Springtime for bird counts

an overview of common bird census techniques

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Cover page: Curlew. Photo: Jens Morin

Introduction

This is an English translation of the booklet “Ny vår för fågelinventeringar: en översikt av de vanligaste metoderna för att inventera fåglar”. The original text was published by the Swedish Ornithological Society (Sveriges Ornitologiska Förening) and is available for purchase at the online book store www.naturbokhandeln.se. Due to copyright reasons I have not included the bird photos contained in the original version but have still chosen to keep the original page numbering in order to facilitate comparison with the Swedish text.

This is a short summary of the various methods that are often used when counting birds. At the end of each chapter is a recommended list of further reading for those interested in learning more about a specific method. I try to provide guidance for those who are planning to conduct bird census work and want to know which method that will be optimal in that particular case.

Bird counts are a vital part of environmental monitoring both on national and international scales. They are also important in many other contexts like when establishing environmental impact assessments for various kinds of developments or when evaluating environmental restorations and other conservation actions. There are several reasons why birds are especially well suited as indicators for the status of the environment. Many bird species have specialised on particular types of habitat and they tend to respond quickly to changes in the living environment. Birds are also comparatively easy to find and identify and there are a large number of competent ornithologists who can potentially help with fieldwork.

Photo of a red kite

*The expansion of the red kite (*Milvus milvus*) in Sweden has been monitored in different bird census projects.*

Choosing a census technique

There are a wealth of different census techniques to choose from, something that may seem unnecessary and complicated. Of course life may have been simpler if there was only one method that everyone used. That would for example, facilitate comparisons between different studies. The reason that so many different counting methods exist is that they are suitable under different circumstances. All methods have their inevitable weaknesses and it is crucial that the method is conforming to the prevailing conditions. The most important factors to acknowledge when choosing a method is the aim of the investigation, what species that are to be counted, how big the area of interest is, what time frame there is, and how much resources (such as the availability of field workers) that can be utilised for the investigation.

First and foremost when it comes to choosing a census method is to consider the aim of the investigation. Different techniques generate different kinds of data and you therefore need to know which types of questions you want to answer. Some of the most common aims of bird count investigations are listed in Figure 1.

A crucial factor when choosing a method is the kind of information you want to get for a certain species. (Figure 2, Table 1). In some cases one is not interested in the number of individuals but only the distribution of the species in question. If so, it is possible to use a very coarse method, where the birds are not counted at all (for example an atlas census). At the other extreme are cases when one wants to know the absolute densities or number of individuals in an area of interest. In such cases much more comprehensive surveys must be made such as territory mapping or distance sampling. It is, however, often not necessary to know the exact number of individuals, but rather an index will suffice. This index can be compared between different time points or treatments (e.g. before and after a conservation effort, or when following a population trend over time). Many methods, like line transects and point counts returns this kind of indices. If such a study is made it is important to perform the count in identical ways at the different time points to be able to make valid comparisons.

Another important issue to consider is if a complete survey of the area is needed or if a random sample should be taken and densities, trends and indexes are to be estimated using statistical methods. If a sample is taken it is vital to ensure that this is representative of the area as a whole. It is often tempting to only

- Describing the biological relevance for an area or comparing different areas
- Estimate the distribution and population sizes for one or more species
- Monitor population trends
- Describe the habitat demands for a certain species
- Find out the reasons behind a population decline/increase
- Monitor the effects of a conservation measure or habitat destruction
- Describing the detailed population dynamics of a species of interest

Figure 1. Some common aims in bird census projects. It is of foremost importance to be clear about the objective of the investigation to be able to choose a method that will yield results related to the questions asked.

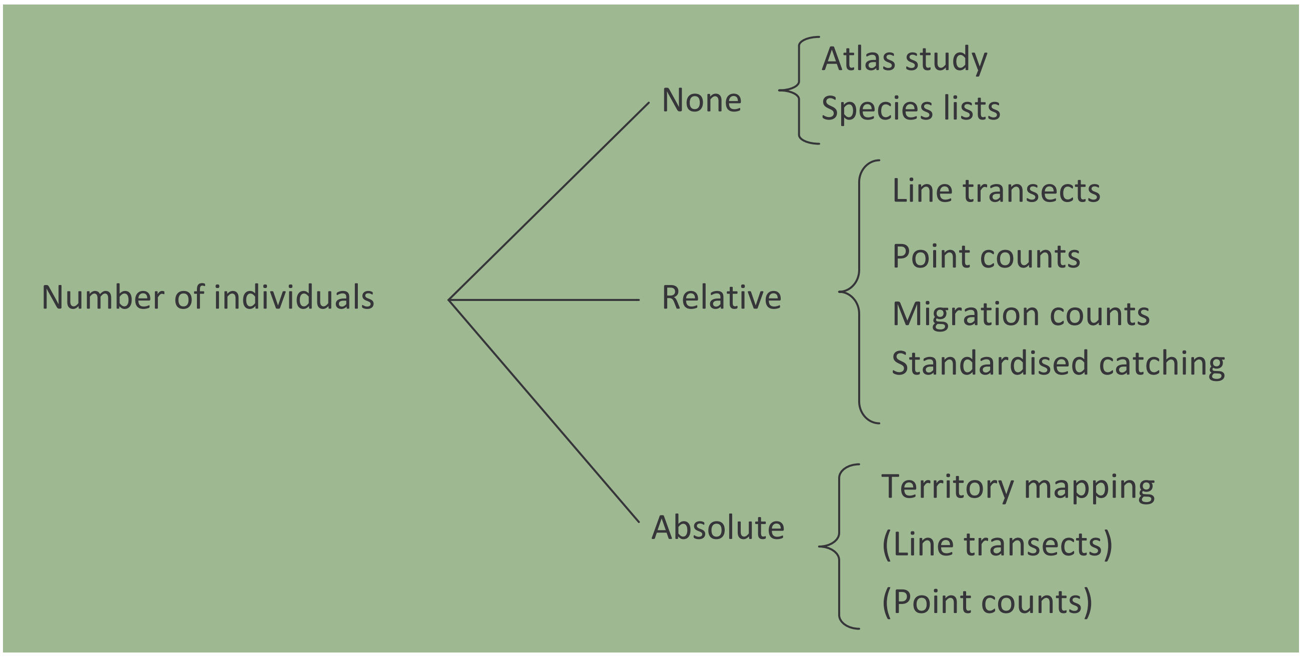


Figure 2. Different census techniques give different kinds of measures of number of individuals. Here are some of the most common methods listed depending on the kind of measure it gives. To get information of absolute number of individuals from line transects and point counts the number of individuals present but not detected must be estimated (i.e. using distance sampling).

choose the most interesting birding spots and make the counts there, but using this practice it will not be possible to extrapolate the data to yield information about a larger area.

Two different kinds of sampling procedures, random sampling and systematic sampling, can be used for bird counts. In random sampling, the sample units (i.e. transects or counting points) should be placed randomly and independently over the area of interest. In systematic sampling the samples are instead placed in a regular way (i.e. using certain map coordinates or a fixed distance between the points) to cover as much as possible of the study area. Both random and systematic samples can also be weighted to ensure equal representation of different types of environments in the study area. This is usually referred to as stratified sampling. There is more information about appropriate sampling procedures in the section on line transects (page 14).

The ultimate limitation when it comes to selection of method is usually the time and recourses available (especially field personnel). Some of the methods outlined here (for example territory mapping) will include a substantial field effort as many visits are needed to the same area during the course of the field season. If the study area is too large it may be impossible to complete the whole project during the specified time frame. If the counts are to be repeated several consecutive seasons it is especially important not to have too extensive field work, simply because of the risk of tiring. You may even have to change the aim of the investigation if it becomes clear that it is beyond scope to be able to answer all questions raised.

