Chapter 21

Tips for bird surveys and censuses in countries without existing monitoring schemes

by

Friederike Woog
State Museum of Natural History Stuttgart
Rosenstein 1, 70191 Stuttgart, Germany
Email: woog.smns@naturkundemuseum-bw.de

Swen C. Renner
Institute of Experimental Ecology, University of Ulm
Albert-Einstein Allee 11, 89069 Ulm, Germany
Email: swen.renner@uni-ulm.de

Jon Fjeldså
Zoological Museum, University of Copenhagen
Universitetsparken 15, DK-2100 Copenhagen, Denmark
Email: JFjeldsaa@snm.ku.dk

Abstract

Birds are important environmental indicators and, for a long time, have been included when surveying biodiversity. This has led to a whole array of publications, some of which are available over the Internet, making them easily accessible worldwide. Here we provide practical guidance, with relevant source references, for how to plan and conduct bird surveys and censuses, especially in tropical environments.

Keywords: biodiversity, bird counts, assessments, monitoring techniques

1. Introduction

When surveying biodiversity, birds are usually included because they have been more completely charted (in terms of taxonomy and distributions) than any other taxonomic group, and because good field guides, and even bioacoustics data, are available for identification for most parts of the world. Furthermore, a large number of skilled birdwatchers are often keen to volunteer in bird monitoring projects. In order to develop bird monitoring as an effective tool in conservation biology, a whole array of literature about bird census and monitoring techniques has been published, the standard book by the late Bibby and his colleagues (2000) covering most of them.

In 1998, Bibby *et al.* presented a guide especially designed for expeditions. Gilbert and a team of specialists published a comprehensive book on monitoring techniques for all sorts of UK bird species ranging from songbirds to raptors to waterfowl (Gilbert *et al.*, 1998). A "Best Practice Guide for Wild Bird Monitoring" was published in 2008 by Voříšek and his colleagues focusing mainly on Europe and giving an overview of existing monitoring schemes. It can be downloaded, making it easily accessible to birdwatchers and ornithologists worldwide (http://www.ebcc.info/index.php?ID=365). More articles with information on specialized count procedures can be found in Gibbons & Gregory (2006). So why include birds in this manual? The goal of this article is to give practical advice on how to plan bird surveys and censuses in countries where monitoring schemes are lacking, and to provide useful Internet links. This is by no means a complete treatment of methods, study design, data management and analysis as this would be far beyond the scope of this chapter. All of these, sometimes rather complicated topics, are covered well in the publications mentioned above (also see Gregory *et al.*, 2004).

This chapter is written from a European perspective. Whereas the general biology and life cycle of European and North American birds is rather well known, we know far less about birds from many other parts of the world. It is useful and important that scientists from developed countries contribute to the study of biodiversity outside Europe, especially in the tropics. To be sustainable, the long-term monitoring in developing countries should be locally based (Danielsen *et al.*, 2006, 2007). Although hard to achieve, this goal should always be kept in mind, and is indeed often feasible once local communities experience how simple monitoring systems can be used proactively to manage their own resources.

2. Preparation for the survey

To start with, we advise contacting local ornithologists, to tell them about the plans and to ask them if they support the idea of a survey and if they would become a partner. It is important to find the right people to work with, people that are accepted locally but ideally biologists by training. In most countries birdwatchers and ornithologists are associated with the Birdlife International Partner and can be tracked down by visiting the Birdlife International homepage, a network of birdwatchers and ornithologists worldwide :

http://www.birdlife.org/worldwide/national/index.html. A local partner can help to answer the following questions: (1) Have surveys already been carried out in the target area or are some being planned? (2) Do other monitoring schemes already exist? (3) When is the best time for a survey (season and time of day)? (4) Are permits needed and how are they to be obtained? If a certain survey or monitoring scheme is already in place one should consider choosing a similar method to make data comparable between sites. A good example for a large-scale bird survey is the second South African Bird Atlas Project SABAP2 (http://sabap2.adu.org.za/index.php). On the homepage there are good descriptions of survey methods and databasing procedures including various downloads.

For your partnership to work, consider that volunteer schemes, as developed in Europe and South Africa (breeding bird surveys, international waterfowl counts etc.) rarely exist in developing countries. People have to work to survive and can rarely afford a hobby like birding. Therefore, find out what the “normal” fees and salaries are. Discuss this issue with your local partner beforehand. Out in the villages, it may be useful to make agreements about donations and salaries with a village chairman, or council, rather than with the individual helpers. Such discussions may be cumbersome (for you) and you may feel awkward, but nothing is worse than having to sort out conflicts afterwards. Sometimes it can be useful to have a small contract telling the nature of your cooperation who is responsible for which aspect, signed by all parties involved and a copy resting with each party.

