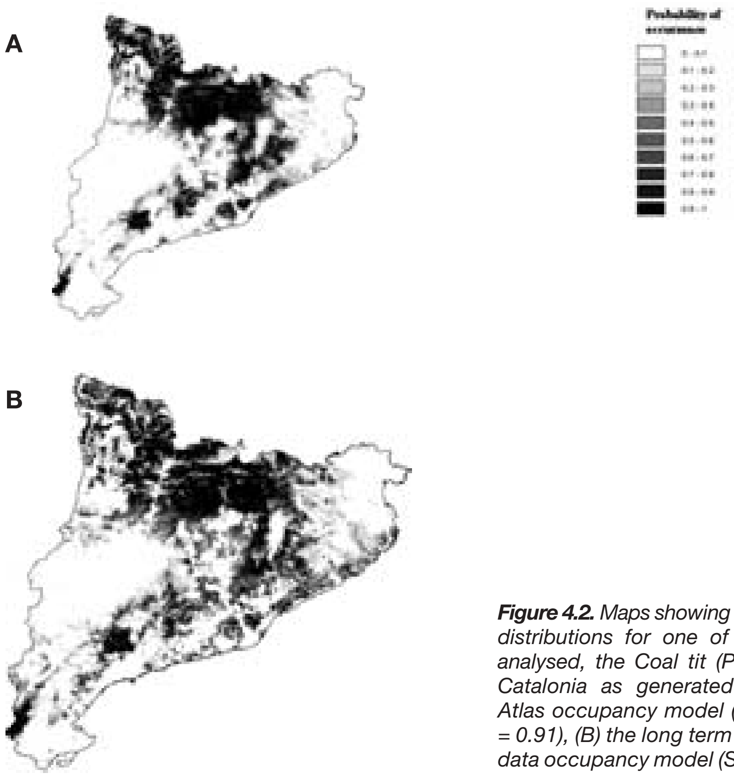


Figure 4.2. *Maps showing the predicted distributions for one of the species analysed, the Coal tit (Parus ater) in Catalonia as generated by (A) the Atlas occupancy model (CBBA, AUC = 0.91), (B) the long term monito- ring data occupancy model (SOCC, AUC= 0.85).*

Chapter 5

USING THE RESULTS

5.1 Using the results for nature conservation, research and communication

Petr Voříšek and Richard D. Gregory

Monitoring data and outputs from monitoring schemes can be used in a number of ways for nature conservation and research. Monitoring outputs can be used to deliver evidence-based conservation action but need to be based on sound scientific methods. Results should be publicised and communicated to a wider audience, with publicity/communication being a core part of any monitoring scheme.

This chapter aims to summarize suggestions for the use of monitoring data for nature conservation and discusses the principles of communication and promotion of the results. This has been written mainly with common bird monitoring schemes in mind, but many of the suggestions can be applied to other types of monitoring schemes too, such as single species surveys, breeding bird atlases, or demographic/ringing studies.

Principal uses of information

The overall purpose of bird monitoring work in general is to provide scientific information to underpin, review and steer conservation objectives and practices. Monitoring often centres on measuring size and trends in bird numbers and range, but can also cover demographic parameters.

The uses of bird monitoring information are varied and encompass:

- setting conservation priorities for species;
- measuring the impacts of land use change on birds;
- measuring the efficacy of conservation actions and helping to focus and refine those actions;
- to champion and raise awareness of conservation/biodiversity issues;
- identifying emerging conservation issues;
- defining bird-habitat relationships and dependencies;
- providing a baseline for future work and comparison;
- providing pointers as to why populations are changing;
- providing scientific underpinning (i.e. evidence base) for policy and advocacy;
- assessing the importance of a site for species;
- measuring the performance of sites for species conservation;

- measuring the impacts of drivers and pressures on bird populations, such as farming or climate change;
- providing summary information (i.e. indicators) to describe the specific and general state of the environment;
- acting as an early warning system or barometer of environmental change.

A number of high-level intergovernmental agreements bring with them a responsibility to monitor biodiversity and, importantly, targets with which to measure progress. For example, the Convention on Biological Diversity (CBD) has prompted a commitment of the 6th Conference of the Parties in Europe '*to halt the loss of biodiversity by 2010'*; the EU Sustainable Development Strategy target aims '*to halt the biodiversity loss by 2010*', and the outcome of the World Summit on Sustainable Development included a pledge in 2002 *'to achieve a significant reduction in the current rate of loss of biological diversity by 2010 at global, regional and national scales'*. Similarly, the Birds and Habitats Directives, Bern, Bonn, and African-Eurasian Migratory Waterbird Agreement (AEWA) conventions bring with them a strong responsibility to monitor specific bird populations and their habitats. Such commitments strengthen the case for basic species and habitat monitoring, and work on birds in Europe leads the way.

How to use results for nature conservation

It is evident that the results of monitoring schemes are fundamental for nature conservation in many aspects. However, it may be necessary to explain the use of monitoring data more specifically to potential users as well as to specify how the results from a monitoring scheme can be used most effectively. Such messages often need to be repeated and reinforced to remind policy and decision makers of the utility of this form of work and the necessity of appropriate funding streams (often involving relatively modest amounts of money) to allow basic monitoring to take place.

Lists of threatened species and conservation status assessment

The development of prioritised lists of threatened species, such as the IUCN Red List of threatened birds, or in the UK '*Birds of Conservation Concern/The Population Status Of Birds*' (Gregory *et al.* 2002), is a key aspect of nature conservation. Such lists help to prioritise the allocation of resources for conservation effort and are often part of national or international legislation. Such lists are compiled using various criteria, but changes in population size are among the most frequently used. These lists need to be updated at a regular interval (perhaps every 5-10 years), which is an opportunity to use information from monitoring schemes to shed new light on the status and development of particular species and populations.

Measuring the progress of conservation effort

Legal conservation status means that species should benefit from being listed as threatened species. Specific conservation actions are also developed and implemented for species listed as threatened or declining. In all cases, assessment of the success or failure of such conservation measures is necessary for nature conservation effort to be effective. Examples of such assessments can be found in Donald *et al*. (2007), Taylor *et al*. (2005) or Male and Bean (2005). Ideally, legislation or government-adopted species action plans should contain measurable and time bound targets, including population size, geographical range and their trends. If such targets are not included, there is still an opportunity for monitoring data to contribute to the evaluation of the effectiveness of conservation effort.

Protected areas and nature reserves can also contribute significantly to the conservation of bird species; this is one of their primary roles. Assessment of a role of protected areas is therefore another opportunity for the potential careful use of monitoring data. Devictor *et al.* (2007) provide an interesting example of this.

Early warning signals

The assessment of the conservation status of a species can take a long time and conservation action has a better chance of success if the process begins as soon as a problem is detected. Annual monitoring schemes can provide such early warning signals to highlight significant declines in species. This might then trigger a more detailed investigation on the pattern and strength of trends, on the potential causes of population decline/increase and the appropriate conservation action to reverse a perceived problem. Examples of the use of monitoring data in this way can be found in the Netherlands or the UK. Here 'alert-based systems' have been developed covering both breeding and wintering bird populations, which use statistical methods to raise alerts in relation to short-, medium- and long-term changes in bird numbers (Gregory *et al.* 2006a,b, Atkinson *et al.* 2006). One of the difficulties in such systems is that there is a real danger of raising false alarms due to statistical noise and fluctuations in trend data, which might then waste valuable conservation effort and discredit the monitoring work. Hence, careful consideration of statistical error is an important part of such systems, but when they work properly they do provide a highly useful early warning system.

Evaluation of development plans, new policies or species management

The use of monitoring data is essential in any assessment of development proposals, such as housing or wind farms, where information on species distribution, trends and potentially species' breeding success and survival is usually required. Policy instruments such as agri-environmental schemes also require basic well-designed monitoring data for the evaluation of their true effectiveness. Rules on the number of certain species that can be hunted or the timing of hunting seasons, for example, require monitoring data for a proper assessment of the sustainability of such activities. However, data from generic monitoring schemes may often not be ideal for such specific purposes, either because of poor geographical coverage of an area, or because they do not provide highly detailed site specific information on numbers and distribution required for these purposes. Thus, the use of monitoring data for such specific purposes should be considered with caution and could be complementary to other monitoring/assessment schemes specifically designed for a given purpose. Basic national monitoring programmes are often very valuable in these cases because their data provides essential background information and context with which to judge specific inquires, but they are not a substitute for such experimental approaches.

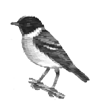
Indicators

The use of birds as bio-indicators has been developed considerably in recent years. Countries that use indicators at a national level include the UK, Sweden, France, Switzerland, the Netherlands, and more countries are following suit. Links to national monitoring schemes and indicators can be found on the EBCC web site (www.ebcc.info). The UK and European wild bird indicators (Gregory *et al*. 2002, 2005, 2007) are good examples of a successful indicator at the national and international levels. Reasons for the positive acceptance of birds as environmental or biodiversity indicators include:

- birds are widespread, diverse, mobile – they occur in nearly all habitats;
- birds are relatively easy to identify, survey and census by skilled volunteers or professionals;
- birds are high in food chains and can be sensitive to environmental change and degradation;
- there are long-term series of data on bird numbers, range and demography;
- data are realistic and relatively inexpensive to collect and analyse, even annually;
- survey methods and analytical methods have been proven and widely published;
- birds are generally better known than any other taxa;
- birds have a resonance and a connection with the public and policy/decision makers alike;
- birds are very useful ‘flagships’ to raise awareness of biodiversity issues in general.

However, some care is needed when using birds as indicators and birds are not always going to be the best environmental indicators in all situations. The following limitations should be considered:

- birds are less specialised in micro-habitat use than many other taxa;
- their distribution at one scale may not match the patterns of other taxa;



- population trends may not always correlate with those of other taxa;
- environmental degradation can result in 'perverse' positive population trends in some situations;
- populations may respond to integrated sets of factors, rather than single ones, so their trends need to be interpreted with care.

It is self evident that any indicator should be designed and used for a specific purpose and care is needed in its interpretation. Questions on the rationale for the indicator development, the users and legislation linked to an indicator, the appropriate indicator name (label), the frequency of update, the nature of any bias and representative coverage, and how it will be communicated, should all be considered very carefully before an indicator can be promoted for use.

It is important to have a large and representative set of sample points and species – in the case of an indicator based on multi-species index of changes in abundance, in general the more species contributing to the indicator, the more reliable it is. Individually, many species may show annual changes in abundance that may reflect a variety of environmental factors, such as extreme weather conditions during the breeding season, poor conditions on the winter grounds, changes in predation pressure, and simple sampling error and statistical noise. Consequently, indicators based on one or a few species are prone to show quite marked volatility, which may have very little to do with real changes in the environment. By using a more representative group of species that, for example, all breed in the same habitat, such variability can be reduced, and directional changes in the abundance of a whole suite of birds – and wider biodiversity – become more apparent. If the majority of species in the group decline, then the indicator trend line goes down, and vice versa. Overall, this can provide a balanced picture of what is happening in the environment (Gregory *et al.* 2002, 2005, 2007).

An overview of national or international legislation linked to indicators and other uses of monitoring data is a useful tool to ensure the outputs of monitoring are used for nature conservation. A list of all pieces of legislation and their requirements is helpful. At EU level, the following main policy instruments should be considered:

- EU Structural indicators (Lisbon European Council 2000);
- EU Sustainable development indicators (Gothenburg European Council 2001);
- EU Headline indicators (6th Environmental Action Programme 2001-2010, EU Biodiversity Strategy 1998/2005);
- integration indicators (Cardiff process 1998).

At a European level, the indicators based on common bird monitoring data have been used for various policy purposes - the Farmland Bird Index was adopted as an official European Union Structural, Sustainable Development, IRENA/agri-environment and Rural Development Regulations indicator. There are many examples of the use of wild bird indicators at a national level that are outside the scope of this publication and is it encouraging to see such uses are increasing rapidly. Information on national monitoring schemes, indicators and the use of their results can be found on the EBCC web site (www.ebcc.info).

How to use results for research

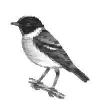
Monitoring data can be used to inform many aspects of scientific work and importantly, results based on robust scientific methods are required for evidence-based conservation and adaptive management. It is not the aim of this chapter to provide an exhaustive list of the possible scientific uses of monitoring data (such a list is almost infinite!), but we wanted to raise the importance of peer-review scientific publications because they add considerable credibility to monitoring programmes, and can provide great insight into bird population dynamics with relevance to conservation objectives. In many situations, the capacity of a national scheme coordinator, or their statistical knowledge and expertise, might be limited thus preventing them from full involvement in the scientific use of monitoring data. In fact, this might be expected because the role of a scheme coordinator is demanding in itself and requires a particular blend of skills. This is where collaboration with other individuals and institutions, especially research institutes and Universities might prove to be highly beneficial. Such collaborations can have added benefits on both sides – links to academics, for example, may give greater scientific credibility to monitoring results and may identify areas of improvement and refinement in monitoring programmes.