It is also important to adjust the survey depending on the experience and identification skills of the field worker(s). Maybe the number of species needs to be restricted to a certain set, which the person has enough knowledge of to be able to count with high enough precision. If more than one person is participating in the field work differences between these also have to be carefully considered during the planning of the study. There can be substantial individual differences in the number of birds that are detected, even between highly experienced field workers. Training and education of the field workers about the census technique to be used can be very effective ways to minimise these problems.

Table 1. Some common bird census techniques and there usage.

Method	Measure of numbers	Number of visits needed	Relevant species	Usage
Territory mapping	Absolute	8-10	Only stationary species defending a territory	Detailed studies of a specific area or species of interest, where the number of breeding pairs and the positioning of the territories are of interest
Line transects/ Point counts	Relative (absolute)	1-some	Shy and silent species are easily missed	Many different kinds of studies where an index of the number of individuals is desired (i.e. to monitor population trends)
Atlas studies	None	A few	All breeding species	General studies where the aim is to find out what different species are breeding in an area or when producing a distribution map

*An atlas study can confirm the distribution of a species but it will not answer the question of how many icterine warblers (*Hippolais icterina*) that are breeding in a given area.*

Photo of an icterine warbler

Further reading:

Bart J & Schoultz JD. 1984. Reliability of singing bird surveys: changes in observer efficiency with avian density. *The Auk* 101: 307-318.

Bibby CJ, Burgess ND, Hill DA & Mustoe SH. 2002. *Bird Census Techniques* (2nd ed.). Chapter 1. Academic Press, London.

Fowler J & Cohen L. 1990. *Practical statistics for field biology*. John Wiley & Sons, Chichester.

Koskimies P. 1989. Birds as a tool in environmental monitoring. *Ann. Zool. Fennici* 26: 153-166.

Sutherland WJ. 1996. *Ecological Census Techniques: a handbook.* Chapter 1. Cambridge University Press, Cambridge.

Verner J & Milne KA. 1989. Coping with sources of variability when monitoring population trends. *Ann. Zool. Fennici* 26: 191-199.

Photo of a yellow wagtail

What species to count

An important question to consider during the planning of the investigation is what species to focus on. During a general census one tries to include as many species as possible and simply counts individuals of all species heard or seen. In such cases the counts are usually done during a time of the year that will maximise the number of species detectable.

In other cases it may be a bit of a waste of time to include the most common species in the survey. If, for example, the main aim of the study is to get an idea of how important a specific area is from a conservation perspective, it may not be so interesting to know whether there are 35 or 50 chaffinch territories in the forest. These very common species thus constitute a disproportionally large part of the total effort of the survey. In such cases it may be more effective to focus on slightly more uncommon species. Focusing on very rare species may also be uninformative. There are likely to be very few recordings of such species, thus limiting the extent of conclusions that can be made from the data.

If a study is to be focused on a subset of species, it may be a good idea to choose those that work as biological indicators. That is, species that are highly specialised on a certain environment and are often encountered in places with high conservation biology relevance. For example Swedish species indicative of a biologically valuable forest may be hazel grouse, lesser spotted woodpecker, red breasted flycatcher, black woodpecker, wood warbler and others, while yellow wagtail may be a good indicator of cropped meadows. corncrake and whinchat are indicative of grazed coastal meadows in different stages of succession. In other instances the interest is mainly species that are threatened and red listed. Or the focus is species that are causing conflicts with humans in one way or another.

Previous page:
*The yellow wagtail (*Motacilla flava*), a species that can be used as an indicator of cropped meadows.*

The focus of a study is often just a single species. Maybe as a part of a larger research effort on the species in question or when a general survey needs to be supplemented with targeted work on a species that is difficult to count. When studying one particular species it is of course important to first gather as much information as possible about the biology of the species in question in order to adapt the method of counting. Maybe a highly specialised method such as playback is needed to be able to work with that particular species. Of course one should also know as much as possible about the habitat preferences, to avoid wasting time with field work in areas that are not suitable for the species. Also try to find as many previous studies as possible on the species of interest (or related species), to follow up on methods that have previously been successful. It is particularly important to try and copy methods of earlier studies if the aim is to compare the results with previous findings. Also take into consideration that the species in question may be protected and that special permissions must be granted to work with it.

Further reading:

Bibby CJ, Burgess ND, Hill DA & Mustoe SH. 2002. *Bird Census Techniques* (2nd ed.). Chapter 8. Academic Press, London.
Nilsson SG. 1978. Kan sällsynta fåglar användas som indikatorer på skyddsvärd natur? *Anser* suppl. 3: 193-194. Lund.
Sutherland WJ. 1996. *Ecological Census Techniques: a handbook.* Page 12. Cambridge University Press, Cambridge.

Photo of a woodlark

*Territory mapping limits the size of the area that can be surveyed. However, by focusing only on some less abundant species, such as the woodlark (*Lullula arborea*), a much larger are can be investigated.*

Territory mapping

Territory mapping is a very extensive method which is primarily used when a rather small area is studied in detail and absolute measures of individual densities are desired. This is how it is done:

1. Choose an area of suitable size (10 – 20 ha in forest or 50 – 100 ha of open country).
2. Devide the area into a grid using existing land features or man made markings (if needed). Detailed maps are important in order to note the exact location of all bird individuals observed.
3. Slowly walk through the area at a time of the day when the activity of singing is at its peak. Note the exact position and activity of all observed birds on a visit map (Figure 1a).
4. Make several (usually ten) such visits during the breeding season.
5. Summarise the data for each species from all visit maps onto a species' map (Figure 1b).
6. Analyse the species' maps to infer the number and location of the territories for all species (Figure 1c).

The territory mapping method is rather time consuming because the whole study area needs to be carefully walked through and all individuals heard and seen should be registered. This poses a limitation on the size of the area to be surveyed. As a rule of thumb the study area should not be larger than 20 ha in forest or 100 ha in open environments. The number of visits needed to get a reliable estimate on number of territories also differs depending on the kind of environment and species composition of the area. But usually at least eight to ten visits are recommended. Note that this method is only suitable for species that are stationary and defend a territory. The big drawback of territory mapping is that it is a very labour intensive method. A benefit is that information is gained on the positioning of the territories in addition to the number of breeding individuals of the area. However, before this kind of study is initiated it is recommended to carefully think about the methodology. If these kinds of data are not necessary it will most likely be more effective to use a different kind of technique than territory mapping.