2.1. Species identification

When planning a survey in an unfamiliar region, prepare yourself beforehand, as this will save a lot of time in the field. This includes surveying existing ornithological literature about birds in the target area, and to identify species of particular interest. For most parts of the world there are field guides for birds and CDs with bird calls and songs. The quality of these guides greatly varies and they rarely include juvenile birds. Some are heavy to take into the field. A simple although somewhat drastic trick is to ask a book binder to split your book into two – one with the plates (to bring into the field) and one with the more extensive text that you may decide to leave at home or at base camp. Some publishers have already caught up with this idea, *i.e.* for West Africa (Borrow & Demey, 2004), New Zealand (Robertson & Heather, 2004) or South Asia (Rasmussen & Anderton, 2005). A good source to check what species occur in an area is http://www.birdtours.co.uk/ which is a collection of trip reports by travelling birders all around the world, including up to date maps, tips on where to stay and who the useful local contacts are.

2.2. Calls and Songs

We very much recommend using a MP3 player with headphones and microphone that can easily be taken into the field. With a special amplifier, a directional microphone can be used, increasing the range and quality of the recordings. The calls from a CD can be transferred onto the player. Most

modern recordings will offer files in mpg-format. If not, the sound files on audio CDs can be transcribed into mpg-files easily, using freeware available (*i.e*. http://www.freerip.com/). Do observe copyright laws and make sure your download is really for free. Free resources are online sound libraries:
http://www.xeno-canto.org/africa/index_static.html
http://www.xenocanto.org/index_static.html
http://www.xeno-canto.org/asia/index_static.html
http://www.xeno6canto.org/australasia/index_static.html

If you are after species from an area where sound recordings are not yet available, you can check with the Wildlife Section of the British Library National Sound Archive (NSA, http://www.bl.uk/soundarchive) or the Library of Natural Sounds (LNS) at Cornell Laboratory of Ornithology (www.birds.cornell.edu). Fees may apply. Once you have all songs and calls you need, arranging the files in folders is useful, so that they can be easily found when in the field (*i.e.* in alphabetical or systematic order, whatever the preference). Time permitting, calls of species one expects in the target area can be put into a separate folder. The recording function of most players is usually good enough to make a (low quality) recording of a bird call or song that cannot be identified at once. These can later be sent to a specialist to aid identification. Take a player with regular AA or AAA batteries as those usually can be bought in most countries or, when sunny enough, use small solar battery rechargers. Avoid complicated recharging systems that you need electrical power and adaptors for, as electrical power may not be available at base camp. In the headphone slot one can usually plug small active speakers (working with batteries) that can be used for playback. We do not recommend the use of playback but for certain species it may be necessary, especially to detect cryptic or understorey species. Playback can disturb birds, especially in the breeding grounds. Therefore it should be only used if absolutely necessary and then only very briefly, *i.e.* for a maximum of five minutes. As soon as there is a reaction, stop. Keep in mind that a bird may not visibly respond, yet may still be disturbed.

2.3. Bird collections in museums

Bird collections are good places to brush up bird identification skills before going into the field. If a survey is for scientific and conservation purposes, most museums will allow such studies. See for example:
http://www.museum.lsu.edu/~Remsen/AVECOLlections.html
http://www.scricciolo.com/European_Bird_Collections_C%20S%20Roselaar.pdf

To find out whether a museum holds the required specimens, the bird curator should be contacted well in advance and arrangements made to see specimens. Bird curators or collection staff should explain the best way how to handle bird skins. Always handle them with great care because they are meant to be used by generations to come! A large number of web pages are useful to study birds. Many of them are accessible through the GBIF platform (http://www.gbif.org/). A useful searchable database is http://avibase.bsc-eoc.org giving links to selected Google images, distribution maps, taxonomy, ITIS, Birdlife and Wikipedia. ORNIS, the Ornithological Information System, is linked to GBIF and allows searching 42 mostly American bird databases, including museum specimens (http://olla.berkeley.edu/ornisnet/). The site offers

a list of the respective curators including email addresses. For the Neotropics, another good source is http://neotropical.birds.cornell.edu/portal/home. The Zoological Museum, University of Copenhagen offers online access to birds collected in Tanzania (http://www.zmuc.dk/VerWeb/Tanzanian_Vertebrates/TanzVert.index.html).