Ideas for scientific use of monitoring data include:

- investigation of possible causes of observed changes in bird numbers, including potential effect of land use change, predators, pathogens, competition, and climate change;
- exploring spatial-temporal patterns in bird numbers and what might be driving them;
- exploring spatial-temporal changes in species' diversity and species' composition of bird communities;
- development of wild bird indicators as measures of environmental change.

How to communicate the results

Ultimately, the results of monitoring schemes are ineffectual if they are not communicated to the right people in the right way. The publication of results, achievements, analysis and messages helps in raising awareness of biodiversity, nature conservation, the funding of monitoring schemes, and generally supporting evidence-based nature conservation. The crucial point in communication is to consider what is the main message and who is the main target group. Each target audience may need to be approached differently to gain maximum benefit



and to communicate in an appropriate fashion. Examples of potential stakeholders and target groups, and various communication tools, are listed below.

Stakeholders/target groups

- national governments;
- national Non-Governmental Organisations (NGOs);
- national coordinators of other surveys;
- general public;
- scientific community;
- media;
- foundations & other potential donors;
- international policy institutions (e.g. EU);
- international treaties and their secretariats;
- international NGOs (e.g. EBCC or BirdLife International);
- international monitoring initiatives.

Communication tools

- leaflets;
- web sites;
- articles in birding, wildlife magazines, newspapers, popular and semi-popular publications;
- scientific papers;
- presentations at scientific conferences, workshops, or other meetings;
- emails - including email discussion groups;
- letters;
- questionnaires;
- personal meetings with key individuals and groups;
- press releases;
- press conferences;
- TV and Radio Interviews;
- posters;
- special publications, e.g. manuals;
- bird Fairs and similar face to face awareness-raising events.

This chapter contains two case studies – a press release by BirdLife International and EBCC on the European bird indicators update 2007, and Frequently Asked Questions (FAQs) on the Farmland Bird Indicator, a document produced for representatives of EU Member states. The first illustrates how to construct a succinct press release with a clear message alongside the key information. The second shows how a 'questions' and 'answers' format can be used to inform a specific audience and clarify areas of uncertainty.

Final recommendations

Things to do

- maintaining the highest scientific standards in all aspects of monitoring work is essential in ensuring the credibility of a scheme and gaining the confidence of key policy/decision makers;
- publicise your results widely and to different audiences;
- make an audit of legal requirements for monitoring data and their relevant use;
- package the scheme to reflect needs of key policy/decision makers;
- design and label scheme outputs and indicators according to their purpose;
- clarify what a scheme can, and cannot deliver, with key audiences to avoid misunderstandings;
- make clear what the message is and to whom you want to deliver the message; use an appropriate tool for each target group;
- keep records of the use of the monitoring data (policy, media, scientific publications…);
- learn from the experience of other schemes and countries, and talk to their monitoring teams. Re-use, improve and adapt information and bright ideas from other places;
- aim high, but not too high. Try to keep lines of organisation, communications, methods, analysis, as simple as possible. Simplistic, but scientifically sound survey designs and analysis will always work better;
- listen to key stakeholders. For example, the volunteer and professional counters, regional organisers, expert ornithologists, the general public, and the policy and decision makers who use the information collected;
- communicate the purpose of the monitoring and the results, and repeat key messages.

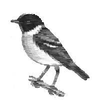
Things to avoid

- giving the impression that outputs from a scheme based on fieldwork of 'volunteers' can be provided entirely for free! This is not the case, but basic monitoring can be relatively inexpensive and highly cost effective;
- raising unrealistic expectations about the results gathered by a monitoring scheme in terms of their use and what they can tell us. Even the very best monitoring data still has limitations as to which biological questions it can reasonably answer.

Useful web links:

http://www.defra.gov.uk/news/2007/071018a.htm

http://www.sustainable-development.gov.uk/index.asp



http://www.scotland.gov.uk/Publications/2007/10/08091435/0
http://miljomal.nu/english/english.php
http://reports.eea.europa.eu/technical_report_2007_11/en/Tech_report_11_2007_SEBI.pdf
http://www.twentyten.net

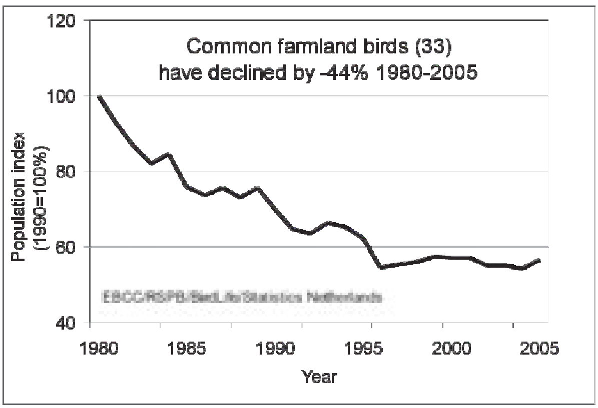
5.2 Case studies

5.2.1 Press release on bird indicators update 2007: Research confirms extent of Europe's disappearing farmland birds

Brussels, 7 June 2007: New research has shown that Europe's farmland birds have declined by almost 50% in the past 25 years – a trend caused by EU-wide agricultural intensification being driven by a policy in need of urgent reform.

The results, released today, bring together the most comprehensive biodiversity indicators of their kind in Europe, collated by the *Pan-European Common Bird Monitoring Scheme* (PECBMS) - a partnership of leading scientists from the European Bird Census Council, the Royal Society for the Protection of Birds, BirdLife International, and Statistics Netherlands. [1]

The indicator of common farmland birds, 1980 - 2005.



The data, collected from 20 national breeding bird surveys spanning Europe over the last 25 years, confirm the extent to which farmland birds have suffered. Across Europe as a whole from 1980 to 2005, common farmland birds have on average fallen in number by 44% - the most severe decline of the bird categories monitored. [2]

"Birds can be vital barometers of environmental change – their declines are clear evidence of the environmental degradation that has occurred across European farmland," said Dr Richard Gregory, Chairman of the European Bird Census

Council, and Head of Monitoring and Indicators at the RSPB. “The data are staring us in the face: many farmland birds - and the species and habitats with which they coexist - are under serious threat.”

Species like Eurasian Skylark *Alauda arvensis*, Red-backed Shrike *Lanius collurio*, Corn Bunting *Miliaria calandra*, Northern Lapwing *Vanellus vanellus* and Eurasian Tree Sparrow *Passer montanus* are familiar names in the long list of declining farmland bird species. [1]

The bird organisations involved in the study are calling for a reform of the Common Agricultural Policy (CAP), a system of European Union subsidies and programmes that has led to considerable agricultural intensification in EU Member States. Although this drive has lessened with successive reforms, the CAP still appears to fail farmland birds and the European environment in general.

“These results show how urgently we need a complete reform of the Common Agriculture Policy, to deliver targeted support for high nature value farming systems and farmed Natura 2000 sites, and to support farmers in delivering environmental improvements throughout the countryside,” said Ariel Brunner, BirdLife’s EU Agriculture Policy Officer, based in Brussels.

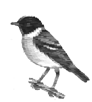
Most concerning is the likelihood of rapid farmland bird declines in new EU Member States that hold some of Europe’s largest concentrations of farmland birds. The study indicates that declines in farmland birds in new EU Member States mirror those declines of more established EU Member States. The fear is that EU accession may accelerate and worsen the situation. [3]

“The EU has made encouraging strides forward in environmental legislation, yet for farmland - which accounts for nearly half of the total land surface of Europe - we are working to an outdated policy that still encourages unsustainable intensive farming, while failing to support those extensive farming systems that are vital for biodiversity conservation and rural economies,” said Brunner.

Findings from the study also show declines for forest birds: across Europe as a whole from 1980 to 2005, numbers of common forest birds have fallen on average by 9%.

While populations have been largely stable in the west and east of Europe, forest birds have shown considerable declines in the north, where they are thought to be threatened by highly intensive forestry exploitation, and in the south, where wild fires and unregulated logging may threaten their populations. [4] One of the reasons behind the substantial regional variation observed in forest bird declines, the researchers argue, is that there is no single unifying policy for forests in Europe, as exists for farmland.

Overall, for both forest and farmland birds, the findings from the *Pan-European Common Bird Monitoring Scheme* (PECBMS) paint a worrying picture of the state of Europe’s wildlife:



"We have the data and the knowledge to help farmland and forest birds, but we need urgently to look deeper into the reasons behind these declines – and to design effective policies that will ensure further losses do not occur," said Dr Gregory.

ENDS

For further information, please contact:

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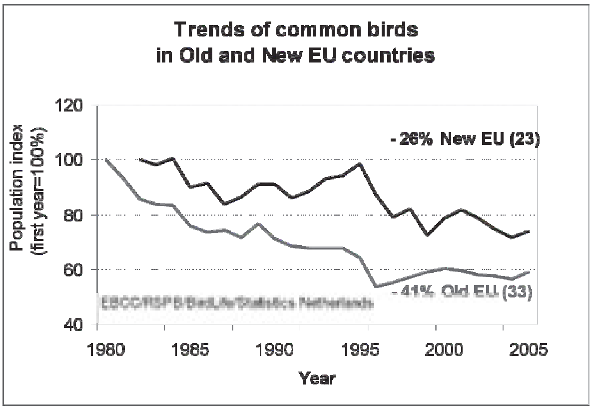
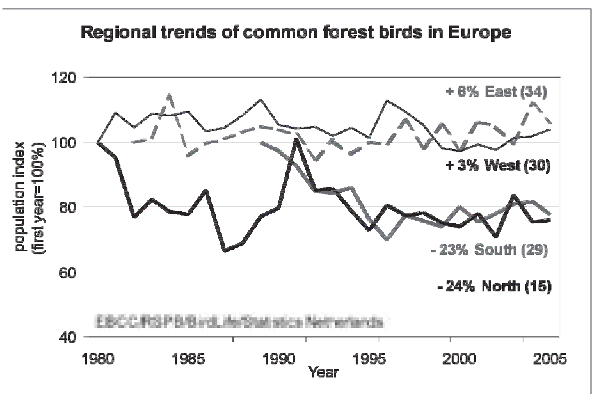
Dr Petr Vorisek
Coordinator PECBMS: +420 257212465, email: euromonitoring@birdlife.cz

Trends of common farmland birds in Old and New EU Countries



Regional population trends of common forest birds in Europe



Notes for editors:

[1] Full details and species lists used can be found at:
http://www.ebcc.info/pecbm.html

[2] The comparable index of all common birds (124 species) decreased by 15% and common forest birds (28 species) decreased by 9% over the same period.

Further details:

1. The need to measure change

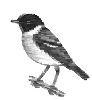
Composite trend indicators, such as the wild bird indicators, provide a tangible basis for measuring progress towards the EU and European targets to halt biodiversity loss by 2010, and thus towards the global target of reducing the current rate of biodiversity loss by 2010. These are the first genuine biodiversity indicators of their kind in Europe and they paint a worrying picture of how the environment is changing. The EU has adopted the farmland bird index as a baseline indicator for Rural Development, and as a Structural and Sustainable Development Indicator. The strengths of this approach are its simplicity, statistical rigour, sensitivity to change, and ease of update. The purpose of the indicators is to enable policy makers to assess changes in the environment and then to review the effectiveness of their actions through time. The indices presented here complement other information on species, sites and habitats.

2. Birds as indicators of the environment

Birds can be excellent barometers of the health of the environment and thus of the sustainability of human activities. Birds occur in all habitats, can reflect trends in other animals and plants, and can be sensitive to environmental change. A great deal of high quality data exists on birds, and new data are realistic and inexpensive to collect. Importantly, birds have a real connection with people and their lives.

3. Species and habitat selection

In the third set of European indices, the ‘2007 update’, 124 species were classified as ‘common farmland species’, ‘common forest species’, or ‘other common species’. The European trends of all 124 species are available via the website http://www.ebcc.info/index.php?ID=148. To reflect regional variation, species classification was based on assessments within bio-geographical regions of Europe, which were then combined and consolidated from the bottom-up to create a single European classification. Regional coordinators were responsible for producing the regional species lists, in cooperation with the relevant experts. Selection was based on species being: (1) abundant and widespread - species with >50,000 breeding pairs in Europe were considered as widespread; (2) characteristic of farmland or forest (or common generalists); (3) characteristic of farmland or forest per bio-geographical region, using an assessment of pre-



dominant regional habitat use; characteristic species are those where ≥ 50% of the regional population uses a particular habitat for breeding or feeding.