It may be a good idea to use permanent markings if the study involves counts during several consecutive years. This facilitates comparing the maps between the different years of the study. Always ask for permission from the land owner before you place markings in the area! If only one or a few species are of interest it may be a good idea to also catch and ring the birds in the study

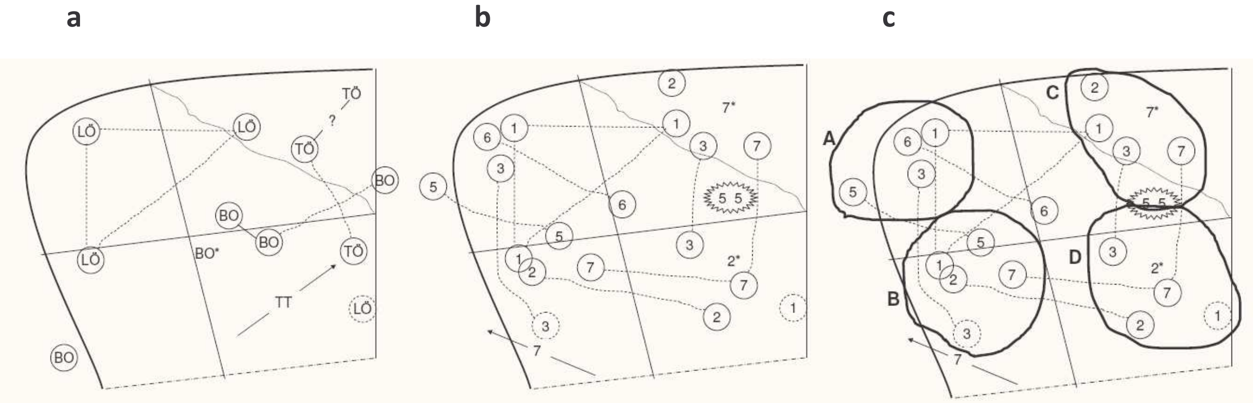
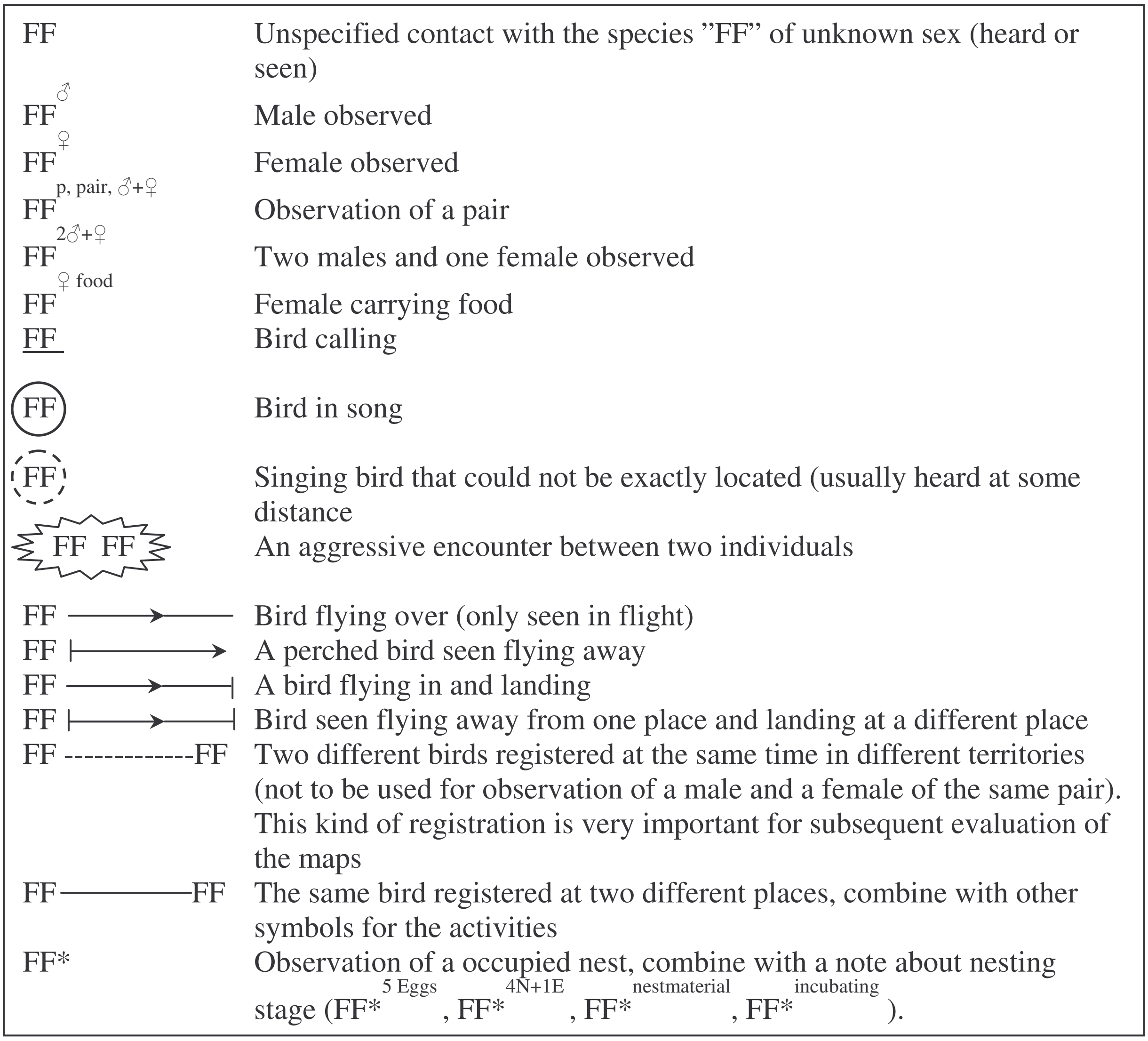


Figure 3. Territory mapping procedure: a) Visit map of a part of a study area for visit number one. Every observed individual bird is marked on the map with a species specific letter code (in this case referring to Swedish species names; see also figure 5) and a symbol for bird activity (see also figure 4). b) After all field visits (in this case eight) have been completed the data from the visit maps are transferred onto species' maps (one per species; in this case willow warbler). The species letter code is changed into a number referring to the field visit. c) Finally the species' maps are analysed using a given set of rules to evaluate how many different territories of the different species there are in the area.

population (given that you have a ringing license). By using specific codes of plastic colour rings, the different resident individuals will be easily recognised in the field.

The most commonly used symbols for bird activities are shown in figure 4. The most important observations are when several different singing individuals of the same species are recorded simultaneously (as indicated by a dashed line between the individuals). This kind of observation is very helpful during the interpretation of the maps, and it is important to try to register as many such observations as possible. Arguably, the most difficult part of the territory mapping procedure is the analyses of the species maps. There is always a certain amount of subjectivity involved here and therefore the same person should do the analyses of all maps if, for example, different areas are to be compared to each other. To increase objectivity it is also important to use a standardised method of set rules. Normally at least three observations are needed for a given territory if eight or more visits have been made and at least two observations if the number of visits are fewer (in the references listed under “further reading” there are more detailed information about interpreting the maps. By using modern GIS (geographic information systems) technology, it is possible to handle the observation data and infer territories on digital maps and in computer programs.

Territory mapping gives an absolute estimate of the number of territories is a given area. This is, however, not necessarily the true number of territories. Even this very thorough method has its limitations, and even though the effect of sampling errors is generally low it is always present.



FF	Unspecified contact with the species ”FF” of unknown sex (heard or seen)
FF$^{♂}$	Male observed
FF$^{♀}$	Female observed
FF$^{\text{p, pair, ♂+♀}}$	Observation of a pair
FF$^{\text{2♂+♀}}$	Two males and one female observed
FF$^{\text{♀ food}}$	Female carrying food
$\underline{\text{FF}}$	Bird calling
FF	Bird in song
FF	Singing bird that could not be exactly located (usually heard at some distance
FF FF	An aggressive encounter between two individuals
FF ——→——	Bird flying over (only seen in flight)
FF ⊢——→	A perched bird seen flying away
FF ——→——⊣	A bird flying in and landing
FF ⊢——→——⊣	Bird seen flying away from one place and landing at a different place
FF -------------FF	Two different birds registered at the same time in different territories (not to be used for observation of a male and a female of the same pair). This kind of registration is very important for subsequent evaluation of the maps
FF————FF	The same bird registered at two different places, combine with other symbols for the activities
FF*	Observation of a occupied nest, combine with a note about nesting stage (FF*$^{\text{5 Eggs}}$, FF*$^{\text{4N+1E}}$, FF*$^{\text{nestmaterial}}$, FF*$^{\text{incubating}}$).