2.4. When to count

The timing of a bird survey will depend on the life cycle of a particular bird species if monitoring one species. Of course, many surveys would be for more than one species. To get an inventory for a given area, typically the major breeding season is best suitable for monitoring the community. Some birds migrate and will be absent from the chosen study area for part of the year. This can include a smaller scale *i.e.* altitudinal movement, but can range to long-distance migration. For most surveys, the time when males are singing on their territory and the birds constructing their nests, are the most suitable, since birds are most active then. Once sitting on the nest, birds often become very silent and cryptic, making it hard for anybody to detect them. In many tropical areas breeding seasons are not as synchronized as in more temperate regions. This means that often only some bird species are breeding whereas other, often closely related species may breed much later. Furthermore, only some individuals within a population may be breeding. The timing of breeding greatly depends on the altitude of your study site and the weather. Even rainforests can be rather dry in certain years. Humidity greatly affects food availability and triggers the onset of the breeding season. Low temperatures in mountain regions can defer the onset of the breeding season. It is often very hard to predict these patterns, even for experienced local people. If logistically possible, we recommend to count at least two times a year.

2.5. Target species

You should aim to find all species possible including breeding birds, wintering birds, cryptic species, nocturnal species, understorey species, rare species, bird colonies and mixed species flocks. Special methods are available for most or can be adapted from closely related species (see Gilbert *et al.*, 1998). The more time you spend in an area, the more species you are likely to find. These species discovery curves (Fig. 1) are quite useful as they help you to identify the point in time when the number of new species discovered in an area becomes rather low. For economic reasons and depending on the question being investigated, one may decide to stop data collection at that point (see below for further details).

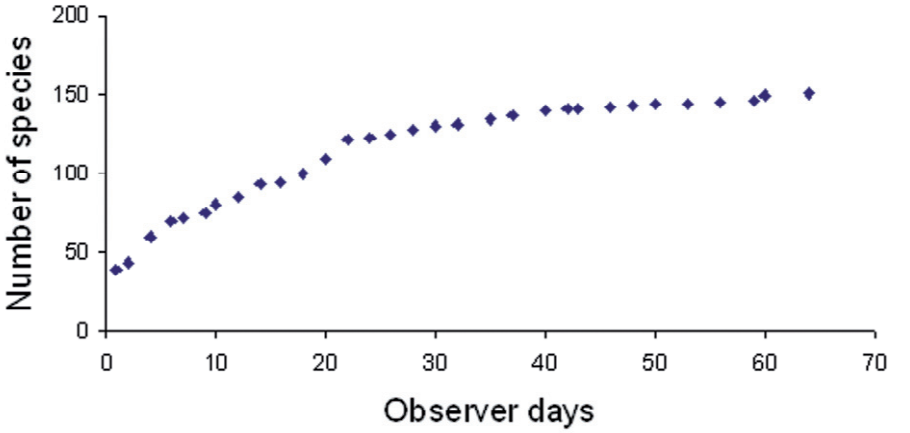

Fig. 1. Species discovery curve, with the total cumulative number of species discovered each day (the time unit could also be hours). At first, the number of species increases rapidly until, after a certain number of days, this number levels off. After that it takes many days to discover a few more species, some of which may only be occasional visitors of the area (after Bibby *et al.*, 1998).

2.6. Habitat

Birds live in almost any habitat you can think of. Clearly, you need to adapt your survey method to the habitat. As an example of two extremes, consider a desert with very low vegetation on one hand, and a dense rainforest with trees ranging up to 40 m into the sky on the other. It is therefore useful to split your survey area into different habitats (*i.e.* forest, scrub, desert, alpine etc.) and to adjust your survey method accordingly (*i.e.* spacing of transects, distance of sample points etc.). If you want to compare different habitats you should, however, use the same protocol. Bibby *et al.* (1998, 2000), Gilbert *et al.* (1998), Gregory *et al.* (2004) and Gibbons & Gregory (2006) offer good advice on this topic.

2.7. Maps

High-resolution maps are essential for a good survey and we recommend obtaining maps prior to surveys. In the capitals of most countries you can contact ministries for geography/geology or local cartographic services. Google Earth images can give you a good idea of your study area, and for many areas high-resolution images are now available. Sometimes they are a few years old and therefore of limited value in areas under rapid “development”.

2.8. Bird behaviour

Birds have very different life styles. Some spend almost all their time up in the air (*e.g.* swifts), some are flightless (*e.g.* Kakapo, Kiwi) or virtually so and skulk around in the understorey vegetation. Birds that live up in the canopy are often almost impossible to detect, as are birds that hide in dense foliage. A few birds

are rather curious and easy to detect, while others are extremely shy. Species detectability depends very much on bird behaviour but also on weather conditions and the skill of the observer. Observers who recognise all of the bird calls and songs of an area will naturally discover more bird species than observers without these skills.