4. Indicator methods

Trend information was derived from annually operated national breeding bird surveys spanning different periods from 20 European countries, obtained through the Pan-European Common Bird Monitoring Scheme (PECBMS). The software package TRIM (which allows for missing counts in the time series and yields unbiased yearly indices and standard errors using Poisson regression) was used to calculate national species' indices and then to combine these into supranational indices for species, weighted by estimates of national population sizes. Weighting allows for the fact that different countries hold different sizes and proportions of each species' European population. Population estimates came from a comprehensive review by BirdLife International. Although national schemes differ in count methods in the field, these differences do not influence the supranational results because the indices are standardised before being combined. In 2007, an improved hierarchical imputation procedure was used to calculate supranational indices. Supranational indices for species were then combined (on a geometric scale) to create multi-species indicators. The computation procedure is based on four regions - West: Ireland, UK, Netherlands, Denmark, Austria, Switzerland, former West Germany, Belgium; North: Sweden, Finland, Norway; East/Central: former East Germany, Estonia, Latvia, Poland, Czech Republic, Hungary; South: France, Spain, Portugal, Italy. [Data from Estonia cover a limited number of species and the period to 2000.] However, we plan to develop this system based on bio-geographical regions in future.

5. A system for harmonised data collection

The Pan-European Common Bird Monitoring Scheme (PECBMS) is a partnership involving the European Bird Census Council, the Royal Society for the Protection of Birds, BirdLife International, and Statistics Netherlands. Its aim is to deliver policy relevant biodiversity indicators to decision makers in Europe. It collates national data in a harmonised way from a network of expert ornithologists. It aims to increase both the numbers of countries collecting and submitting data on trends, and the number of bird species and habitats covered. More widely, the project aims to improve the scientific standard of bird monitoring by fostering co-operation and the sharing of best practice and expertise. The project depends on cooperation with national monitoring schemes, who are crucial partners as a source of national data and expertise.

Project co-ordinator: Dr Petr Vorisek, Technical Assistant, Alena Pazderova; Project Manager: Dr Richard D. Gregory; Statistical Advisor: Dr Arco van Strien. Website: http://www.ebcc.info/pecbm.html

6. Special thanks to the PECBMS network & volunteer counters

The success of this project owes much to the co-operation, goodwill and expertise of the PECBMS network. Special thanks go to the individuals and organisations responsible for national data collation and analysis, and to the many thousands of skilled volunteer counters responsible for data collection.

Special thanks to the data providers & organisations responsible for national data collection and analysis: Norbert Teufelbauer, Michael Dvorak, Christian Vansteenwegen, Anne Weiserbs, Jean-Paul Jacob, Anny Anselin, Thierry Kinet, Anotoine Derouaux, Jiri Reif, Karel Stastny, Henning Heldbjerg, Michael Grell, Andres Kuresoo, Risto Väisänen, Frederic Jiguet, Johannes Schwarz, Martin Flade, Tibor Szep, Olivia Crowe, Lorenzo Fornasari, Elisabetta de Carli, Ainars Aunins, Ruud P. B. Foppen, Magne Husby, Przemek Chylarecki, Dagmara Jawinska, Geoff Hilton, Juan Carlos del Moral, Ramón Martí, Virginia Escandell, Åke Lindström, Sören Svensson, Hans Schmid, Andrew Joys, David G. Noble, Mike Raven, and Andrew Joys. We also thank Arco Van Strien, Adriaan Gmelig Meyling, Ian Burfield, Zoltan Waliczky, Lukas Viktora, Lucie Hoskova, Norbert Schaffer, Adrian Oates, David Gibbons, Jose Tavares, Henk Sierdsema, Sergi Herrando, Dominique Richard, Grégoire Lois, Pierre Nadin, Laure Ledoux, and Anne Teller for valuable comments and for general support.

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8. Lead organisations in the production of the wild bird indicators are:

European Bird Census Council

The European Bird Census Council (EBCC) is an association of like-minded expert ornithologists co-operating in various ways to improve bird monitoring and atlas work in Europe, and thereby inform and improve the management and conservation of bird populations. It aims to promote exchange of news, ideas and expertise through a journal and a programme of workshops and conferences. It

works closely with ornithological and conservation organisations, and encourages links between ornithologists, land managers and policy makers. The EBCC oversees specialist working groups and European monitoring projects; these have included in the past the atlas of European breeding birds, and currently the Pan-European Common Bird Monitoring Scheme. Website: www.ebcc.info.

BirdLife International

BirdLife International is a global alliance of conservation organisations working in more than 100 countries and territories which, together, are the leading authority on the status of birds, their habitats and the issues and problems affecting them. Website: www.birdlife.org

RSPB

The RSPB is the UK charity working to secure a healthy environment for birds and other wildlife, helping to create a better world for us all. The RSPB saves birds, protects special places, educates people about the natural world around them and campaigns for a better environment. As a charity, the RSPB depends on the goodwill and financial support of people like you. Please visit www.rspb.org.uk/supporting or call 01767 680551 to find out more.

Statistics Netherlands

Statistics Netherlands (SN) is the official Bureau of Statistics in the Netherlands and responsible for compiling national statistics on a wide range of developments in society. In the framework of wildlife statistics, SN assesses trends for many animal and plant species using data of NGO's. Its role in the European wild bird indicators is limited to the calculation of the supranational indices and to statistical advice about the use of the indexing program TRIM.

5.2.2 The Farmland Bird Index (FBI) and the Pan European Common Bird Monitoring Scheme (PECBMS): Answers to some frequently asked questions, July 2006

Petr Voříšek, Richard D. Gregory, Ian Burfield and Ariel Brunner

1. What is the farmland bird index (FBI)?

The FBI is an aggregated index of population estimates from a selected group of breeding bird species that depend on agricultural land for nesting and/or feeding. The data used to produce the index are collated by national or regional generic bird monitoring schemes. Most of the counting is carried out by a large network of trained and skilled volunteers. Survey details and methods vary by country and region, but all are carefully designed and statistically sound. Counts take place during the breeding season, when bird populations are sedentary (i.e. not during migration or in the winter, when birds are more mobile). The count data are collated by regional and national coordinators and then analysed using TRIM, a software package developed specifically for this purpose by Statistics Netherlands. TRIM can overcome various statistical problems (e.g. missing counts, over-dispersion and serial correlation), thereby allowing national species' indices to be calculated. These indices are calculated independently for each species, and are then weighted equally when combined in the aggregate national index. The PECBMS coordinator is able to collate the national species indices from each country and combine them using TRIM to produce the EU-level FBI, which has been adopted as an EU Structural Indicator and a Sustainable Development Indicator.

2. Why is a multi-species indicator better than one based on a few species or even a single species?

For the same reason that it is important to have a large and representative set of sample points – the more species contributing to the sample, the more reliable it is. Individually, many species may show interannual changes in abundance that may reflect a variety of environmental factors – for example, extreme weather conditions during the breeding season, poor conditions on the winter grounds, changes in predation pressure, etc. Consequently, indicators based on one or a few species are prone to show quite marked volatility, which may have very little to do with changes in the sustainability of agriculture. By using a more representative 'basket' of species that all breed in the same habitat, such variability is reduced, and truly directional changes in the abundance of a whole suite of birds – and wider biodiversity – become more apparent. If the majority of species in the basket decline, then the indicator trend line goes down, and vice versa. Overall, this provides a balanced picture of what is happening in the environment.

3. What should I do if some of the farmland species listed do not breed in my country or region, or are rare and patchily distributed, rather than common and widespread?

When establishing a monitoring scheme for this purpose, the prime consideration is that it should use generic methods to give representative coverage of *all* common breeding farmland birds in each country or region. The 23 species listed were those used in the first release of the Pan European Common FBI in 2003. This list was revised slightly in 2004 to reflect the classification used in *Habitats for birds in Europe* (Tucker and Evans 1997), such that 19 species were included in the second release in 2005. With support from the European Union, the PECBMS is continuing to fine-tune and improve the species selection for both farmland and forest habitats. For farmed habitats, however, the crucial point to note is that these minor changes have a negligible impact on the overall trend for the 'basket' of species (further reflecting the indicator's reliability). Most of the species listed are common farmland birds in most Member States, so national data

can be combined to produce multi-national indicators, meeting the demand for EU-level indicators (e.g. Structural and Sustainable Development Indicators). For Rural Development Planning, however, the most important priority is to ensure national representativeness. Thus, you should focus on covering as many of the 23 species listed as possible (provided that they occur as widespread breeders in your country), along with any other species that are locally common and widespread farmland breeders. Such modifications make good ecological sense. National and regional monitoring scheme coordinators are best placed to advise on this and suggest possible modifications.

4. Can the farmland bird index tell me about the effectiveness of specific agri-environmental measures?

As stated above, the FBI is designed to paint a broad-scale picture of the state of farmland biodiversity, and thus the overall performance of agri-environmental schemes at regional or national level. As such, it is not intended to measure the effectiveness of specific, fine-scale agri-environmental measures implemented at site level. In general, assessing the effectiveness of such micro-scale measures demands more detailed and experimental monitoring protocols, based upon clear ecological hypotheses and tailored to the specific targets of each agri-environmental measure. These need careful design to ensure that they can detect effects operating at finer scales (e.g. field boundaries), and will usually focus on a small set of target species (or even a single species). They will follow basic principles of high-quality experimental design, such as replicates, test and control plots, and before and after treatments, to help ensure that any effects detected are caused by the measure. If the measure in question is being implemented at a very broad scale (e.g. reducing pesticide inputs across entire farms), and there are enough sample plots in farms where the measure is being taken to compare with those where it is not, then it *might* be possible to use the results of common farmland bird monitoring to assess the effectiveness of the measure.

5. Can the farmland bird index tell me about the state of biodiversity in Natura 2000 sites?

The FBI is designed to provide information about the general state of farmland biodiversity – and thus the sustainability of agriculture – across the region or country to which each Rural Development Plan applies. To give an accurate picture, sample plots must therefore be distributed in a representative way across the region or country in question. This may mean that a subset of sample plots fall in Natura 2000 sites, especially in Member States with many sample plots and/or many Natura 2000 sites. However, the type of species involved (common and widespread farmland birds) means that they are usually not features for which Natura 2000 sites are identified. Thus, the potential value of these data in this regard is limited. If the number and coverage of sample plots allow, then it *might*

be possible to use the FBI to provide additional information about the state of biodiversity in localities within and outside a subset of (farmland) Natura 2000 sites. However, the quality of the data may differ among Member States, so their suitability for this purpose should be checked with coordinators of national/ regional common bird monitoring schemes. Ultimately, it should be re- membered that monitoring Natura 2000 sites demands bespoke monitoring of the species and habitats for which the sites are identified and managed. Only by monitoring these qualifying features can you assess whether a site's condition is favourable or unfavourable.

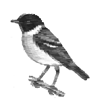
6. Can the farmland bird index tell me about the state of biodiversity in other habitats, like forests?

The species listed were chosen specifically because they are characteristic users of farmed habitats across much of Europe. A completely different set of species is required to provide an equivalent picture for forests, or any other habitat (e.g. wetland or marine habitats). Many national bird monitoring programmes already monitor such species, and the PECBMS has collated these data to develop a common forest bird index, which is updated annually at the same time as the FBI. In the future, the PECBMS hopes to be to develop analogous indices for other habitats. For the purposes of the Rural Development Plan, only the FBI will be considered mandatory under the current policy. However, further indices for other habitats or groups of species can of course be developed and delivered by individual Member States. For example, the complementary forest bird index that is being further developed with the help of the BirdLife Forest Task Force would be well worth considering, as it should help inform your Rural Development planning for those aspects concerning forestry measures.

7. Which year should I use as the baseline?

At present, the PECBMS uses an agreed EU-wide baseline year of 2000 when presenting the FBI; this year was selected to provide maximum geographic coverage. When reporting to the European Commission on the implementation of the new Rural Development Plans, the baseline should be the present situation, as this is what your agri-environmental measures are aiming to improve upon. Wherever earlier data exist, though, we strongly recommend using them to put current trends in a longer-term context and provide a deeper understanding of trends and their drivers. In many Member States, national common bird monitoring schemes already exist and have been running for years or decades. This is how the PECBMS has managed to produce the multi-species, multi-country indicator that has now been adopted as an EU Structural Indicator and a Sustainable Development Indicator.

By contacting the coordinator of your national scheme, you can find out how long the scheme has been running and how well it covers your country or region.



In some Member States, data are available from as far back as the 1970s. These are very valuable, because they show that farmland birds in many Member States suffered their most severe losses during the 1970s and 1980s. By referring to these older data, you will be able to measure the extent to which your new agri-environmental measures help to restore farmland bird populations to a more ecologically meaningful baseline. In the few Member States where no scheme exists, your most important priority now should be to design a scheme that can be set up to start delivering data in 2007. Otherwise you will not be able to meet your obligation to report on the indicator in the mid-term (2010) and final (2013) evaluations of your Rural Development Plan.