Figure 4. Standard symbols for bird activities for visit- and species’ maps during territory mapping. The name of the species can be abbreviated as suggested in figure 5. In this case the activity of the hypothetical species “FF” is shown. E = Eggs, N = Nestlings.

SD	Stock Dove	MT	Marsh Tit
GS	Great Spotted Woodpecker	WT	Willow Tit
S	Skylark	CT	Coal Tit
TP	Tree Pipit	BT	Blue Tit
WR	Wren	GT	Great Tit
R	Robin	NH	Nuthatch
N	Nightingale	TC	Treecreeper
SC	Stonechat	MG	Magpie
B	Blackbird	RO	Rook
ST	Song Thrush	C	Carrion Crow
SW	Sedge Warbler	RN	Raven
RW	Reed Warbler	SG	Starling
LW	Lesser Whitethroat	CH	Chaffinch
WH	Whitethroat	GR	Greenfinch
GW	Garden Warbler	GO	Goldfinch
BC	Blackcap	LI	Linnet
WO	Wood Warbler	LR	Redpoll
CC	Chiffchaff	BF	Bullfinch
GC	Goldcrest	Y	Yellowhammer
PF	Pied Flycatcher	RB	Reed Bunting
LT	Long-tailed Tit	CB	Corn Bunting

Figure 5. Standard codes for species names to be used for visit maps (from Bibby et al. 2002).

When performing territory mapping, the scale of the study will determine whether random sampling and statistics are needed. If only a small area is of interest and this can be covered as a whole, statistics is generally not used. However, if the area of interest is too large to be fully covered there is an option to use statistical sampling. In such cases a number of small study areas are placed randomly across the full area of interest and each of these are mapped independently. The number of territories of a given species from these smaller areas can then be extrapolated using statistics to infer the total number of territories in the complete area of interest.

If the study area is too large to perform a complete mapping, an alternative is to exclude very common species (for example the 40 most common). Very common species are often not very interesting from a conservation perspective. By this procedure it is often possible to cover an area of 100 – 200 ha (depending of course of the type of environment) during a single visit (say five hours or so). The number of visits can also be restricted to maybe eight, but it may also be important to include a few night time visits to be able to cover species that are mainly active during the dark hours. Night counts are usually less labour intensive and an area twice as large can possibly be covered compared to during morning. This method is described in more detail by Robertson & Skoglund (1985). There are also simplified territory mapping methods for different kinds of environments (mountains, wetlands and agricultural areas), where ever fewer visits may suffice, and an even larger area can be covered (see Svensson 2003).

Further reading:

Bibby CJ, Burgess ND, Hill DA & Mustoe SH. 2002. *Bird Census Techniques* (2nd ed.). Chapter 3. Academic Press, London.

Robertson JGM & Skoglund T. 1985. A method for mapping birds of conservation interest over large areas. I: Taylor K, Fuller RJ & Lack PC (Ed.). *Bird census and atlas studies: Proceedings VIII International Conference on Bird Census and Atlas work.* BTO. Tring.

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Svensson S. 2003. *Revirkartering, generell metod* (version 1:1). Naturvårdsverket, Stockholm. http://www.naturvardsverket.se/dokument/mo/hbmo/del3/landskap/revg.pdf.

Witham JW & Kimbal AJ. 1996. Use of geographic information system to facilitate analysis of spot-mapping data. *J. Field Ornithol.* 67: 367-375.

Photo of a penduline tit at its nest

Line transects

Line transects is a commonly used census technique for bids. This method is less labour intensive compared to territory mapping and can be used to address a number of questions. It is, for example, well suited for monitoring population changes if the same count is repeated over time. The method can also be adapted to suit different environments and species. The rationale is that all bird individuals and species are registered while moving along a line through the area of interest. Such lines are usually termed transects.

It is important not to move to quickly along the transect, since there is a risk that many birds may be missed. A walking speed of around two kilometres per hour is often suitable for forested areas, while the speed can be slightly higher in open areas. It is often good practice to make short and frequent stops to listen for birds singing some distance away form the line. It can sometimes be difficult to know if a given individual of a common species has been registered earlier on the transect or whether it is a new individual. There may be many individuals to keep track of at the same time, especially if many different species are registered simultaneously. Because of this, it is a good idea to train the field workers in advance to ensure that the results are comparable between different areas and points in time.

Also note that shy and silent species are often hard to count since the probability of detection is low. In most bird counts the movement along the line is by foot, but under special circumstances the transect may be travelled by car, boat or even airplane. It can also take some practice to learn to keep on the transect while simultaneously searching for and registering birds. If the transect is walked, it is common to use a compass or a GPS to keep on the straight line. If the same transect is to be surveyed repeatedly it may be a good idea to use various kinds of markings to aid in the orientation. Be sure to contact the land owner before making any type of markings in the survey area.

Previous page:
*A penduline tit (*Remiz pendulinus*) building a nest. Note that the bird is marked with colour rings.*

Usually it is not possible to cover the study area completely using line transects. Instead a random and representative sample of transects are placed in the area. General points about sampling theory is discussed in Box 1, and some different ways to place the transects in the area of interest is visualised in Figure 6. If using a random sampling procedure there are no limitations on the size of the study area. If you want to avoid a sampling procedure and instead cover the whole area with transects it is vital to know the maximum distance at which an individual of the species of interest is likely to be observed. If the transects are placed too close to each other, there is a risk that the same individual is counted twice from different lines, something that could bias population estimates. If, on the other hand, the transects are placed too far apart, there is a risk of missing individuals between them. Covering the whole area with transects is therefore only recommended in circumstances where only one or a few species are counted and the probability to observe an individual at a given distance is known.

Instead of an absolute estimate of the number of individuals of a given species, line transect methods give a relative index. These indices can be used to compare the densities of individuals in different areas or in one area between different time points, for example before and after a conservation action or exploitation. This kind of indices are also very useful in monitoring programmes where the same areas are visited during many consecutive years to be able to follow long term population trends. In order for the counts to be comparable between different time points it is vital that the same methodology is carefully followed in every year.

It is also possible to get absolute estimates of densities and number of individuals using line transects, but a little bit more effort is needed. Species differ in the probability of detection. Some species (shy or discrete) will only be

Box 1. Statistical sampling

There are several different options for placing transects or counting points across the area of interest. Which method to choose, depends on the questions asked and practical limitations. The simplest form is to just follow a path, road or stream through the area (Figure 6a). Particularly in dense habitats this may be the only option that is practically possible. It should, however, be noted that this practice will not give results that are representative of the study area as a whole. If this method is adopted, the data can thus only be used to calculate densities, numbers or trends for a small area surrounding the line. In cases when conclusions are to be drawn regarding the whole study area, a statistically sound sampling procedure has to be adhered to. Such a sampling can for example involve randomly placing a number of shorter transects across the area of interest (Figure 6b). A blind draw or random number generator can be used to ensure that the lines or points really are randomly and independently scattered over the area. An alternative to completely random sampling is to use some restrictions to the placement. This is usually referred to as stratified random sampling. This can for example be applied when there are several different habitats represented in the study area. If a completely random sampling approach is used in that case there is a risk that all the transects are (by chance) placed in one of the habitats, something that would bias the outcome of the counts. This can be avoided by deciding in advance that the lines should be representatively spread across the different available habitats, while sampling randomly within each habitat (Figure 6c). Finally something called systematic sampling can be used (Figure 6d). Here the transects are placed in a regular pattern across the study area. The lines can for example be placed at a given distance from each other or using a predetermined set of map coordinates.