Birds also sing at very different times of day, some start very early in the morning, or advertise their territory around daybreak by giving a single call, some sing at night (*e.g.* owls). Whereas for some species it may be useful to count breeding territories identified by their territorial song, for other species it may work better to count them during foraging or when they are flying to a roost (*i.e.* gulls or terns). Many tropical forest birds move around in multi-species feeding parties, or become active only when such parties pass through their territory and provide effective antipredator vigilance. Thus, it is of great advantage to pay attention to these bird parties, which often follow the same route day after day (Poulsen, 1996). In the neotropics, mixed flocks are known to follow ant swarms (Vallely, 2001; Roberts *et al.*, 2000).

Although the books by Bibby *et al.* (1998, 2000) and Gilbert *et al.* (1998) offer more detailed guidance, the annual cycles of birds outside Europe and North America are, in comparison, poorly known. Indigenous people are often the only ones that can give you some ideas about certain species (Ng'weno, 2008). Sometimes their stories may make Europeans sneer because they contain a lot of mystery. Don't sneer at the stories but try to interpret them. A bird spending winter in a tree cavity and coming out of its hole when the thunder arrives could simply mean that it is a migratory species returning with the rains. Documenting all bird behaviour and observations during surveys is a very worthwhile exercise!

2.9. Local knowledge and training of locals

Once in the field, it is very useful to ask a local guide, hunter or project partner to accompany you and to talk to local communities. Going through a bird book with indigenous people can give you priceless information. Depending on where in the world you are, birds are often part of the day-to-day diet of people, so they may have extensive knowledge about them. Talking to the elders of a village one may also find out which species used to occur in an area but may now have become scarce or have disappeared (Ng'weno, 2008). However, when it comes to smaller, similar-looking species, locals often cannot distinguish them as they lack binoculars. It is useful to bring extra binoculars that you can give to local guides or other project participants. To get hold of them ask friends and colleagues back home if they have a pair they don't need anymore. The most important achievement of your trip may not be your species list, but instead the training of locals in bird identification, to make them interested and to possibly teach them how to carry out a monitoring scheme themselves (http://monitoringmatters.org, http://www.springerlink.com/content/100125/) (Danielsen *et al.* 2005, 2006). Like other monitoring approaches, locally-based methods may be less precise and biased, but may on the other hand be very effective tools for locally based resource management, once locals realize how data can be used for empowerment, *e.g.* for rapid management decisions to counter habitat loss by

interventions from foreigners and from corrupt administrations. Typically, data collected by locals may lead to prompt and local decisions, while data collected by scientists feed into long-term government regulation (Danielsen *et al.*, 2007). Thus, a combination of both is needed.

2.10. Personal safety

In remote areas always take somebody with you. Local people often know an area very well and have a fabulous sense of orientation. Put an emergency mechanism in place in case you do not return in time. Let other people know where you are going and how long for. When discovering a rare animal the temptation to leave known ground becomes very high and suddenly you don't know how to get back. If one person remains on a path, the second person can go off in search for the animal, remaining in shouting distance you will always find your way back. A handheld GPS and a compass are very useful, but you need to know how to use them. Familiarize yourself with these on known ground. It is good to note the direction of larger roads, or rivers, mountain ranges, steep valleys as they can lead you back in case you get lost. Always think about the basics: enough water, emergency food, sun and mosquito protection, small headlamp (LED's), raingear if needed, small first aid kit, waterproof matches etc. A very powerful yet lightweight torch is the Supernova run with LED's which can function as a signal light (or to be used as a spotlight to see owls…).

Before your trip make sure you have all necessary vaccinations. When mist-netting this includes one against rabies, as bats that are sometimes caught are known to have transmitted this disease. Make sure you have enough medication for all likely diseases with you. When leaving medication behind give it to a local doctor or hospital. Being in remote places it is always useful to know first aid and to be able to diagnose diseases, not only concerning yourself but also the people that work with you (Werner, 1979; Merry, 1994; AAOS, 2007). If one does become sick, one should always go to a doctor. Usually, local doctors have a very good knowledge of local diseases.

3. Short overview of methods available

For anybody planning a survey we strongly recommend to thoroughly study Bibby *et al.* (1998) as it offers in depth advice on many relevant topics (http://biology.kenyon.edu/courses/biol229/fieldmanual%20birds.pdf). The best way to learn is to join a professional team for a few days, to get some first field experience and training. The Tropical Biology Organisation offers a wide range of training courses (http://www.tropicalbiology.org/).

There are methods that will give you an idea of the species present in an area (qualitative data) but not how many of them (quantitative data). When introducing the factor "time" or "space" into a simple species survey, you can very quickly improve the quality of your data (species discovery curve, encounter rates, MacKinnon index or timed species counts, see Table 1). Quantitative methods are, in general, more time consuming and require more

skill. There are point counts, line counts and even the mapping of territories. In quantitative methods often the distance between observer and bird has to be estimated (see below).