8. How can the regulation be applied when regional governments are responsible for implementing it?

In some Member States, farmland bird population trends must be monitored and reported on at a regional level (rather than nationally), as this is the scale at which Rural Development policies are implemented. Such cases should not prove problematical – provided that there is detailed national co-ordination, steerage and integration of actions and measures. In many Member States, national co-mmon bird monitoring schemes already provide good coverage of their regions, in which case the data-gathering structures should be in place. Before proceeding, it will be important to check this with your national coordinator, in order to avoid possible duplication of effort and proliferation of different approaches, which would waste precious resources and deliver little. The new Rural Development policy provides an impetus to review regional requirements in a national context and respond accordingly. This may involve supplementing survey effort in some areas, while maintaining a single robust design nationally to allow comparability between regions. The value of data collected at regional scales will be greatly enhanced if they can be combined seamlessly with equivalent information at national and international scales.

9. The PECBMS already delivers the farmland bird index to Eurostat every year, so why do I need to do anything else?

The PECBMS indicators do not yet include data from all Member States. There are still a few gaps where common bird monitoring schemes do not exist, have ceased to exist, or where the existing schemes are not currently considered to provide representative coverage of farmed habitats. The major reason for these gaps is a lack of institutional funding for the ongoing coordination of these schemes. In virtually every country, the field data are collected not by paid professionals but by skilled volunteers – in other words, there are no (or at most very low) labour costs associated with these schemes. However, to ensure they function properly, it is essential that they are well coordinated at national and (especially in large Member States) regional level. Such coordinators are responsible not only for collating the field data and analysing them to produce the regional or national trends, but also for 'servicing' the network of volunteers, by providing training, feedback and motivation. We know from the PECBMS network that many national schemes face an annual struggle to secure enough funding to continue operating, even in some Member States with a long history of bird monitoring. The huge amount of valuable data that can be leveraged from thousands of volunteers, just by funding a few coordinators, shows how efficient these schemes are – and what excellent value for money they offer. The European Commission has already recognised this, and now makes a vital contribution by funding the PECBMS coordination work at EU level. By funding the essential coordination work required at national/regional level, you can ensure the long-term sustainability of these schemes – and meet your own Rural Development obligations very cost-effectively.

10. Where can I find more information and help?

PECBMS is a joint initiative of the EBCC (www.ebcc.info) and BirdLife International (www.birdlife.org). It is currently funded by the European Commission and the Royal Society for the Protection of Birds (RSPB, the BirdLife Partner in the UK). The EBCC and BirdLife International both have networks of national delegates or partners across Europe. These experts are responsible for and often lead national bird monitoring initiatives, or can put you in touch with the relevant people. If you are not already in touch with them, these individuals should be your first port of call to discuss how to meet this monitoring and reporting requirement. The national networks, the expertise, the knowledge and the data are all available to help you. Members of the EBCC Executive Committee and the BirdLife International European Division staff are also available to help and provide advice.

Chapter 6

THE PAN-EUROPEAN COMMON BIRD MONITORING SCHEME

Alena Klvaňová and Petr Voříšek

6.1 PECBMS: aims and results

What is PECBMS

The Pan-European Common Bird Monitoring Scheme (PECBMS) is a joint initiative by the European Bird Census Council (EBCC) and BirdLife International. It started in January 2002, with the first set of indicators released in 2003, the second set in 2005 (PECBMS 2006) and the latest update in 2007. The main PECBMS partners are the RSPB (UK BirdLife Partner) and Statistics Netherlands. The project has established a large European network of collaborators – coordinators of national or regional monitoring schemes, EBCC delegates and/or BirdLife Partners. The project is coordinated by a central coordination unit based at the Czech Society for Ornithology (CSO) in Prague, Czech Republic. A Steering Group and Technical Advisory Group oversee the work.

The main PECBMS aim is to use common birds as bio-indicators of the wider environment, by using scientific data on changes in breeding populations across Europe. The PECBMS aims to produce regional and European indices of species population changes and then to produce annual multi-species indices (indicators) for the main habitats (farmland and forest so far).

Methods

Trend information is derived from the annual national breeding bird surveys from 20 European countries, spanning different time periods, that are organised through PECBMS (Figure 6.1). There are several new monitoring schemes that are currently being developed in Europe with EBCC and PECBMS assistance, and which are now at the pilot stage, although they are not yet ready to provide data into the PECBMS dataset. These new schemes still need further development and financial assistance to be able to provide trend data for indicator updates in the future.

The software package TRIM (TRends and Indices for Monitoring data, Pannekoek and van Strien 2001) is used to calculate national species indices. TRIM allows for missing counts in the time series and yields Poisson regression. The national indices are then combined into supranational species indices, weighted by national population size estimates. This weighting allows for the fact that different countries hold different proportions of each species European population. Updated population size estimates from BirdLife International (2004) are used for the weighting. In 2007, an improved hierarchical imputation procedure was used to calculate supranational indices for each species, which were then combined on a geometrical scale to create multi-species indicators. Four regions of Europe were used in the calculation of indices. We plan to further develop this system, to be based on bio-geographical regions.

For the latest set of indices (published in 2007), 124 species were classified as common farmland species, common forest species or other common species. To reflect regional variation, species classification was based on assessments within bio-geographical regions (Atlantic, Boreal, Continental and Mediterranean), which were then combined to create a single European classification. For details of the species classification, see www.ebcc.info/pecbm.html.

Extended data quality control included checks on whether data are available from countries which hold at least 50% of the European population. For details and quantitative criteria of the data quality control, see www.ebcc.info/pecbm.html.

Main results

All the sets of common European bird indicators produced so far highlight the sharp decline of farmland birds (Figure 6.2). According to the latest update, from 1980 to 2005, the common farmland bird index has fallen by 44%. This decline is evidence of the environmental degradation that has occurred across European farmland, particularly through specialization and intensification of agricultural methods (Vickery *et al.* 2004, Krebs *et al.* 1999, Pitkanen and Tiainen 2001). Five of the ten common European species showing the greatest declines are species characteristic for agricultural habitats, including Grey Partridge *Perdix perdix* and Northern Lapwing *Vanellus vanellus*. The previous differences in farmland bird population trends in the old and new EU Member states (which joined the EU in May 2004) appears to be diminishing in recent years. The slow decline in the old EU countries since 1990 continues, while the recovery of farmland birds in the new EU countries until the mid 1990s has now been followed by a continuous decline, mimicking the trends in old EU countries.

Common forest birds have also declined across Europe, with numbers having fallen by 9% between 1980 and 2005. While farmland birds declined across Europe, forest bird trends exhibit different regional patterns. Forest birds are declining most in northern Europe, where they are thought to be threatened by highly intensive forestry practices and in the south, where the trends themselves and their drivers are much more uncertain, perhaps wild fires and unregulated logging are implicated in the decline.

The 2007 update included larger amounts of data and, as a result, the European trends of several species were produced for the first time (PECBMS 2007). Apart

Figure 6.1. *European countries with large-scale sample breeding bird surveys which are used (or can be used in the future) for generating European indices and indicators.*

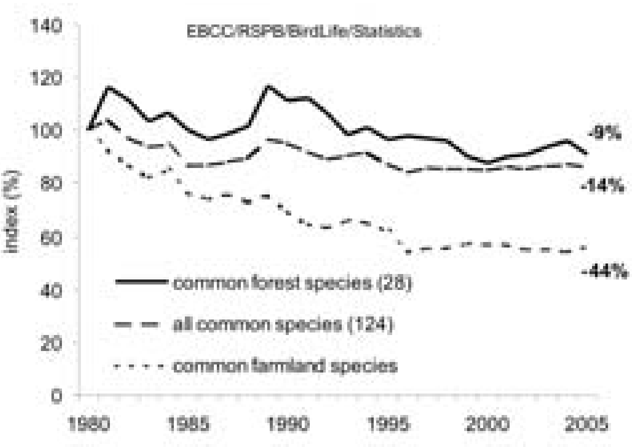
from a greater robustness and higher quality of indicators, it is perhaps surprising that declines of particular species were found, such as Meadow Pipit *Anthus pratensis* and Crested Tit *Parus cristatus*. It may be that these species, although considered as Secure at the European level (BirdLife International 2004), are showing signs of declines that could require further study.

Scheme achievements and plans for the future

The PECBMS project is an example of successful international cooperation in applied conservation science, which is communicating information on biodiversity trends in Europe.

The European wild bird indicator has attained a certain level of success so far. It has had a very high impact across Europe and is used in a wide range of environmental reporting processes in Europe and also globally. Data on common birds are used in the EEA's core set of indicators as well as in the SEBI 2010 biodiveristy indicator set. The Farmland Bird Index is used as an official European Union Structural and Sustainable Development Indicator (http://epp.eurostat.ec.

Figure 6.2. *The wild bird indicator for Europe. The numbers in parentheses show the number of species in each indicator.*



europa.eu), it is part of the agri-environment indicator set, and is used as an indicator to underpin the Rural Development Regulations.

There is, however, further effort needed to help develop the project in the future. We aim to publish updates on an annual basis, improve geographical coverage, increase the number of species and explore the possibility of producing indicators for other habitats, e.g. urban or inland wetlands and for climate change. We also hope to increase the scientific research to reveal the main driving forces behind the species trends.

6.2 Review of large-scale generic population monitoring schemes in Europe 2007

Introduction

Several attempts to summarise information on bird surveys in Europe have been made in the last few decades; the last summary focused on large-scale breeding population schemes (Vorisek and Marchant 2003). Updates of these survey summaries have proved to be a very useful tool in assessing the current status of bird monitoring, especially in identifying gaps and areas for further development, and are also a useful source of information for those who seek to establish a new monitoring scheme, improve a current one, or just to get more information on bird monitoring in a concise form. Thus, a new review (Klvaňová and Voříšek 2007) was completed recently and the results are presented in this chapter.

Methods

Our review was limited to large-scale breeding monitoring schemes that were based on sample surveys, because these form the core source of data for the PECBMS. For simplicity, we refer to them as Common Bird Monitoring (CBM) schemes. We prepared a new questionnaire and distributed it as an electronic form in MS Word. We tried to make it as easy as possible to fill in. The questionnaires were sent to 40 European countries, usually to several contacts (monitoring scheme coordinators, BirdLife International partner organisations and EBCC national delegates) in each country.

Results

We have received information on 42 large-scale common bird monitoring schemes from 35 countries (see Table 6.1). Seven schemes began in 2007 and are referred to as pilot schemes here and, as well as one scheme currently at the planning stage, are not considered in our further analyses. The remaining 35 schemes meet the criteria of this review, but eight of them have now ceased to operate. Two schemes are included in the further analysis only when the information supplied to us allowed such analysis. Information from another three schemes was too patchy, so could not be included in the analysis. All of the following results are thus based on 28 ongoing schemes.

Since the previous review in 2003, fourteen new CBM schemes have arisen. Other schemes in Latvia, Finland and France have ceased to operate. However, in each of these countries there is another monitoring programme in their place.

Scheme coordinators were asked for information about the number of species reliably monitored. On average a scheme monitors 82 species. However the number of monitored species may be affected by the scheme method as well as by the diversity of bird species of different countries or regions. Habitats features are recorded as a part of 24 surveys. Regarding the frequency of survey within the year, most of the schemes collect data once a year (11 schemes) or twice a year (11 schemes). However, the number of visits obviously depends on the methods used and size of survey plot; for example, territory mapping needs more visits than point counts.

The point count method is still the predominant field method used in Europe, but line transects are also used very frequently. Only three schemes use territory mapping, and a further three schemes use a combination of methods. The sampling design (selection of sample plots) has changed remarkably, and in a very positive fashion, since the last review. Fewer schemes allow a free choice of plot selection and more desirable sampling methods have become more widespread.