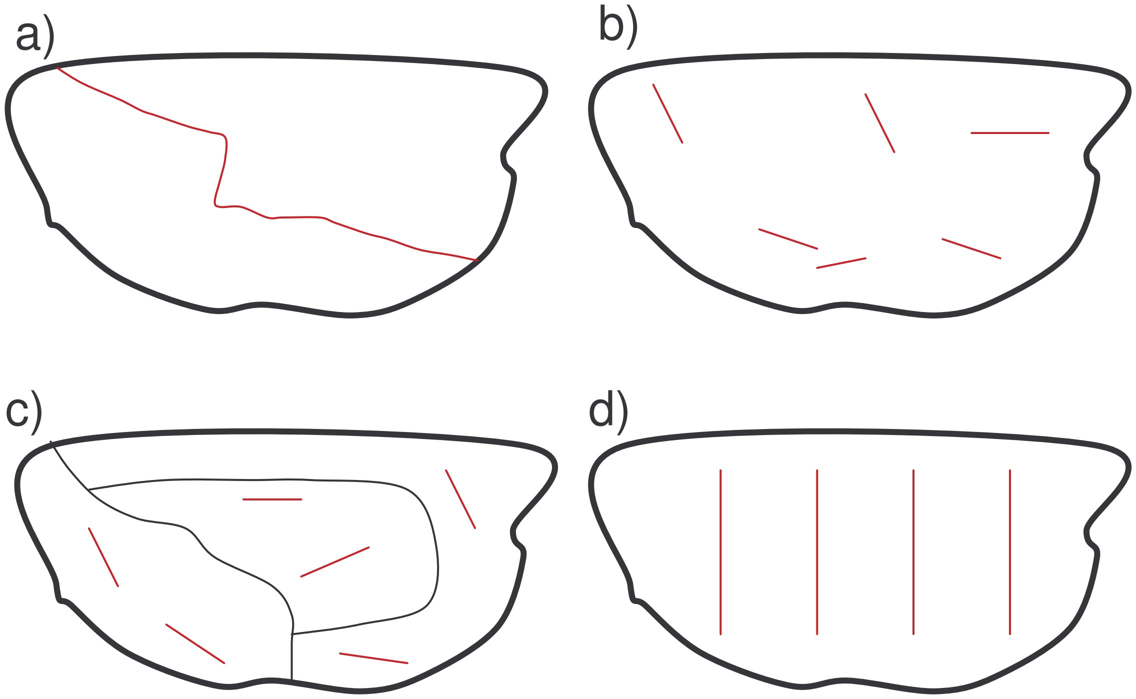

Figure 6. Different ways to place transects in the study area. a) The transect follows a path or other natural feature through the area. b) Several short transects are scattered randomly over the study area. c) Stratified random placement of transects. The area of interest consists of three different kinds of habitat. Two short transects have been placed randomly within each kind of habitat. d) Systematic placement of transects where the lines are placed on a predetermined distance from each other and with a given orientation.

*Photo of a gyrfalcon (*Falco rusticolus*)*

registered very close to the line, while others may be observed over large distances. There are several ways to control for these kinds of factors by estimating the number of species present but not detected in a given area. One example is distance sampling, where the distance between the transect and each observed bird is measured. You can read more about these kinds of methods in the section “Methods for estimating true densities based on indexes”.

Further reading:

Bibby CJ, Burgess ND, Hill DA & Mustoe SH. 2002. *Bird Census Techniques* (2nd ed.). Chapter 4. Academic Press, London.

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Franzreb KE. 1976. Comparison of variable strip transect and spot-map methods for censusing avian populations in a mixed-coniferous forest. *The Condor* 78: 260-262.

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Thomas L, Laake JL, Strindberg S, Marques FFC, Buckland ST, Borchers DL, Anderson DR, Burnham KP, Hedley SL, Pollard JH, Bishop JRB & Marques TA. 2005. *Distance 5.0.* Research Unit for Wildlife Population Assessment, University of St. Andrews, UK. http://www.ruwpa.st-and.ac.uk/distance/

Photo of a bittern

Point counts

The kind of data collected using point counts is very similar to what is obtained using line transects. Consequently this method is also appropriate when similar kinds of questions are being asked. The field work is, however, rather different between these two methods. In general, point counts are easier to perform and the challenges posed to the field worker are fewer. This method is often used in environments where line transects are hard to complete in an acceptable way. That said, point counts are often less effective than line transects, since a lot of time is spent travelling between the points. The results can also, sometimes be a bit more difficult to analyse and interpret.

In short, the method is performed by stopping for a given time at a number of points in the study area and registering all bird individuals heard or seen from the point. The way of travelling between the points is of no importance. Depending on where the points are placed, the field worker can choose to walk, go by bike, car or on skis. During planning one should consider placing the points at such a distance that the risk of counting the same individual from different points is minimised. However this point also calls for a bit of pragmatism. If several different species are surveyed simultaneously, it may be impossible to place the points distantly enough to completely eliminate the risk of double counting of species that can be heard over very long distances (like cuckoo , bittern and black grouse). As a rule of thumb the points should be at least 250 meters apart in forest and with more than 350 meters distance in open habitats. Also be aware that some species which are shy and silent may be easy to overlook during point counts. By surveying the environment surrounding each point this method is very suitable for investigating the habitat preferences of different species.

As for line transects, point counts give an index of number of individuals. That means that the method is primarily useful when investigating population trends over time. It is of course crucial for such studies that the methodology is strictly conserved between the different time points of investigation. If distance sampling is applied to point counts to get information on absolute densities, it is important that the distances are very accurately measured. This is because the distances will be analysed on an exponential scale for point counts and small measurement- or rounding errors may have big consequences for the results.

When conducting point counts there is a risk that birds close to the point will be flushed away while one approaches the point, before the counting is started. One option is to wait for one or a few minutes at the point before starting the count to give the birds a chance to return to their original positions. The suitable length of time to count from each point is dependent on the kind of species counted and the habitat surrounding the point. Five minutes of counting is often recommended but in difficult and bird rich habitat the period may have to be extended to twice that length. If the count time is too short there is a risk that some individuals may be missed, but if the time is too long some individuals may easily be double counted. Too long time spent on a point also increases the risk that the density of individuals in an area is overestimated, since birds may have moved into the area during the time of the count. One way around this problem is to count only for a very brief period some predetermined time after arrival to the point (so called snap shot counting). The time before the “snap shot” is used to locate and identify all individuals around the point. There is also an option to have some time after the count to make supplements to the identification and to verify the exact position of the counted individuals.

During a point count a random sample usually needs to be taken from the study area. There is thus (as for line transects) no limitation for the size of the studied area. If statistics is to be used for drawing conclusions for the whole

Previous page:
*There is a big risk that the same individual bittern (*Botaurus stellaris*) is registered from several points close to each other. This must often be considered when interpreting the results from a point count survey.*

area it is crucial to use a random or systematic placement of points (see Box 1). Just as for line transects there is also the option to use a stratified sampling scheme. The simplicity of point counts make them suitable for large scale and long term monitoring of populations for a number of species. Such studies are for example performed by the Swedish bird survey project (Box 2).