The key decisions are (from Gregory *et al.*, 2004):

- Do we want to estimate population size accurately or will an index meet our needs? In other words, are we interested in absolute or relative abundance (index)?
- 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?
- What are the recording units: individuals, singing males, breeding pairs, nests or territories?
- How will the subsequent data analysis be carried out?
- How will the results be reported and used?

You need to adapt your method to: a) the question you are asking, b) your skill, c) the time available, and d) the habitat. In open habitats, distance sampling may be easy and therefore the method of choice, but this will be hard in rainforest. Notice, though, that comparisons between habitats require that similar methods are being used.

When trying to survey a dense lowland rainforest you will quickly notice your limitations. It will be hard to see birds and to estimate distances to vocalizing birds. This makes standardised quantitative sampling difficult or even impossible (Bibby *et al.*, 2000). With the many logistic constraints during fieldwork in such environments, it is therefore important to consider how to best spend the time available. Rather than working hard to obtain perfect quantitative data from a single site, it may be better to use the time to get semi-quantitative data for several sites. This approximates random sampling of the metacommunity and, in addition, gives some information about variation across different habitats. Small samples mean that some rare species are unrecorded, and this truncation of the community (Preston, 1948) reduces the possibility to discriminate between different abundance models. However, even incomplete samples will suffice to identify dense (viable) populations of species of conservation concern, and will allow estimates of species richness.

3.1. Pilot Survey

Unless you have been there, you will not know what your survey area is really like. Plan a pilot survey of at least two weeks to a) get to know your species and the habitat, b) to try out methods and c) to practise them.

3.2. Qualitative methods, relative abundance

- **Simple species list.** All species are noted, regardless of time of day or season. The presence or absence of rare or threatened species (Birdlife International 2000, http://www.iucnredlist.org/) is the key for conservation and management of a site. The problem with simple species lists is that there is no control for observer effort. Chance observations will obviously increase with the time you spend in the field and some cryptic resident species don't show up immediately.

- **Species discovery curves**. Species discovery curves that record survey effort can be obtained by recording the time spent in the field for each observer. It is important that observers work at different areas or at different times. By also noting the date and time each species was discovered, some simple analysis becomes possible. Having separate lists for different areas may enable you to come up with further detail, *e.g.* if you split your area into degraded and natural forest, you can make a simple comparison

- **Encounter rates.** Encounter rates are calculated for each species by dividing the number of birds recorded by the number of hours spent searching, giving a figure of birds per hour for each species. When doing this separately for different habitats, more detailed information can be obtained. However, beware that encounter rates will vary with the structure of the vegetation. In dense vegetation encounter rates may be lower than in more open habitat. Encounter rates are not a substitute for true density estimates but they allow a comparison of relative abundance. Abundance categories can be scored.

  As an example (from Lowen *et al.*, 1996), for each species assume the number of individuals/100 field hours to be your value, then you could use the following abundance categories: rare (< 0.1), uncommon (0.1-2.0), frequent (2.1-10.0), common (10.1-40.0) or abundant (>40.0). If these categories do not work for your data you can of course adapt them accordingly. To avoid counting birds several times, it is important that different observers move to a starting point at some distance from base camp and plan their routes so that they are not overlapping. Birds that call loudly will be recorded more often than more quiet ones and the likelihood to record a species will depend on its state in the annual cycle.

- **MacKinnon lists** (MacKinnon & Phillips, 1993)**.** They are often used in "Rapid Assessments" (Herzog *et al.*, 2002). Make a list by recording each new species seen until you reach *e.g.* 20 species; then start again with a new list. Any one species will only be recorded once in your first list of 20, but may be recorded again in subsequent lists. Analysis of ten or more lists for a given area will give a good picture of its avifauna. Plotting the cumulative total number of species recorded against the number of lists made, this produces a species discovery curve whose steepness reflects species richness and indicates how many more species are likely to be found in an area (Fig. 2). If you are in a habitat that is species poor, you may decide to use a lower number than 20, maybe 15 or even 10 (Poulsen

et al., 1997). You need to try this out. Your speed of walking will greatly affect the kind of species you will encounter. Whilst walking slowly through the forest one will get a good number of scrub or canopy dwelling birds, but for some ground-dwelling birds such as pheasants, pittas or thrushes, moving quickly but silently through the forest will yield better results, as birds have less time to react to your approach. It is recommended to discover every bird that is active within 50 m from the transect line (Schieck, 1997) and thus it is not practically possible to achieve a constant walking speed.