***Table 6.1**. Country overview of Common Bird Monitoring Schemes in Europe, where the questionnaires were sent. Note that some countries have more than one scheme in place. Names of schemes given in italics are indicative only, there are no exact titles known to us or established yet.*

Country	Scheme Name	status	start	end	Number of species
Austria	Monitoring der Brutvögel Österreichs	ongoing	1998		60-65
Belarus	National Scheme of Environmental Monitoring in Belarus	pilot	2007		?
Belgium-Flanders	Common Breeding Birds in Flanders	pilot	2007		?
Belgium-Wallonia	*Common Bird Monitoring Scheme*	ongoing	1990		?
Belgium-Brussels	*Common Bird Monitoring Scheme*	ongoing	1992		?
Bulgaria	Common Bird Monitoring Scheme	ongoing	2004		30
Croatia	*Common Bird Monitoring Scheme*	planned			?
Cyprus	Cyprus Common Bird Census	pilot	2005		?
Cyprus	Western Cyprus Common Bird Census	ongoing	2003		?
Czech Republic	Breeding Bird Census Programme	ongoing	1981		100
Denmark	Point count census of breeding and wintering birds	ongoing	1976		100
Estonia	Point Count Project	ongoing	1983		45
Finland	Annual monitoring of breeding birds in Finland	ongoing	1981		100
Finland	Summer bird atlas of breeding birds	finished	2000	2005	?
France	Temporal Survey of Common Birds	finished	1989	2001	?
France	New Temporal Survey of Common Birds	ongoing	2001		150
Germany	DDA monitoring programme for common breeding birds	ongoing	1989		100-150
Germany	DDA Monitoring programme of common breeding birds in the wider countryside	ongoing	2004		100-130
Greece	Hellenic Common Breeding Bird Monitoring Scheme (HCBBMS)	pilot	2006		?
Hungary	Monitoring of our common birds (MMM)	ongoing	1999		100
Hungary	Point counts of passerines	finished	1988	1998	?
Ireland	Countryside Bird Survey (CBS)	ongoing	1998		55
Italy	MITO2000 (Monitoraggio ITaliano Ornitologico)	ongoing	2000		75
Latvia	Monitoring of birds and habitats in agricultural lands	finished	1995	2006	?
Latvia	Breeding Bird Counts	finished	1983	1994	?
Latvia	Latvian Breeding Bird Monitoring scheme	ongoing	2005		60
Lithuania	Monitoring of breeding birds	suspended	1991		20
Luxembourg	Common bird monitoring programme	finished	2002	2003	?
Macedonia	Common bird Monitoring Scheme - Macedonia	pilot	2007		?
Netherlands	BMP - Common breeding species project	ongoing	1984		113
Norway	Norwegian breeding bird census	ongoing	1995		58

Table 6.1, *cont. from the previous page*

Country	*Scheme Name*	*status*	*start*	*end*	*Number of species*
Norway	New Norwegian breeding bird census	ongoing	2005		?
Poland	Monitoring Pospolitych Ptakow Legowych (MPPL)	ongoing	2000		178
Portugal	Censo de Aves Comuns (CAC)	ongoing	2004		60
Romania	Common Bird Monitoring (CBM) in Romanian	pilot	2006		?
Russia	*Bird population monitoring*	?	1973	?	?
Slovakia	Monitoring of breeding bird populations in Slovakia	ongoing	1994		?
Slovenia	Slovenian monitoring of common birds of agricultural landscape	pilot	2007		?
Spain	Common Breeding Bird Monitoring Scheme (“SACRE”)	ongoing	1996		100
Spain	Catalan Common Bird Survey (SOCC)	ongoing	2002		100
Sweden	Swedish Breeding Bird Survey	ongoing	1975		120
Sweden	Swedish Breeding Bird Census	finished	1969	?	?
Sweden	Swedish Breeding Bird Survey	ongoing	1996		80
Switzerland	Monitoring of abundant breeding birds	ongoing	1999		75
Turkey	Common Bird Monitoring (CBM) in Turkey	pilot	2007		?
UK	Breeding Bird Survey	ongoing	1994		70
UK	Common Birds Census	finished	1962	2000	?
UK	Waterways Bird Survey	ongoing	1974		24
UK	Waterways Breeding Bird Survey	ongoing	1998		70
Ukraine	Counts of birds in Western Ukraine	ongoing	1980		50

Of the 28 schemes, 17 use the distance sampling method. Each scheme usually discriminates between two or three distance bands, which are <25 or <50m wide, <100m wide and >100m wide. The use of distance sampling in scheme design is promising from the perspective of spatial modelling in the future, in allowing bird detectability to be addressed, and in allowing estimates of density to be made in a robust fashion.

Regarding the analytical methods used today, twenty schemes are using TRIM to produce trends and indices. The change to more robust methods is most welcome and offers individual countries much greater scope to use and develop their indices. All but one of the ongoing monitoring schemes store their data in a database. The most common type of database is MS Access.

The question on the production of a Farmland Bird Indicator (FBI) was a new one since 2003. Quite surprisingly a high number of schemes (15) reported producing an FBI. However, in only 10 countries was the FBI agreed and adopted for use by the government.

Conclusions

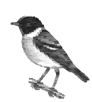
Considerable progress has been achieved in establishing new CBM schemes across Europe, as well as in re-organising the 'old' schemes. Since the last review in 2003, the number of schemes analysing data in TRIM has markedly increased and practically all data are now stored in some kind of database. Problems, however, still exist – for example, there is a need for training coordinators at the national level and a strong need for funding to support bird monitoring at a national level. Also, gaps remain in geographical coverage for CBMs that need to be filled, mainly in eastern and southern European countries (such as Belarus, Russia and Turkey). In some of these countries there are plans to develop pilot schemes, or at least to build capacity and interest, and as small-scale monitoring is established this will pose a challenge as to how this information can be incorporated and used at a European level, and how the required monitoring effort can be funded. In several countries, new schemes have started and have been running concurrently with older ones. Considerable attention will be needed to combine the outputs of these schemes. This review must be seen as a snapshot that provides an overview of the monitoring situation in the winter of 2007. However, we fully intend keeping the section "Common bird monitoring schemes in Europe" on the EBCC website (www.ebcc.info/pecbm.html) as a living document, and will update information as and when it becomes available.

Any updates or corrections to the current information on national monitoring schemes should be sent to the authors of this chapter.

Acknowledgements

Completing this review would not have been possible without the efforts of the many ornithologists across Europe who kindly filled in the questionnaires. We are very grateful to all of them:

Patric Lorgé, Janis Priednieks, Risto A. Väisänen, Olivia Crowe, Sören Svensson, Åke Lindström, Henning Heldbjerg, Michael Dvorak, Norbert Teufelbauer, Jiří Reif, Andres Kuresoo, Frederic Jiguet, Martin Flade, Tibor Szép, Karoly Nagy, Andras Bóhm, Lorenzo Fornasari, Ainars Aunins, Arend van Dyk, Ruud Foppen, Magne Husby, Jozef Ridzoň, Virginia Escandell, Juan Carlos del Moral, Hans Schmid, Michael Raven, David Noble, John Marchant, Igor Gorban, Georg Willi, Katarina Denac, Tomaž Mihelič, Dmitrii Zhuravliou, Ortaç Onmus, Özge Balkiz, Metodija Velevski, Glenn Vermeersch, Michael Miltiadou, Svetoslav Spasov, Derek Pomeroy, Alexander Mitschke, Theodoros Kominos, Ricardo Martins, Zoltán D. Szabó, Cristi Domsa, Sergi Herrando, Ólafur K. Nielsen, Gudmundur A. Gudmundsson, Arnthor Gardarsson, John Cortes, Charles Perez, Oksana Osadcha, Jasmina Muzinič, Andreja Radovič.



Chapter 7

SUMMARY

Richard D. Gregory and Petr Voříšek

'The 10 best suggestions'

1. define your survey objectives at the outset and stick to them;
2. keep things simple - since complexity often adds only marginal benefits and has associated costs;
3. aim high and be ambitious, but not too high;
4. learn from others – there is a wealth of experience and knowledge out there;
5. follow the basic principles of good survey design – as set out in this guide and elsewhere;
6. talk and listen to the many people who might be linked to your bird survey; the counters, regional organisers, expert ornithologists, technical experts, and the people who might be using the information;
7. incorporate a pilot phase in the introduction or modification of a count scheme and use that experience to shape how it develops;
8. store data in a database and archive the information properly;
9. report the results on a regular basis to a range of audiences – from newletters to volunteers, leaflets for policy makers, to scientific publications;
10. design a survey that can be expanded in size or scope if more resources become available. Monitoring should be viewed as an adaptive and ongoing process.

'The 10 things to avoid'

1. repeating mistakes other people have already made;
2. being unrealistically ambitious and trying to do several things at once;
3. collecting information that is not inputted and never analysed;
4. forgetting to look after, nurture and train the skilled volunteer counters, on which much good bird monitoring is based;
5. forgetting to thank the counters, regional coordinators, funding bodies on a regular basis;
6. believing that no birds are missed when you are out counting (detection of birds is perfect in all habitats and at any distance from an observer);
7. not knowing the statistical difference between accuracy and precision;
8. changing monitoring methods part way through a survey;

9. failing to analyse data and write up the results – failing to tell the world what you have found and why it is important;
10. failing to use the information to help inform the management and conservation of birds.

Useful further reading

(For full citations see the Chapter 8 References at the end of the book.)

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http://www.birdlife.org
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http://www.defra.gov.uk/environment/statistics/wildlife/kf/wdkf03.htm
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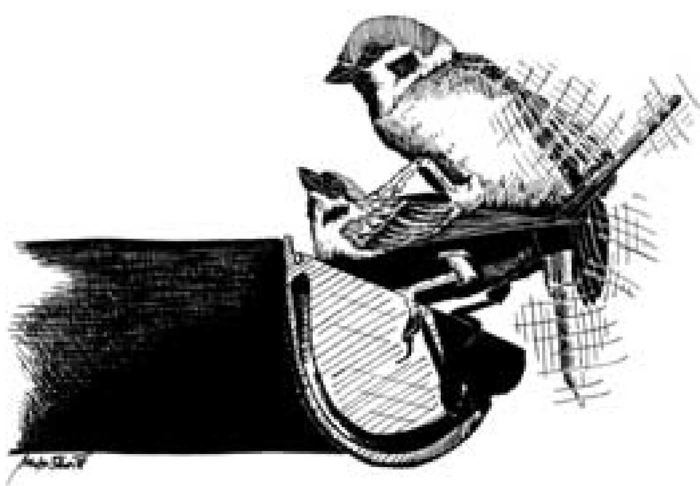

Chapter 8

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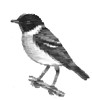

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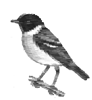

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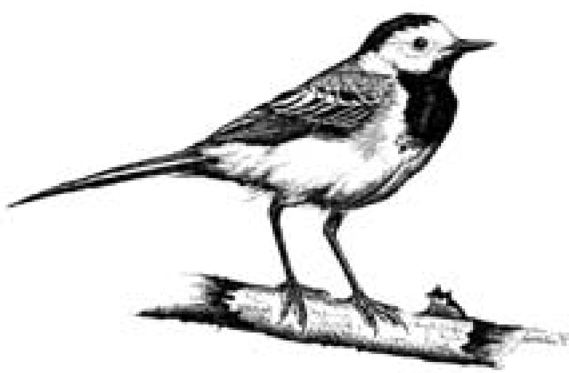


Chapter 9

APPENDIX

Instructions for fieldworkers, Breeding Bird Survey in the UK

BREEDING BIRD SURVEY
INSTRUCTIONS

Thank you for volunteering to take part in the Breeding Bird Survey (BBS), a scheme designed to keep track of breeding bird populations in the UK. The survey is a quick, simple and, most importantly, an enjoyable birdwatching exercise. Plots are 1x1-kilometre (km) squares of the National Grid. Observers make just three visits to specially selected squares, the first to record habitat types and to set up a suitable survey route, and the second and third to record birds that are seen or heard while walking along the route.

These instructions should be used by both the BBS-Online user (observers who will be entering their data via the Web, www.bto.org/bbs) and the paper-form user.

The main aims of the BBS

1. To provide information on year-to-year and longer-term changes in population levels for a wide range of breeding birds across a variety of habitats throughout the UK. Knowing to what extent bird populations are increasing or decreasing is fundamental to bird conservation. Monitoring birds has the added advantage that they act as indicators to the health of the countryside.
2. To promote a greater understanding of the population biology of birds and in particular to focus on factors responsible for declines. The BBS is a key component of the BTO's Integrated Population Monitoring Programme.
3. To promote bird conservation through the involvement of large numbers of volunteers in survey work in the UK.

Paper forms to receive

Once you have contacted your Regional Organiser and have been allocated a randomly selected 1-km grid square, you should receive the following paper forms in the post (one set of forms for each square you have agreed to cover):

1 x Breeding Bird Survey Instructions booklet (yellow)
2 x Field Recording Sheets (white)
2 x Count Summary Sheets (white)
1 x Habitat Recording Form (green)
1 x Mammal Count Summary Sheet (pink)
1 x OS Map of your square (blank)
1 x OS Map with transect route (if available)

We recommend that both BBS-Online and paper-form users take their Field Recording Sheets and Habitat Recording Forms out in the field to record their sightings on. Only the paper-form user needs to transfer bird count records from the Field Recording Sheet to the Count Summary Sheet. The BBS-Online user can enter their bird count data directly from the Field Recording Sheet.

Organisation

The BBS is organised through the BTO's network of voluntary Regional Organisers (ROs), most of whom are also BTO Regional Representatives. The UK is divided into 124 BTO regions, defined primarily by 10km grid squares. Each BTO region has an RO assigned to it, and it is their responsibility to allocate you a BBS square and to issue and collect completed forms. All completed forms should be sent direct to the RO. The RO will also be able to deal with any questions you have about BBS methodology and land access issues. For answers to Frequently Asked Questions, please refer to our FAQ web page. If your BTO region does not have an RO, the BBS National Organiser will act as your RO and all completed forms should be sent directly to BTO HQ in Thetford. The National Organiser and other staff from the BTO Census Unit will be happy to deal with any questions you have regarding the survey.

Which square should you survey?