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Box 2. The Swedish Bird Survey

The Swedish bird survey is a national bird monitoring project financed by the Swedish government and coordinated by Prof. Åke Lindström at the University of Lund. The vast majority of the bird counting is performed by volunteering Swedish ornithologists. In total almost 500 field workers take part in the counting each year. The project was started in 1969 and is now composed of three independent parts: summer point counts, winter point counts and standardised transects. Summer point counts and standardised transects are done once every year during the breeding season while the winter point counts are done one or five times during the winter. The methodology of the point counts is similar in summer and winter with all seen and heard birds being counted during five minutes from 20 different points. The field worker has complete choice over the positioning of the points. The methodology is kept as simple as possible to enable the same points to be counted for many consecutive years by the same field worker. The drawback of this simple method is that the points are not systematically or randomly spread across all habitats of the country. Because of this problem the standardised transects were started in 1996 as a complement to the point counts. These are systematically placed over the whole of Sweden allowing a more general interpretation of the results. The standardised transects consists of 2x2 km large squares and the methodology is a combination of line transects and point counts. The field worker walks along the square and makes stops at each corner and on the middle of each side. There is thus eight points, each being counted for five minutes and eight one kilometre transects being counted once each. The survey is completed during the breeding season, i.e. from the middle of May to the beginning of July depending on how far north in the country the square is situated. The contact details of Åke Lindström can be found at the end of the booklet if you are interested in learning more about the Swedish bird survey. More information can also be found on the webpage: http://www.zoo.ekol.lu.se/birdmonitoring/Eng/index.htm.

Photo of a bullfinch

*Bullfinch (*Pyrrhula pyrrhula*), a species that is often encountered during winter point counts.*

Photo of a sedge warbler

*A sedge warbler (*Acrocephalus schoenobaenus*) singing in suitable breeding habitat, breeding criterion 3. If it is concluded that it is a permanent territory (singing on more than two days) it will be upgraded to criterion 5.*

Atlas studies

Atlas study is the most casual method that is presented here. It is used when number of individuals is not of interest but only the breeding distribution of different species. The method is typically used to produce species lists or distribution maps. The methodology is simply to systematically search the whole area of interest (usually divided into separate squares) during a number of visits and carefully note all observed species, trying to give them as high breeding criterion as possible (Figure 7). The method sometimes also goes under the name of breeding survey. Since the aim is to include as many species as possible it is advisable to spread the visits in time so that species that breed at different times of season are included. It is also good to include a few visits during night time to address species which are active after dark. This means that even though the methodology is quite relaxed during this kind of survey, the field worker may still have to devote a substantial amount of time. In most cases the study area is divided using a grid, and each square is surveyed independently. This methodology is also suitable for studies of habitat preferences by investigating the environment of each square.

It is important to think about the size of the squares to be used. This depends on the scale of the study and the resolution of the results. Small squares give higher resolution but also note that more species will be included in each square for larger squares. The positive relation between square size and species richness is, however, not linear and if different size of squares are used in different investigations the results may become difficult to compare. If the aim of the study is to investigate distribution changes between different points in time it is therefore crucial to use the same methods and sizes of the squares. In Sweden squares of 5x5 km have traditionally been used, while larger squares (10x10 km or 25x25 km) have often been used in other countries.

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Possibly breeding

1. Observation during breeding season
2. Observation during breeding season in suitable habitat
3. Male defending a territory
4. Pair of birds in suitable habitat

Probably breeding

5. Permanent territory (>2 days)
6. Courtship display, lekking, mating
7. Visits at a probable nesting site
8. Anxiety call or agitated behaviour of adult individual indicating presence of young or nest
9. Adult with incubating patches
10. Nest building (including excavating nest hole).

Secured breeding

11. Distraction display or injury feigning
12. Used nest found
13. Recently fledged young or pulli
14. Adult entering or leaving nest-site in circumstances indicating occupied nest
15. Adult carrying faecal sacs
16. Adult carrying food to young
17. Eggshell found near nest
18. Nest with incubating adults
19. Nest where young have been heard
20. Nest where young or eggs have been seen

Figure 7. Breeding criteria usually used in atlas studies. During the field work the aim is to reach as high score as possible for each species in each part of the investigated area.

Photo of a sand martin

Photo of a black headed gull

Other methods

The most commonly used methods for counting birds have now been discussed. However, some environments and/or species are particularly difficult to survey and specialised methods can be designed and adapted to deal with these. Below is a very brief overview of some of these other methods.

Breeding colony counts

Species with breeding colonies, for example cormorants, herons, gulls, terns, auks, rook, and martins can often be surveyed by counting the number of nests in the colonies. The number of nests can often be used directly as an index of the number of breeding pairs. However if an absolute figure of the number of breeders is preferable, the proportion of nests that are active also needs to be known. Note that approaching colonies may cause a substantial disruption to the birds and any field work needs to be carefully planned to minimise the disturbance to the breeding birds. Many seabird colonies can easily be counted from a boat. For cormorants and other birds with nests in trees it is often most convenient to perform the counts just before the trees get their leaves.

Pair counts of water birds

Many water birds stay together in very apparent pairs during the beginning of the breeding season. This facilitates counting resident breeders at this time of year. The counts can be performed from land, boat or airplane. The optimal timing of counts varies slightly between different species. For mallard the best time is just after the waters have become ice free while the goosander, for example, stay together slightly longer in pairs. This species also stay together in pairs close to the breeding site making it possible to use territory mapping to count breeding pairs.

Previous page:
*The sand martin (*Riparia riparia*) and the black headed gull (*Larus ridibundus*), two species that ban be surveyed using colony nest counts.*

Counts at leks

There are four species of lekking birds in Sweden (capercaillie, black grouse, ruff and great snipe). These can be surveyed during the breeding season by first locating all (or a sample of) leks in the area of interest and then count the number of displaying males at each of these. Given an even sex ratio and that a large proportion of the males are present at the leks, this number can be directly converted to number of “breeding pairs”. Note however that this is not a very suitable term in these cases since lekking species, by definition, don’t form pairs.

Capture – recapture

In this method a (random) sample of individuals is first caught, ringed and released. After some time to allow for mixing of the individuals, a second catching is performed in the same population. By counting the ratio of unmarked and marked bird in this second catching it is possible to estimate the total number of individuals in the population. Different versions of this technique are commonly used for a number of different kinds of animals; however its use for bird counts has been rather limited. Several of the assumptions of this method are often violated for bird studies. Most importantly, the birds caught are generally not a random sample of all birds in the area.

Standardised catching

This is actually one of the most common methods used in bird studies. On bird ringing stations around the world millions of birds are caught and ringed in a standardised way every year. The long time series available from these studies are very valuable for monitoring long term population trends. Through ring recoveries it is also possible to gain information on migration routes, wintering areas, morphometrics, phenology etcetera. Much has been published elsewhere about the merits of standardised ringing and I only briefly touch on the subject here. If you want further information or experience of the method I suggest that you contact a bird ringing station in your area.

Sweden is also part of a European network of ringing sites called CES (constant effort sites), where catching is performed in a standardised way with the aim of investigating population trends. Because the birds are handled closely, the CES project (and other ringing efforts) yields information that is not possible to get using other kinds of census techniques. The sex and age of the individuals can, for example, often be identified and the prevalence of parasites and injuries can also be registered. As the birds are individually marked with a unique ring number, it is possible to follow individuals over time. This enables drawing conclusions not only about species but the analyses can often also be done on a smaller scale, investigating trends and effects in different age classes or sexes. Importantly, the methodology also gives demographic data on yearly recruitment and between-year survival of individuals. Thus conclusions can be drawn not only about population trends but also about reasons for population declines and increases.

Migration counts, counts at stopover sites

These methods are also preformed on large scale on many places around the world (especially by bird stations). Migrating birds are usually counted during spring and fall, and this method is important for a number of species that are very difficult to count on the breeding grounds (such as raptors and waders). It is of course crucial that the counting is done in a standardised way every year and that the counting effort is measured, to be able to draw conclusions about long term trends.