If this method is used to describe community structure, there are some fundamental flaws, as some records will be single birds and others will be flocks with many individuals of the same species; fortunately this problem is not so serious in tropical forests where most species appear in pairs and family groups (2-4 individuals). The data can be much improved by writing down the number of individuals and use this raw data for the final analysis of community composition and species richness (Herzog *et al.*, 2002).

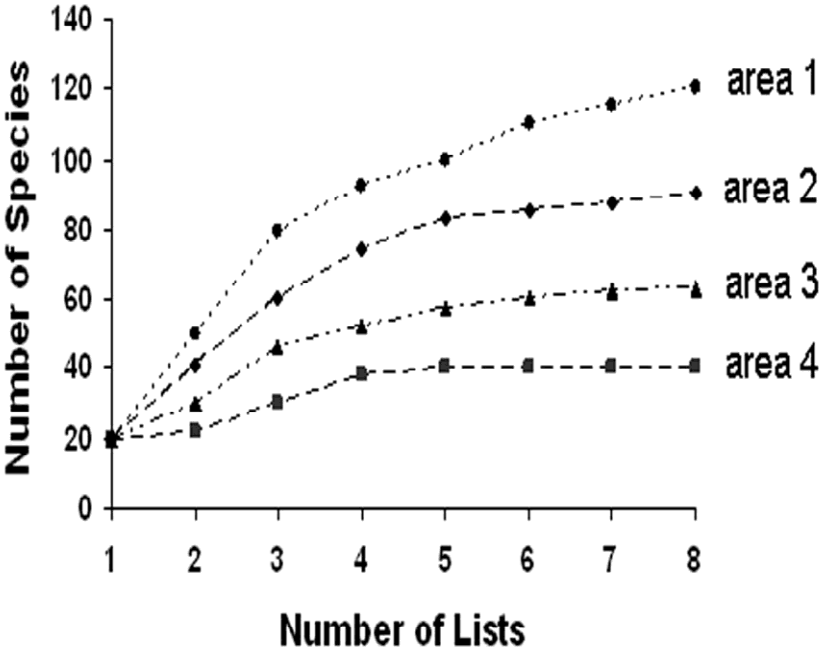

Fig. 2. Species curves derived from MacKinnon lists, simplified and altered from MacKinnon & Phillips (1993).

- **Timed species counts.** Timed species counts (TSCs) are especially useful for open habitats (Pomeroy & Tengecho, 1986), but as mentioned above this approach may not be useful off-trail in thick vegetation. Data for TSCs are recorded in six columns, corresponding to six 10-min intervals during an hour-long survey. The observer walks at a slow pace (about 1-2 km/h). For the first 10 min, every species seen or heard is noted down in the first column, regardless of the number of individuals. For the second 10 min-

period, any species not already recorded is noted in the second column and so on. For one observation hour each species is only noted once. A minimum of 15 surveys should be carried out for a site, corresponding to 15 observation hours. Pomeroy & Tengecho (1986) suggest to physically cover an area of 1 km² for each count. Depending on the habitat this may of course be modified.

3.3. Quantitative Methods

- **Positioning of sampling points.** There are various possibilities to place sampling points or beginnings of transects (Fig. 3), each one with advantages and disadvantages. For statistical reasons it is important to place all sampling points at random or at least to place your first point in a line of points at random. When counting along roads or existing paths (Fig. 3A) it is likely that not all species are discovered because the path does not run through all the different habitats. More importantly, the presence of the road or path may influence the species (or numbers) present. Placing the points randomly may give better coverage (Fig. 3B), however, choosing a completely random approach may leave some areas unsampled. A stratified random sample (Fig. 3C) using a grid (at least 500 m apart) is the best choice. In each resulting square one point is chosen at random. If points from two neighbouring squares are too close to each other (so that possibly the same birds are counted twice) then it may be useful to omit that point and choose a new one.

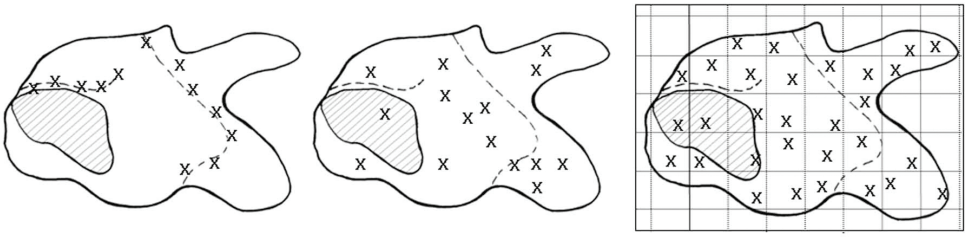

Fig. 3. Three possibilities for positioning point counts or beginnings of transects. a. along existing roads or paths; b. entirely random or c. stratified random (after Bibby *et al.*, 1998).