Either your BTO Regional Organiser (RO) or the BTO Census Unit will have provided you with the Ordnance Survey (OS) grid reference of the 1-km square we would like you to survey. Grid references are in standard OS format (i.e. two letters for the 100-km square, two numbers representing the 'easting' and two numbers representing the 'northing'). Please check carefully the reference of the square you have been allocated. Squares have been chosen according to a formal sampling strategy to cover all habitats and regions. Comprehensive coverage is vital to the survey design. Please make every effort to cover the square that is assigned to you. **We will not be able to use data collected from additional or substituted squares.**

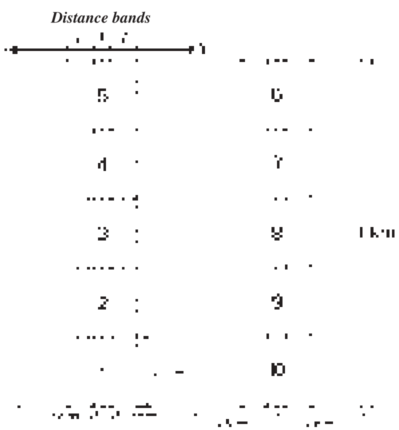
In cases where survey work proves impossible in a large part of the square you have been allocated, e.g. because it is physically impossible to visit, or access permissions are not granted, please report this to your RO so that a replacement square can be provided. It is **very important** not to reject squares on the grounds that they appear uninteresting - squares containing few species are just as valuable as squares with many species. For squares containing a large area of water, estimate how many of the 10 'ideal' transect sections are located on dry land (above Mean High Water). If this is less than 4 (i.e. less than 800m of transect) regard the square as 'uncoverable' and report it to Census Unit via your RO.

Tips to volunteers:

For all users:
1. **Do not record birds you see or hear before or after your transect line (i.e. behind your first 200m section or in front of your last 200m section).**
2. **Record all birds to the sides of your transect line.**
3. **Record all birds from your transect line that you can see or hear that are to the sides of your transect line, even if they are in adjacent 1-km squares.**
4. **Record habitat details each year. If you are only able to fill in the first two columns on the habitat form, this is still extremely useful.**

For paper-form users only:
5. **Ensure that only the number of birds recorded is written in each box on the count summary forms. Additional information such as "+" or "many" complicates the forms and should be avoided.**
6. **Birds can be listed in any order on the Count Summary Sheet.**
7. **Please put your forms in the following order on completion - from top to bottom: habitat, summary 1, summary 2, mammal, field 1, field 2. This will help speed up the processing of forms.**

Finding and marking a route



Transect sections are labelled 1-10

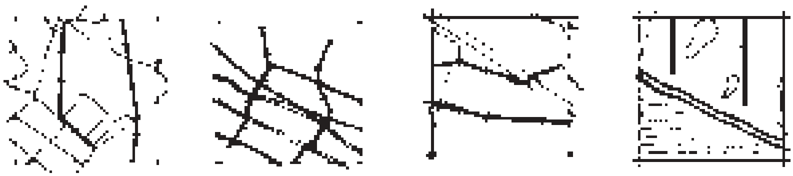
If the square has been surveyed before, your RO should provide you with a sketch map of the counting route (the transect line) taken by the previous BBS observer. This route must be followed to ensure consistency of recording on that square (i.e. if a different route is taken, different birds will probably be recorded). If the route has to be changed because you can no longer get access to it, please consult your RO and return the completed Habitat Recording Form, with a sketch map of the new route on it. If the square has never been covered before (your RO will tell you this), you will you need to create your own transect route across it.

The transect line should ideally consist of two parallel lines, north-south or east-west, each 1-km long. **Please ensure that the route followed is the same as in previous years.** Transect lines should be roughly 500 metres (m) apart and 250m in from the edge of the square. Each transect line should be divided into 5 equal sections of 200m in length,

making a total of ten (2x5), numbered 1 to 10. It is important to note the starting points of each transect section either by using permanent landmarks (trees, hedges, boulders, houses etc) or by using temporary markers (coloured tape or cord etc).

In practice, your transect lines are likely to deviate from the 'ideal' because of problems with access, or barriers such as roads, rivers, and canals: possible solutions are given below. Once you have decided upon a route, it is of the greatest importance that the same route is followed year after year. In cases where the transect lines deviate considerably from the 'ideal', at no point should the two lines be closer together than 200m. **Minor intrusions into adjacent squares are perfectly acceptable and may provide the only practical way to carry out the survey. Please record the exact route taken in the box provided on the green habitat form.**

Examples of transect routes: bold lines indicate suggested transect route with divisions in 200m sections. Note that the start and finish of the transects need not be at a square boundary.



a. b. c. d.

a. NO0861 (Tayside): mostly open fields, but limited places to cross stone walls.
b. SP9808 (Herts): mostly urban; access restricted to roads and paths; only 2 places to cross the obstructions.
c. SU8291 (Bucks): footpaths mimicking ideal pattern but running W-E avoid problem caused by M40.
d. TV5496 (E Sussex): part of the square contains sea, however, 5 200m sections on land can be covered N-S.
Note: if less than 4 200m sections lie on land the square must be treated as uncoverable.

SUMMARY OF FIELDWORK

March - April	Reconnaissance visit to set up or check census route and complete habitat recording form.
Early April - mid-May	Complete 'early' transect count.
Mid-May - late June	Complete 'late' transect count.
July – August	Enter all data online or return completed forms to Regional Organisers (or to the Nunnery if there is no RO).

N.B. The fieldwork should begin and end later in more northerly parts of the UK.

When to visit

The main part of the breeding season, roughly between 1st April and 30th June, in the lowlands of southern Britain, should be divided into two counting periods (early season visit = April to mid-May; late season visit = mid-May to late June) and one visit should be made in each half. **Visits should be at least 4 weeks apart**. The first should coincide with the main activity period of the resident breeding birds in an area, while the second should take place after the arrival of the latest migrant breeding birds. At higher altitudes or further north, visits should be shifted later in the season, but the final transect count should be completed by mid-July. From late June, counts will almost certainly include a much greater proportion of unidentified young birds, and most species will have reduced or stopped singing, making detection more difficult.

Counts should ideally start between 6am and 7am, and no later than 9am. Please try to keep the starting times similar within a breeding season and across years, preferably to within half-an-hour. Please also try to keep the visit dates similar across the years. Counts will be more productive earlier in the day, with birds generally becoming quiet and inactive during the middle of the day (11am to 3pm). Starting times can be shifted to begin later in more remote and less accessible areas. If survey times extend beyond midday please use the 24-hour clock.

Weather

Please do not attempt to census birds in conditions of heavy rain, poor visibility or strong wind. Birds generally become inactive in windy and wet conditions. However, activity often increases considerably after rain showers and therefore showery weather is generally okay for conducting surveys. Please record weather conditions in the boxes provided on the forms that describe cloud cover, rain, wind speed, and visibility. Choose one number (1-3) from each of the four headings below and enter these in the box provided on the Field Recording Sheets. If the weather conditions change during your survey visit, please select a single weather category that best represents the overall conditions.

Cloud cover	Rain	Wind	Visibility
0 – 33% = 1	None = 1	Calm = 1	Good = 1
33 – 66% = 2	Drizzle = 2	Light = 2	Moderate = 2
66 – 100% = 3	Showers = 3	Breezy = 3	Poor = 3

County codes

Observers are asked to use the official BTO county code to indicate where the census was carried out (which is **not necessarily their BTO region**). Most codes start with GB followed by two letters, so for example Norfolk is GBNK. A full list of County Codes is given in Appendix 1.

Recording birds

Please record all the birds you encounter as you walk along the two linear transects. Birds should be noted in the appropriate distance category, measured at right angles to the transect line. Do not record birds that are behind you as you begin a census or beyond the end of the transect.

From your chosen starting point walk the transect route at a slow and methodical pace, pausing briefly to listen for bird songs and scan for birds flying overhead. Please note the starting and finishing times of each transect (using a 24-hour clock, e.g. 0630 for 6:30am, 1300 for 1pm). As a guide an average visit should last around an hour and a half. Record all the birds you see and hear on the field recording sheets in the appropriate transect sections 1-10 and in the appropriate distance category (see below). The transect is divided into 200m sections for convenience; please don't worry about birds at the boundary of two sections: record them in the one that seems more appropriate, but not in both. At the end of the first half (section 5) of the transect record the time and then make your way to the start of the second half of the transect route. Commence recording again through sections 6-10. Try not to record the same individual bird twice, e.g. a Mistle Thrush that can be heard singing from several 200m sections should be recorded once, where it was first detected.

We would strongly encourage observers to use the standard BTO species codes (see Appendix 2). Please familiarise yourself with the most likely codes before you go into the field. If a species is not listed in Appendix 2, please give the full common name. There is no need to record the activity or sex of the birds, although you may wish to do so. Where possible, distinguish juvenile birds from adults (e.g. B.juv, juvenile Blackbird), because **juveniles should not be entered onto BBS-Online or the Count Summary sheets**. Please also note any feral species.

Birds should be recorded in one of the following four categories when they were first noted:
1. within 25 metres either side of the line;
2. between 25 and 100 metres either side of the line;
3. more than 100 metres either side of the line **including birds outside the 1-km square boundary;**
or
F. birds in flight only (at any distance).

Please note that distances are measured perpendicular to the transect line (i.e. at right angles to the line). A bird seen 200m ahead of the observer but close to the transect line should be recorded in

category 1. We recommend that observers measure out distance categories (25m and 100m) using a combination of a tape measure and pacing to familiarise themselves with these before fieldwork begins. Category F, *Birds in flight*, relates to those flying over. Draw an arrow through the species' two-letter code to indicate that it is in flight (e.g. BZ). If a bird is seen to take off or land it should be recorded in the appropriate distance category (1-3) at that position. **Skylarks in display flight and hovering Kestrels should be recorded in the relevant distance category. Record Swifts, Swallows and martins in the flight category, unless they are seen to land or fly into a nest site.**

Juvenile birds

Juvenile birds can be recorded on the Field Recording Sheets, but must NOT be entered onto BBS-Online or the Count Summary Sheets. If you have difficulty distinguishing adult and young birds simply estimate, to the best of your ability, how many adults were present. We appreciate that mixed-aged flocks of crows or Starlings, for example, will present problems later in the season and ask that you observe and record with great care. Colonial nesters should be entered separately on BBS Online or in the box provided at the end of the Count Summary Sheet (paper-form users only).

Example of a completed Field Recording Sheet (header)

Please do not write in the shaded boxes. PLEASE USE BLOCK CAPITALS

Obs. code	_ _ _ _	Observer name	Mr/Mrs/Ms *Mr M J Raven*		Address *B T O*	
1-km square reference (eg SK0212)			*T L 9 0 8 7*		*The Nunnery, Thetford*	
County code (eg GBSY)			*G B S K*		*IP24 2PU*	
Visit date (DD:MM:YY) (eg 08:05:03)			*2 5 : 0 4 : 0 5*		Tel. No:	email:
Early or late season visit (E/L)	*E*	Weather (1,2 or 3)		Cloud *1*	Rain *2*	Wind *2* / Visibility *3*
First half	Start time (HH:MM)	*0 6 : 4 5*	Finish time	*0 7 : 2 0*		
Second half	Start time (HH:MM)	*0 7 : 3 0*	Finish time	*0 8 : 1 5*		

Example of a completed Field Recording Sheet (birds recorded)

Recording birds in the field

3 (100m)	2 (25m)	1	2 (25m)	3 (100m)
SL	*B.*	↑ *2B.*	*3R.*	*B.*

1

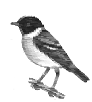
Transferring counts onto summary sheets

3 (100m)	2 (25m)	1	2 (25m)	3 (100m)
~~*SL*~~	~~*B.*~~	↑ ~~*2B.*~~	~~*3R.*~~	~~*B.*~~

2

Count Summary Sheets (paper-form users only)

Please complete the summary sheets (one for each field recording sheet) as soon as possible after each field visit and preferably on the same day. The form summarises the information so that it can be analysed. Simply transfer the number of individual birds (**excluding juveniles**) recorded in each 200m transect section (1-10), on each visit, in each distance band. Print the two-letter species codes in the appropriate boxes (and remember to add a **full stop** for single letter codes e.g. B. = Blackbird). You may find it helpful to cross through species registrations on the Field Recording Sheet as you transfer this information to the summaries (see page 5). This reduces the chance of duplicating or missing records. **Each volunteer is assigned an observer code (Obs. code) by BTO Census Unit when we receive the completed forms - please leave this box blank.**



Colonial nesting birds

Birds nesting in dense colonies within the square (e.g. Rook, Sand Martin and gulls) will not be adequately censused using the standard method, and we ask observers to count or estimate the number of nests in the whole 1-km square. Colony counts should be conducted separately from the transect counts. Please include counts of adult birds seen at these colonies during your normal line-transect counts (i.e. record the number of adults seen during your two line-transect counts **as well as** the number of active nests counted on your separate colony counts).