Playback

Individuals of some species are very difficult to find. In such cases it may be useful to use playback or imitations of the birds' calls and listen for responses. This method is for example useful when surveying wetland birds, owls and hazel grouse. It can also be used in environments where it is hard to locate birds, like rain forests. Note however, that playback can cause bias to density estimates if birds are attracted to calls from outside of the study area. Some species can also be very disturbed by conspecific calls during the breeding season and may even choose to evacuate a territory after playback.

Counts of droppings

Large birds like geese, ducks and grouse, can often be censused by counting droppings in the study area. Similarly, owls can be surveyed using counts of pellets. In practice, the study area is often sampled using transects or squares where all droppings are counted. This can then be used directly as an index of the number of individuals in the area. By measuring how much droppings are produced by an individual and the degradation rate of the droppings on the grounds, this method will even give absolute estimates of number of individuals. Genetic analyses of feathers or droppings found in the study area can also be used to estimate individual densities.

Nest box studies

By regularly checking nest boxes in a standardised way it is possible to get abundance data that can be compared between different years. A drawback of the method is that the breeding density is likely to be increased when nest boxes are placed in the study area. It is therefore important to consider how the study itself will affect the results of the survey. An advantage with this kind of surveys is that data on individual breeding success and yearly recruitment in the study area will also be gathered.

Rope-dragging

By dragging a rope or a chain across an area it is possible to flush birds that would otherwise be difficult to find. This method can for examples be used to study waders. Dogs can also be used to flush birds.

Hunting statistics

Some bird species (e.g. grouse and ducks) are hunted for sport and food on a regular basis. For these species, bag statistics (number of individuals shot) may be used to study population dynamics. However, in order to get unbiased estimates from this kind of data, it is crucial that the hunting effort involved has been quantified in each case and carefully controlled for.

Individual sound differences

Some species have large individual variations in vocalisations something that can be used to estimate the number of singing males in an area. The vocalisations can be recorded and

Photo of a long-eared owl (Asio otus)

specific computer software used to analyse the data.

Species lists

In some cases, a very simple count method has to be used. This applies to inaccessible areas like tropical rain forests. One of the simplest census methods is the use of species lists. These can for example be a list of all species observed during a given time (one hour or a day). By making many such lists, a relative measure of the abundance of different species in the area can be estimated. Another version is to make lists of a predetermined length (so called McKinnon-list or x-species list). Here the first ten or twenty (depending on the species richness in the area) species encountered are listed. As soon as this first list is full a new list is started and so on.

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Photo from a rain forest

Methods to estimate absolute numbers from indexes

The number of individuals of a given species registered (C_i) during a survey (i) is dependent on two factors: the true number of individuals in the study area (N_i) and the probability that a given individual is detected during the survey (p_i). If p_i is constant between two different surveys, the registered number of individuals can be used directly to compare these two investigations. In such cases C_i is usually termed an index and will serve as a relative abundance measurement.

Many of the methods described here (such as line transects, point counts, standardised catching and migration counts) gives this kind of relative density estimates (see also the section "Choosing a census method"). There are however, often good reasons to believe that that p_i is not constant between different surveys. Various factors such as the sex and species of the bird, the hearing and experience of the field worker, the habitat, time of day, time of the year and weather are all likely to affect the probability that an individual is observed. A change in a density index may therefore often be hard to evaluate as the effect on p_i from such factors are unknown. One way around this problem is to try to estimate p_i for the different surveys. This will enable the calculation of the absolute number of individuals (N_i) for each study, which can then be compared directly.

Several different methods are available for this kind of estimation and I will briefly mention a few of the most commonly used.

Parallel sampling

One common way to convert indices to absolute estimates is to merge the results from two different surveys (using different methods) from the same area. For example a large scale point transect survey can be complemented with more detailed counts (like territory mapping) in a few subsamples of the area. The information from the detailed counts can then be used to estimate the efficiency of the more large scale counts.

Previous page:
In habitats that are difficult to survey, simplified census methods are often necessary. Braullio Carillo, Costa Rica

Double observer counts

A slightly different approach is to have two field workers performing the counting together. One observer (primary observer) is making the counts (using for example a point count or line transect) in the standard way, but notifies the other field worker (secondary observer) of all observations made. The task of the secondary observer is to note as many individuals as possible missed by the primary observer. The two persons should alternate between being primary and secondary observer.

Distance sampling

Another common way to calculate absolute densities from line and point counts is to use distance sampling. I have previously mentioned this method in the sections "Line transects" and "Point counts" but here is a slightly more thorough description.

In distance sampling the distance to each observed bird (or anything else being counted) is measured. This distance data is then used to estimate the probability of detecting an individual of the species in question at a certain distance. Using the resulting "probability of detection function" an absolute estimate of densities and number of individuals in the study area can be obtained. The method can be applied both to line transects and point counts. A specialised computer software named "DISTANCE" can be used to analyse the data produced. This freeware can be downloaded from the University of St Andrews web page (http://www.ruwpa.st-and.ac.uk/distance/). There is also a manual and a number of examples of studies using this method.

It is extremely important to be rigorous when collecting distance sampling data. The task to record not only the number of individuals of each species, but also the distance to each individual, is both labour-intensive and difficult. In order to get high-quality data the field worker usually has to be well trained and experienced in bird census techniques. There are several assumptions regarding the data collection that need to be met in order to get reliable density estimates. The most important of these assumptions for distance sampling data are:

1. **Correct species identification**
   It is important that the species is correctly identified for all individuals registered. If the distance is too large, or observation too brief, for correct species identification such an observation should not be registered.

2. **Correct measurement of distances**
   One important assumption is that the distances are measured correctly. Note that for line transects the measure is the closest distance from the bird to the transect line (which is perpendicular to the line), and not to the observer. This distance can be estimated in different ways. The position of the bird can be noted at the time of finding and the distance measured when reaching that spot on the transect. Alternatively the distance can also be calculated from the observation point through trigonometry by also recording the angle between the line and the bird from the observation point. A third alternative is to mark each observation on a detailed map and afterwards measure the distance on the map. Laser rangefinders can be helpful for measuring distances to the birds or to the vegetation patches from which they are singing. If the exact measurement of distances is impractical there is also an option to record distances into two or more discrete categories (for example 0 – 10 m, 10 – 25 m, 25 – 50 m, 50 – 100 m and 100 – ∞ m).

3. **Birds do not move in relation to the observer**
   It is important that the bird has not moved in relation to the observer before it is discovered. If for example the bird flies away from the observer before the first observation is made, the recorded distance will be too large, leading to an overestimate of the density and number of individuals in the study area.

4. **Birds on the transect are always detected**
   In order to get reliable estimates of the probability of detection function it is important that individuals on (or directly above) the line (or point) are always detected. It is also preferable that the probability of detection function has a "shoulder" so that birds close to the line/point also have a very high probability of detection.

5. **The lines or points are a representative sample of the study area**
   In order to extrapolate the density estimates from the sampled transects into the entire study area it is important for the transects to be representative of the area as a whole. If this assumption is violated the data around the lines or points can not be used in extrapolations to infer the densities and number of individuals in the study area as a whole.

6. **Sufficient number of observations**
   In order to estimate a probability of detection function from the data, it is generally advised that sample sizes be rather large. As a rule of thumb 60 to 80 observations are a minimum to produce reliable density estimates.

*Photo of an oystercatcher (*Haematopus ostralegus*)*

Further reading:

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Photo of a group of dunlins

Publishing the results

A study is not over just because the fieldwork has been completed. The data collected needs to be analysed and, importantly, the results should be suitably published. Spreading the conclusions to other people that may be interested of the study is, in a way, the most important part of the whole project. I will not go into any details about data analysis and statistics in this text. Plenty has been written on these subjects elsewhere (see further reading at the end of the chapter).