Method	What for?	Advantages	Disadvantages	Cost
Species list	Species present	Easy, no data analysis	No control of observer effort making comparison between areas or counts impossible	Cheap
Species discovery curve	Estimate of the total number of species present	Different sites and counts can be compared	Plotting of data requires computer analysis, but simple	
Encounter rate	Index of relative abundance for individuals of a species per unit time	Crude comparison of abundance between species within a site and within species between sites	Differences in species detectability not accounted for. To count all individuals of all species present can be a practical problem	
MacKinnon lists	Index of relative abundance based on the number of encounters with species per block of effort. Plotting a species discovery curve	Crude comparison of abundance between species within a site and within species between sites. Data collection is simple, allowing the observer freedom to roam. Relatively unaffected by observer skill and concentration	Differences in species detectability not accounted for, underestimation of flocking species	
Timed species-counts	Index of relative abundance based on the number of encounters with species per weighted block of time. Plotting a species discovery curve	Crude comparison of abundance between species within a site and within species between sites. Data collection is fairly simple, allowing the observer freedom to roam	Underestimation of flocking species	
Mist-netting	Secret understorey species, index of relative abundance when use of standardized net length and time	Detect understorey birds, get to know the birds	Proper training and special equipment required, time-consuming, mostly limited to understorey species, not cost-effective, capture conditions introduce strong bias	Expensive

Table 1. Bird survey and count methods (adapted from Bibby *et al.*, 1998).

There are some practical considerations for choosing a certain sampling pattern and distance between sampling units (Robinson *et al.*, 2000). In a mountainous rainforest with dense understorey using existing paths or roads may be the method of choice because: a) observers could get lost otherwise, b) finding random points would be very time consuming and c) to get to these points a lot of vegetation needs to be cut down which is not only time consuming but may also be quite destructive. Furthermore, some canopy species are impossible to detect when obscured by foliage, thus using a road may enable you to see them (MacKinnon & Phillips, 1993). When cutting transects during the breeding season there is a danger to destroy nests and you will open pristine forest to people and animals that may follow your tracks to exploit the forest. The disadvantage is obvious – you will not cover your study area evenly, thereby not encountering some bird species that you may have found using a random approach. In forest, two sampling points should be at least 150 to 200 m apart, in open habitat even further. Doing your survey in open farmland savannah it will be more easy to set up transects or to find random points.

- **Distance sampling** (from Bibby *et al.*, 1998)**.** Quantitative methods often require the estimation of the distance between the observer and the bird (Fig. 4). Errors can be minimized by practising beforehand, and it is important that different team members synchronize their estimates. Optical range finders can be useful when you see a bird (but not when you hear it). If you sample from points you can mark certain distances in advance. However, in dense vegetation neither of these methods will work. Estimation of the distance to a calling bird can be practised by placing a tape recorder at various distances. To make things easier one can use distance bands, *i.e.* within 5, 10, 15, 20, 30, 40, 60, 80, 100 m of the observer.

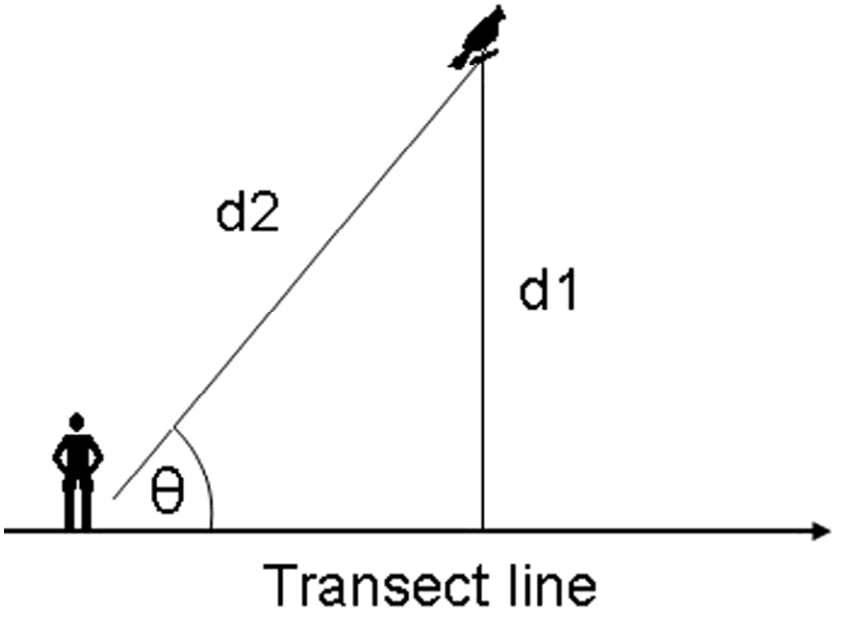

Fig. 4. d1 (perpendicular distance) can be calculated using d2 and the sighting angle θ (d1=d2*sin(θ)).