Example of a completed Count Summary Sheet

Two-letter species code and species name	Distance Category	Number of birds recorded on each transect section									
		1	2	3	4	5	6	7	8	9	10
B. *Blackbird*	1	*2*		*2*							
	2	*1*							*1*		*6*
	3	*1*					*1*				
	F										*2*

Habitat recording

Habitat recording is an essential part of the BBS because it allows changes in bird numbers to be related to changes in habitat. **Habitat forms must be completed each year** using the coding scheme that is common to a range of BTO projects. This is shown on the back of the green form and can be used without specialist knowledge. We advise that habitat details are recorded on your reconnaissance visit or following a count. Please do not record birds and habitat at the same time.

Habitat should be recorded separately for each of the 10 200m transect sections. Please record what you feel to be the most appropriate codes for each section (i.e. the area within a box 200m long by 50m wide). Codes allow you to describe both the predominant habitat, termed the **First habitat** on the form, and the secondary habitat termed the **Second habitat**. In many cases two habitats will have equal importance and the order they are entered does not matter. For each habitat, choose one habitat code from each of levels 1 and 2, and up to two codes from levels 3 and 4. Please complete as much detail as you feel able: the first two levels are most important.

The example below describes an area of arable farmland. Transect 1 comprises tilled land with a hedgerow without trees, an active farmyard, with autumn cereal growing. There is no secondary habitat and so this is left blank. Transect section 2 is a similar area containing woodland. The first habitat codes are the same and the second codes are for woodland i.e. coniferous, young plantation with low disturbance, moderate shrub layer and sparse field layer. Note that the **Shrub layer** comprises woody plants less than 5m tall and the **Field layer** comprises herbaceous, non-woody plants. If there is no appropriate code in levels 3 or 4 please put a dash ('-') in that column.

Transect Section	First habitat						Second habitat					
	Levels:						Levels:					
	1	2	3		4		1	2	3		4	
1	*E*	*4*	*2*	*6*	*7*							
2	*E*	*4*	*2*	*6*	*6*	*1*	*A*	*2*	*5*	*8*	*2*	*6*

Please note about every five years (the last year being 2007), we ask for additional habitat information as well as details of the habitat along the ideal (straight) transects. Outside of these assigned years, observers can use the more simple form as shown above, recording only the actual habitat details. 'Ideal' transects can be either N-S or E-W, depending on your chosen route. If major habitat changes occur on your square through the course of the survey these changes should be recorded in the box provided. Please enter the transect number and the new codes. Examples include ploughing of set-aside, introduction or removal of animal stock, and tree felling.

Return of data (by the end of August)

BBS Online user:
We recommend that you enter your BBS records onto BBS-Online soon after you have completed your survey visits. All data should be entered by the end of August as late entries delay the production of BBS results the following year. If no route map was enclosed with your forms or if the transect route has changed (hopefully this is very rarely!), please return the OS map to your RO with the actual route and 200m sections marked on it. Otherwise no paper forms or map need to be returned.

Paper-form user:
Please return all completed forms to your RO by the end of August. Forms for each square should include: one green Habitat Recording Form, two Field Recording Sheets, two Count Summary Sheets and the Mammal Count Summary Form. If no route map was enclosed with your forms or if the transect route has changed (hopefully this is very rarely!), please return the OS map to your RO with the actual route and 200m sections marked on it. Please note that once we have received your completed forms from your RO, you will receive an acknowledgement letter from BTO HQ.

The name and address details of BBS observers will be kept on a computerised database for the purpose of BBS administration, and for furthering the BTO's objectives. The Data Controller is the Director of Services, BTO, The Nunnery, Thetford, Norfolk, IP24 2PU.

Appendix 1. County Codes

Always fill in the county on recording and summary sheets using the four-letter code from the list below.

England	
Avon	GBAV
Bedford	GBBD
Berkshire	GBBK
Buckinghamshire	GBBC
Cambridgeshire	GBCA
Cheshire	GBCH
Cleveland	GBCV
Cornwall (excl Scilly)	GBCO
Cumbria	GBCU
Derbyshire	GBDB
Devon	GBDV
Dorset	GBDO
Durham	GBDU
Essex	GBES
Gloucestershire	GBGL
Hampshire (excl IoW)	GBHA
Hereford & Worcs	GBHF
Hertfordshire	GBHT
Humberside	GBHU
Isle of Wight	GBIW
Kent	GBKE
Lancashire	GBLA
Leicestershire	GBLE
Lincolnshire	GBLI
London (Greater)	GBLO
Manchester (Greater)	GBMA
Merseyside	GBME
Norfolk	GBNK
Northamptonshire	GBNH
Northumberland	GBNL
North Yorkshire	GBNY
Nottinghamshire	GBNT
Oxfordshire	GBOX
Shropshire	GBSA
Scilly Isles	GBSI
South Yorkshire	GBSY
Staffordshire	GBST
Somerset	GBSO
Suffolk	GBSK
Surrey	GBSR
Sussex (West & East)	GBSX
Tyne & Wear	GBTY
Warwickshire	GBWK
W Midlands	GBWM
West Yorkshire	GBWY
Wiltshire	GBWT
Isle of Man	**GBIM**
Scotland	
Borders Region	GBBR
Central Region	GBCR
Dumfries & Galloway Region	GBDR
Fair Isle	GBFI
Fife Region	GBFR
Grampian Region	GBGR
Highland Region	GBHR
Lothian Region	GBLR
Orkney	GBOR
Shetland (excl. Fair Isle)	GBSH
Strathclyde Region	GBSC
Tayside Region	GBTR
Western Isles	GBWI
Wales	
Anglesey	GBAN
Clwyd	GBCW
Dyfed	GBDY
Glamorgan (all)	GBGM
Gwent	GBGT
Gwynedd	GBGD
Powys	GBPO
Northern Ireland	
Antrim	GBUN
Armagh	GBUR
Down	GBUD
Fermanagh	GBUF
Londonderry	GBUL
Tyrone	GBUT
Channel Islands	
Alderney	CIAL
Guernsey	CIGU
Herm	CIHE
Jersey	CIJE
Sark	CISA

Please ensure that you have obtained the relevant permission to enter private land over which your transect lines cross. Many thanks for helping with this important project and enjoy your censusing!

The Breeding Bird Survey is organised by the BTO with the support of the Joint Nature Conservation Committee (**JNCC is the statutory adviser to Government on UK and international nature conservation, on behalf of the Council for Nature Conservation and the Countryside, the Countryside Council for Wales, Natural England and Scottish Natural Heritage**) and the Royal Society for the Protection of Birds.

Appendix 2. BTO Bird Species Codes

AC Arctic Skua	GA Gadwall	LE Long-eared Owl	SM Sand Martin
AE Arctic Tern	GX Gannet	LT Long-tailed Tit	SS Sanderling
AV Avocet	GW Garden Warbler	MG Magpie	TE Sandwich Tern
BO Barn Owl	GY Garganey	MA Mallard	VI Savi's Warbler
BY Barnacle Goose	GC Goldcrest	MN Mandarin	SQ Common Rosefinch
BA Bar-tailed Godwit	EA Golden Eagle	MX Manx Shearwater	SP Scaup
BR Bearded Tit	OL Golden Oriole	MR Marsh Harrier	CY Scottish Crossbill
BS Bewick's Swan	GF Golden Pheasant	MT Marsh Tit	SW Sedge Warbler
BI Bittern	GP Golden Plover	MW Marsh Warbler	NS Serin
BK Black Grouse	GN Goldeneye	MP Meadow Pipit	SA Shag
TY Black Guillemot	GO Goldfinch	MU Mediterranean Gull	SU Shelduck
BX Black Redstart	GD Goosander	ML Merlin	SX Shorelark
BJ Black Tern	GI Goshawk	M. Mistle Thrush	SE Short-eared Owl
B. Blackbird	GH Grasshopper Warbler	MO Montagu's Harrier	SV Shoveler
BC Blackcap	GB Great Black-backed Gull	MH Moorhen	SK Siskin
BH Black-headed Gull	GG Great Crested Grebe	MS Mute Swan	S. Skylark
BN Black-necked Grebe	ND Great Northern Diver	N. Nightingale	SZ Slavonian Grebe
BW Black-tailed Godwit	NX Great Skua	NJ Nightjar	SN Snipe
BV Black-throated Diver	GS Great Spotted Woodpecker	NH Nuthatch	SB Snow Bunting
BT Blue Tit	GT Great Tit	OP Osprey	ST Song Thrush
BU Bluethroat	GE Green Sandpiper	OC Oystercatcher	SH Sparrowhawk
BL Brambling	G. Green Woodpecker	PX Peafowl/Peacock	AK Spotted Crake
BG Brent Goose	GR Greenfinch	PE Peregrine	SF Spotted Flycatcher
BF Bullfinch	GK Greenshank	PH Pheasant	DR Spotted Redshank
BZ Buzzard	H. Grey Heron	PF Pied Flycatcher	SG Starling
CG Canada Goose	P. Grey Partridge	PW Pied Wagtail	SD Stock Dove
CP Capercaillie	GV Grey Plover	PG Pink-footed Goose	SC Stonechat
C. Carrion Crow	GL Grey Wagtail	PT Pintail	TN Stone-curlew
CW Cetti's Warbler	GJ Greylag Goose	PO Pochard	TM Storm Petrel
CH Chaffinch	GU Guillemot	PM Ptarmigan	SL Swallow
CC Chiffchaff	FW Guineafowl (Helmeted)	PU Puffin	SI Swift
CF Chough	HF Hawfinch	PS Purple Sandpiper	TO Tawny Owl
CL Cirl Bunting	HH Hen Harrier	Q. Quail	T. Teal
CT Coal Tit	HG Herring Gull	RN Raven	TK Temminck's Stint
CD Collared Dove	HY Hobby	RA Razorbill	TP Tree Pipit
CM Common Gull	HZ Honey Buzzard	RG Red Grouse	TS Tree Sparrow
CS Common Sandpiper	HC Hooded Crow	KT Red Kite	TC Treecreeper
CX Common Scoter	HP Hoopoe	ED Red-backed Shrike	TU Tufted Duck
CN Common Tern	HM House Martin	RM Red-breasted Merganser	TT Turnstone
CO Coot	HS House Sparrow	RQ Red-crested Pochard	TD Turtle Dove
CA Cormorant	JD Jackdaw	FV Red-footed Falcon	TW Twite
CB Corn Bunting	J. Jay	RL Red-legged Partridge	WA Water Rail
CE Corncrake	K. Kestrel	NK Red-necked Phalarope	W. Wheatear
CI Crested Tit	KF Kingfisher	LR Lesser Redpoll	WM Whimbrel
CR Crossbill	KI Kittiwake	RK Redshank	WC Whinchat
CK Cuckoo	KN Knot	RT Redstart	WG White-fronted Goose
CU Curlew	LM Lady Amherst's Pheasant	RH Red-throated Diver	WH Whitethroat
DW Dartford Warbler	LA Lapland Bunting	RE Redwing	WS Whooper Swan
DI Dipper	L. Lapwing	RB Reed Bunting	WN Wigeon
DO Dotterel	TL Leach's Petrel	RW Reed Warbler	WT Willow Tit
DN Dunlin	LB Lesser Black-backed Gull	RZ Ring Ouzel	WW Willow Warbler
D. Dunnock	LS Lesser Spotted Woodpecker	RP Ringed Plover	OD Wood Sandpiper
EG Egyptian Goose	LW Lesser Whitethroat	RI Ring-necked Parakeet	WO Wood Warbler
E. Eider	LI Linnet	R. Robin	WK Woodcock
FP Feral Pigeon	ET Little Egret	DV Rock Dove	WL Woodlark
ZL Feral/hybrid goose	LG Little Grebe	RC Rock Pipit	WP Woodpigeon
ZF Feral/hybrid mallard type	LU Little Gull	RO Rook	WR Wren
FF Fieldfare	LO Little Owl	RS Roseate Tern	WY Wryneck
FC Firecrest	LP Little Ringed Plover	RY Ruddy Duck	YW Yellow Wagtail
F. Fulmar	AF Little Tern	RU Ruff	Y. Yellowhammer

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If you have any queries about BBS, please contact either your BTO Regional Organiser or the Census Unit (BTO, The Nunnery, Thetford, Norfolk, IP24 2PU, Tel: 01842 750050, Fax: 01842 750030, Email: bbs@bto.org or visit our website: www.bto.org/bbs

Field recording sheet, Breeding Bird Survey in the UK

BREEDING BIRD SURVEY

FIELD RECORDING SHEET

*** please return with other forms**

Please do not write in the shaded boxes. **PLEASE USE BLOCK CAPITALS**

Obs. code	_ _ _ _	Observer name	Mr/Mrs/Ms
1-km square reference (eg SK1898)	___ ___ ___ ___ ___ ___	Please write address on summary sheets	
County code (eg GBSY)	___ ___ ___ ___		
Visit date (DD:MM:YY) (eg 02:05:03)	___ ___ : ___ ___ : ___ ___		
Early or late visit (E/L)	___	Weather (1,2 or 3)	Cloud ___ Rain ___ Wind ___ Visibility ___
First half	Start time (HH:MM) ___ ___ : ___ ___	Finish time	___ ___ : ___ ___
Second half	Start time (HH:MM) ___ ___ : ___ ___	Finish time	___ ___ : ___ ___

Distance categories: **1**. 0-25 metres from the transect line, **2**. 25-100 metres from the transect line,
3. More than 100 metres from the transect line whether within the 1-km square boundary or not
F. Birds in flight only (at any distance) [record on sheets using an arrow, eg ⟶]

N.B. Record singing Skylarks in the distance category, not as in flight.
Record breeding colonies (Rooks, Sand Martins and gulls) and estimate the number of nests.