There are many ways to spread the results of a study, and it is important to consider how this should be done already during the planning of the investigation. What form of publishing to choose is, of course, mainly dependent on whom one wants to share the results with. If you just want to reach other bird watchers in the area to share the results of a local survey, maybe the best option is to write an article for the local bird journal or give an oral presentation at the bird watching club. In other cases you may want to enable researchers from around the world to take part of the results. In such a case it is important to publish the results in an international scientific journal. If you wish to reach out to a broader public, you may want to consider writing for a popular scientific journal or making a press release to the media.

The different forms of publishing have their own demands on the format of the report. The work can, for example, have been commissioned by a company or government agency. In such cases it is often specified how the results should be shared and the report framed. Large companies and agencies have often even got special report templates to use. For this kind of jobs it is good to have an advance agreement regarding how the results may be used by the investigator, for example in a separate scientific publication.

Previous page:
*Dunlins (*Calidris alpina*).*

Research articles can be published in a wide range of journals ranging from local ornithology papers to large international scientific journals. These all have a specialised structure in common, facilitating information finding and extraction. The most obvious part of the article is the *Title*. This should be short and comprehensive, and also draw the attention of the reader. After the title there is usually an *Abstract* (or summary). Here all parts of the study are summarised, highlighting why and how the investigation has been conducted together with the most important results and conclusions.

The first large body of text is usually the *Introduction*. Here the background to the study is given and the questions are introduced. There should also be a summary of previous work on the subject and lastly the main aims of the present investigation are presented. The next section is usually the *Materials and Methods*. This should be a thorough description of how the investigation has been performed. The description should be detailed enough that the study can be performed in a similar way by someone else. Not only the field work should be described, but also the data analyses performed. In this section it is also common to describe the geographic area surveyed and the species of interest. After this the *Results* section follows. Here the results are described and the statistical analyses are reported. The results should both be described in the text and using tables and figures. In the *Discussion* that follows, the results are clarified and put into perspective. It is stated how the current study relates to results from other studies on the subject. This is also the place to raise possible limitations with the study and how future research should proceed. Last in the article is a list of *References*. Here all the other research that has been referred to in the text is listed.

The language of the presentation is of course dependent on where the article is to be published. English is by far the most common language in international research journals while the local language is used for publications within the country. *Ornis Svecica* is a Swedish research journal for local and international bird studies. Here the text can be written in either Swedish or English, but there should be a comprehensive summary in the other language.

A popular scientific article is completely different from a research paper. Here it is even more important to have an interesting title to catch the eye of the reader. After this there is a short opening paragraph, highlighting the most interesting results of the study. Also the main text should start with the most interesting results of the study while details about how the study was performed and relation to other work comes later in the text. Needless to say, unnecessarily complicated language should be avoided.

Oral presentations are a very effective way to spread research results. Such presentations can take place at conferences with other ornithologists and researchers or in more informal settings such as local bird watching clubs. Ensure that the scientific level of the presentation is in line with that of the audience. Prepare yourself thoroughly and use visual aids (such as PowerPoint presentations) wisely in order to get your message through.

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Next page:
*Rough legged buzzard (*Buteo lagopus*).*

Photo of a rough legged buzzard

*Photo of a group of whooper swans (*Cygnus cygnus*)*

The twenty commonest censusing sins

The following points are taken from Chapter 11 of the Book *Ecological Census Techniques: A Handbook*, edited by William J. Sutherland (Cambridge University Press, Cambridge, 1996). Carefully think your methodology trough in order to avoid these common mistakes as much as possible!

1. NOT SAMPLING RANDOMLY.
   It is very satisfying to sample rarities or rich patches but it ruins the exercise. One common error is just to visit the best sites and use the data to estimate population size.
2. COLLECTING FAR MORE SAMPLES THAN CAN POSSIBLY BE ANALYSED.
   This is a waste of time and may raise ethical and conservation issues.
3. CHANGING THE METHODOLOGY IN MONITORING.
   Unless there is a careful comparison of the different methods, changing the methodology prevents comparisons between years.
4. COUNTING THE SAME INDIVIDUAL IN TWO LOCATIONS AND COUNTING IT AS TWO INDIVIDUALS.
5. NOT KNOWING YOUR SPECIES.
   Knowing your species is essential for considering biases and understanding the data.
6. NOT HAVING CONTROLS IN MANAGEMENT EXPERIMENTS.
   This is the greatest problem in interpreting the consequences of management.
7. NOT STORING INFORMATION WHERE IT CAN BE RETRIEVED IN THE FUTURE.
   The new warden of a national nature reserve in England could find out from old work programmes the days on which his predecessor had counted a rare orchid but could find no record of the actual numbers!
8. NOT GIVING PRECISE INFORMATION AS TO WHERE SAMPLING OCCURRED.
   Give date and precise location. ‘Site A’, ‘behind the large tree’ or ‘near to the road’ may be sufficient now but mean nothing later.
9. COUNTING IN ONE OR A FEW LARGE AREAS RATHER THAN A LARGE NUMBER OF SMALL ONES.
   A single count gives no measure of the natural variation and it is then hard to see how significant any changes are. This also applies to quadrats.

10. NOT BEING HONEST ABOUT THE METHODS USED.
    If you only survey butterflies on warm still days or place small mammal traps in the locations most like to be successful then this is fine but say so. Someone else surveying on all days or randomly locating traps may otherwise conclude that the species has declined.
11. BELIEVING THE RESULTS.
    Practically every census has biases and inaccuracies. The secret is to evaluate how much these matter.
12. BELIEVING THAT THE DENSITY OF TRAPPED INDIVIDUALS IS THE SAME AS THE ABSOLUTE DENSITY.
13. NOT THINKING ABOUT HOW YOU WILL ANALYSE YOUR DATA BEFORE COLLECTING IT.
14. ASSUMING YOU KNOW WHERE YOU ARE.
    This can be a problem when marking individuals on maps or when censusing areas, e.g. a one-kilometer square marked on a map. Population overestimates can result from incorrectly marking the same individuals as occupying very different locations or by surveying a larger block than intended.
15. ASSUMING SAMPLING EFFICIENCY IS SIMILAR IN DIFFERENT HABITATS
    Differences in physical structure or vegetation structure will influence almost every censusing technique and thus confound comparisons.
16. THINKING THAT SOMEONE ELSE WILL IDENTIFY ALL YOUR SAMPLES FOR YOU.
17. NOT KNOWING WHY YOU ARE CENSUSING
    Think exactly what the question is and then what data you need to answer it. It is nice to collect additional data but will this slow down the project so that the objectives are not accomplished?
18. DEVIATING FROM TRANSECT ROUTES.
    On one reserve the numbers of Green Hairstreaks *Callophrys rubi* seen on the butterfly-monitoring transect increased markedly one year. It turned out that this was because the temporary warden that year climbed through the hedge to visit the colony on the far side.
19. NOT HAVING A LARGE ENOUGH AREA FOR NUMBERS TO BE MEANINGFUL.
    If it is impossible to have a large enough area then question whether the effort might not be better spent on another project.
20. ASSUMING OTHERS WILL COLLECT DATA IN EXACTLY THE SAME MANNER AND WITH THE SAME ENTHUSIASM.
    The International Biological Programme gave very specific instructions, yet it was hard to make much sense of the data because the slight differences in interpretation led to very different results.

*Photo of a redshank (*Tringa totanus*)*

Contact information

Do not hesitate to contact us if you have further queries about this booklet or other questions about bird census techniques:

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