[NB: Boxes are not drawn to scale]

Section 1

100m 25m 25m 100m

3	2	1	2	3
		↑		

START

Section 2

100m 25m 25m 100m

3	2	1	2	3
		↑		

4

100m	25m		25m	100m
3	2	1	2	3

6

100m	25m		25m	100m
3	2	1	2	3

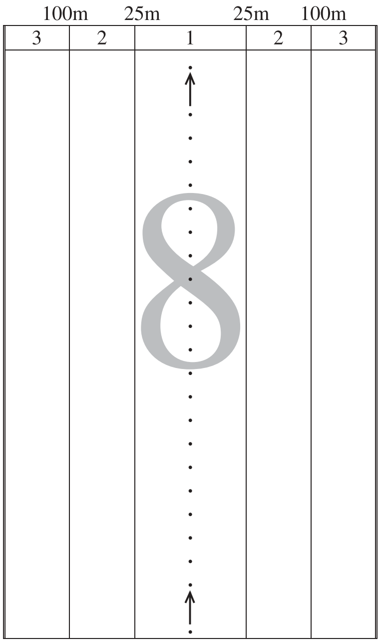
BREAK Time start __ __ : __ __
Time finish __ __ : __ __

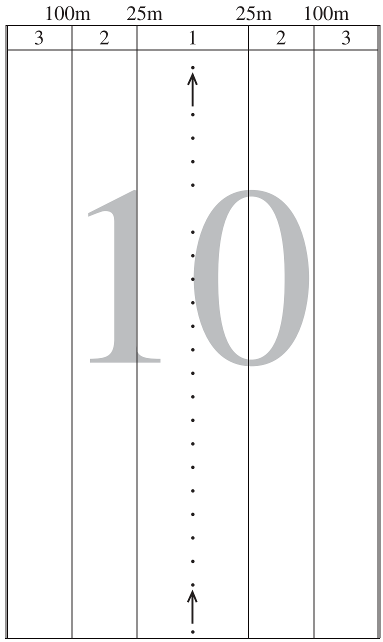
3

100m	25m		25m	100m
3	2	1	2	3

5

100m	25m		25m	100m
3	2	1	2	3


100m
25m
25m
100m
3
2
1
2
3
8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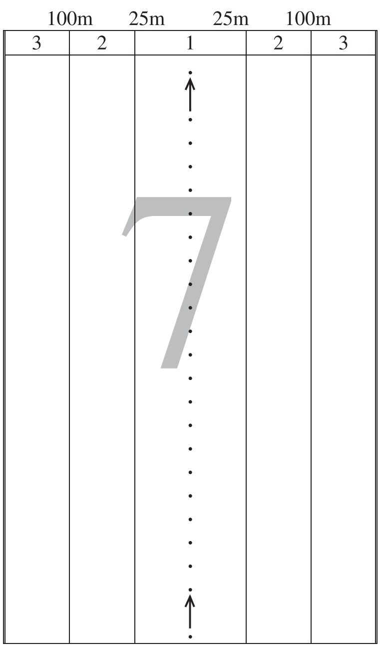
10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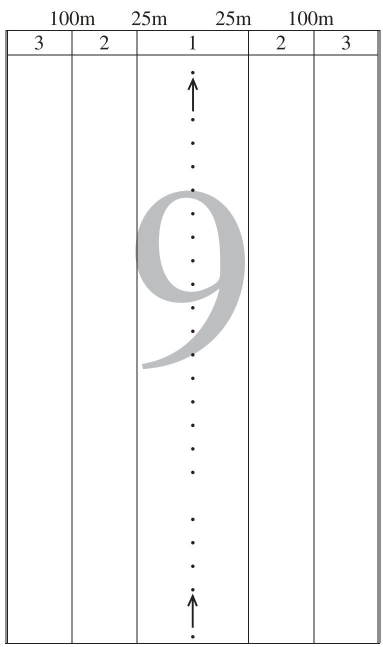
100m
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25m
100m
3
2
1
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3
9

APPENDIX 2. BTO SPECIES CODES

AC	Arctic Skua	GA	Gadwall	LE	Long-eared Owl	SM	Sand Martin
AE	Arctic Tern	GX	Gannet	LT	Long-tailed Tit	SS	Sanderling
AV	Avocet	GW	Garden Warbler	MG	Magpie	TE	Sandwich Tern
BO	Barn Owl	GY	Garganey	MA	Mallard	VI	Savi's Warbler
BY	Barnacle Goose	GC	Goldcrest	MN	Mandarin	SQ	Scarlet Rosefinch
BA	Bar-tailed Godwit	EA	Golden Eagle	MX	Manx Shearwater	SP	Scaup
BR	Bearded Tit	OL	Golden Oriole	MR	Marsh Harrier	CY	Scottish Crossbill
BS	Berwick's Swan	GF	Golden Pheasant	MT	Marsh Tit	SW	Sedge Warbler
BI	Bittern	GP	Golden Plover	MW	Marsh Warbler	NS	Serin
BK	Black Grouse	GN	Goldeneye	MP	Meadow Pipit	SA	Shag
TY	Black Guillemot	GO	Goldfinch	MU	Mediterranean Gull	SU	Shelduck
BX	Black Redstart	GD	Goosander	ML	Merlin	SX	Shorelark
BJ	Black Tern	GI	Goshawk	M.	Mistle Thrush	SE	Short-eared Owl
B.	Blackbird	GH	Grasshopper Warbler	MO	Montagu's Harrier	SV	Shoveler
BC	Blackcap	GB	Great Black-backed Gull	MH	Moorhen	SK	Siskin
BH	Black-headed Gull	GG	Great Crested Grebe	MS	Mute Swan	S.	Skylark
BN	Black-necked Grebe	ND	Great Northern Diver	N.	Nightingale	SZ	Slavonian Grebe
BW	Black-tailed Godwit	NX	Great Skua	NJ	Nightjar	SN	Snipe
BV	Black-throated Diver	GS	Great Spotted Woodpecker	NH	Nuthatch	SB	Snow Bunting
BT	Blue Tit	GT	Great Tit	OP	Osprey	ST	Song Thrush
BU	Bluethroat	GE	Green Sandpiper	OC	Oystercatcher	SH	Sparrowhawk
BL	Brambling	G.	Green Woodpecker	PX	Peafowl/Peacock	AK	Spotted Crake
BG	Brent Goose	GR	Greenfinch	PE	Peregrine	SF	Spotted Flycatcher
BF	Bullfinch	GK	Greenshank	PH	Pheasant	DR	Spotted Redshank
BZ	Buzzard	H.	Grey Heron	PF	Pied Flycatcher	SG	Starling
CG	Canada Goose	P.	Grey Partridge	PW	Pied Wagtail	SD	Stock Dove
CP	Capercaillie	GV	Grey Plover	PG	Pink-footed Goose	SC	Stonechat
C.	Carrion Crow	GL	Grey Wagtail	PT	Pintail	TN	Stone-curlew
CW	Cetti's Warbler	GJ	Greylag Goose	PO	Pochard	TM	Storm Petrel
CH	Chaffinch	GU	Guillemot	PM	Ptarmigan	SL	Swallow
CC	Chiffchaff	FW	Guineafowl (helmetted)	PU	Puffin	SI	Swift
CF	Chough	HF	Hawfinch	PS	Purple Sandpiper	TO	Tawny Owl
CL	Cirl Bunting	HH	Hen Harrier	Q.	Quail	T.	Teal
CT	Coal Tit	HG	Herring Gull	RN	Raven	TK	Temminck's Stint
CD	Collared Dove	HY	Hobby	RA	Razorbill	TP	Tree Pipit
CM	Common Gull	HZ	Honey Buzzard	RG	Red Grouse	TS	Tree Sparrow
CS	Common Sandpiper	HC	Hooded Crow	KT	Red Kite	TC	Treecreeper
CX	Common Scoter	HP	Hoopoe	ED	Red-backed Shrike	TU	Tufted Duck
CN	Common Tern	HM	House Martin	RM	Red-breasted Merganser	TT	Turnstone
CO	Coot	HS	House Sparrow	RQ	Red-crested Pochard	TD	Turtle Dove
CA	Cormorant	JD	Jackdaw	FV	Red-footed Falcon	TW	Twite
CB	Corn Bunting	J.	Jay	RL	Red-legged Partridge	WA	Water Rail
CE	Corncrake	K.	Kestrel	NK	Red-necked Phalarope	W.	Wheatear
CI	Crested Tit	KF	Kingfisher	LR	Redpoll	WM	Whimbrel
CR	Crossbill	KI	Kittiwake	RK	Redshank	WC	Whinchat
CK	Cuckoo	KN	Knot	RT	Redstart	WG	White-fronted Goose
CU	Curlew	LM	Lady Amherst's Pheasant	RH	Red-throated Diver	WH	Whitethroat
DW	Dartford Warbler	LA	Lapland Bunting	RE	Redwing	WS	Whooper Swan
DI	Dipper	L.	Lapwing	RB	Reed Bunting	WN	Wigeon
DO	Dotterel	TL	Leach's Petrel	RW	Reed Warbler	WT	Willow Tit
DN	Dunlin	LB	Lesser Black-backed Gull	RZ	Ring Ouzel	WW	Willow Warbler
D.	Dunnock	LS	Lesser Spotted Woodpecker	RP	Ringed Plover	OD	Wood Sandpiper
EG	Egyptian Goose	LW	Lesser Whitethroat	RI	Ring-necked Parakeet	WO	Wood Warbler
E.	Eider	LI	Linnet	R.	Robin	WK	Woodcock
FP	Feral Pigeon	ET	Little Egret	DV	Rock Dove	WL	Woodlark
ZL	Feral/hybrid goose	LG	Little Grebe	RC	Rock Pipit	WP	Woodpigeon
ZF	Feral/hybrid mallard type	LU	Little Gull	RO	Rook	WR	Wren
FF	Fieldfare	LO	Little Owl	RS	Roseate Tern	WY	Wryneck
FC	Firecrest	LP	Little Ringed Plover	RY	Ruddy Duck	YW	Yellow Wagtail
F.	Fulmar	AF	Little Tern	RU	Ruff	Y.	Yellowhammer

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If you are not submitting your data electronically using BBS-Online, please return your completed Field Recording Sheets, along with your other BBS forms, to your Regional Organiser. If you would like to submit your data using BBS-Online, please inform your RO first, then visit www.bto.org/bbs.

Pan-European Common Bird Monitoring Scheme (PECBMS)
is a joint initiative of the European Bird Census Council (EBCC) and BirdLife International. The main aim of the scheme is to use common birds as indicators of the general state of nature, using scientific data on changes in breeding populations across Europe. The PECBMS scheme uses data from large-scale monitoring schemes based on volunteer fieldwork with a standardised methodology and formal design. Through the generation of national and supra-national indices for individual species, it produces European composite indices for groups of species (indicators). The PECBMS supports and provides assistance to national or regional common bird monitoring schemes, facilitates in the sharing of knowledge between monitoring schemes and strives to establish new monitoring schemes in countries and regions where such schemes are lacking.

www.ebcc.info/pecbm.html

The European Bird Census Council (EBCC)
brings together ornithologists from all European countries representing national bodies responsible for monitoring bird populations, distribution and demography, to encourage bird-monitoring work aimed at better conservation and management of bird populations and at providing indicators of the changing ability of European landscapes to support wildlife generally.

www.ebcc.info

BirdLife International
is a worldwide partnership of conservation organisations, represented in more than 100 countries (including more than 40 in Europe) and with more than 2.5 million members worldwide. BirdLife works for the diversity of all life and the sustainable use of natural resources through the conservation of birds and their habitats.

www.birdlife.org

Statistics Netherlands
is the official Bureau of Statistics of the Netherlands and is responsible for compiling statistics on a wide range of developments in society. SN cooperates closely with NGO's to produce wildlife statistics. These statistics currently concern 14 monitoring programmes, ranging from birds to butterflies and plants.

www.cbs.nl

The Royal Society for Protection of Birds (RSPB)
is the UK charity working to secure a healthy environment for birds and wildlife, helping to create a better world for us all. The RSPB is the BirdLife Partner in the UK.

www.rspb.org.uk

Czech Society for Ornithology (CSO)
is a non-governmental organisation which aims to perform, support and promote research and conservation of wild living birds and their habitats. CSO is the BirdLife Partner in the Czech Republic.

www.birdlife.cz