For the analysis of these data the software "Distance" can be used (Laake *et al.*, 1994). Please check Bibby *et al.* (1998) for further detail. Distance sampling can be used both in line counts and point counts (see Table 2 for advantages of each method).

- **Point Counts.** Points are usually laid out on a random transect, *i.e.* every 50 m. One walks from one point to the other, stops at the point for a predetermined amount of time (*i.e.* 5-10 min) to count all birds present (individuals and species) and then walks to the next point to repeat this and so forth. Distance between points and amount of time spent counting need to be adapted to the habitat. For more details see Bibby *et al.* (1998).
- **Line Counts.** You walk continuously along a certain line and record all bird contacts either side of the track. Walking speed should be constant, a goal very hard to achieve, especially in dense forest. Avoid counts along streams and rivers as your splashing about will flush birds along the river often long before you have even had a glimpse on them. For more details see Bibby *et al.* (1998).

Line Counts	Point Counts
+++ extensive, open and uniform habitats	+++ dense forest or scrub
+++ mobile, large or conspicuous species and those that easily flush	+++ cryptic, shy, skulking species
+++ low population densities or species poor	+++ high population densities or species rich
Cover the ground quickly and efficiently recording many birds	Time is lost whilst walking between points, but at point more time for observation and identification
Double counting minor as observer is on the move	Double counting potential problem
Birds are not so much attracted to observer	Curious birds may be attracted to the observer
+++ when easy access	+++ when difficult access
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 sampling point)

Table 2. Differences between point and line counts (modified from Gregory *et al.,* 2004), +++ = good for.

- Territory mapping and other methods. For more advanced methods like territory mapping we refer to the literature (i.e. Bibby *et al.*, 2000). A method especially designed for tropical environments is “Multi Time-Window Transect-Mapping” (see Jahn, in press).

3.4. Mist-netting

Mist-netting is useful to learn the birds in an area and to discover skulking understorey species but it is not time effective and the data obtained are not useful for a quantitative description of the local bird community. According to Remsen & Good (1996), the record of birds through mist-netting measures the activity of birds within 3-4 m above the ground rather than the community composition in the habitat. Mist-netting is very time-consuming, extremely weather dependant and should only be carried out by well-trained people. A good description of how to responsibly use mist nets to catch birds is given in Redfern & Clark (2001). Training is offered in many countries by institutions that organize the national bird ringing schemes.
Europe: http://www.euring.org/national_schemes/contact_schemes.htm

Out Europe:
http://www.euring.org/national_schemes/non_euring_schemes.htm.

Fig. 5. A mist-net of 6 m height using bamboo poles to catch birds in Madagascar. (Photo: F. Woog).

Also see Hofmann *et al.* (this manual) for a detailed description of the use of mist-nets for catching bats. For most passerines, 16 mm Nylon mesh is used, nets are 6 or 12 m long and have 4-5 shelves (giving them a height of about 2.5 m). Mistnets can be placed on ridges, in thickets or at forest edges, where birds often pass close to the ground. If nets are set in wrong places a lot of damage can be done to the birds (bird colonies, roosting places and nests have special rules). Generally, avoid putting the nets in the sun, where they are easily visible, and where captured birds can rapidly dehydrate. Taking birds out of the nets, and handling them, has to be done properly and enough people need to be present to monitor the nets that have been put up at close intervals (every hour, or more often under warm conditions or when it drizzles; but close the nets when it rains!). After extraction from the net birds are usually placed in double-sowed light cotton bags for further processing.

Birds can transmit diseases. To reduce this risk, make sure that bird bags stay dry and clean (turn them inside out and shake them after each capture, and wash them often). Make sure to thoroughly disinfect nets, especially when moving between countries or continents. It is unacceptable to use mist-nets first in an European country and then use them, unwashed, in a pristine tropical forest (the same is of course true for all your camping and outdoor equipment). Also observe principles of hygiene: wash your hands, preferably with disinfective soap. Do not take soiled bird bags into the tent you sleep in.

When you have the bird in your hand, make careful records (photos, weight, fat score, brood patch, moult stage, wing length and other measurements) (Svensson, 1992; Baker, 1993) and, depending on additional research questions, take a blood sample for DNA-analysis or feather for the analyses of stable isotopes (see paragraph on collecting birds). Bird ectoparasites are often poorly known and collecting them may yield new species (preserved in 2 ml vials in 70% alcohol, use very fine tweezers).

Canopy nets can increase the number of species you catch. They are not easy to handle. The best way to learn about these is to ask somebody that uses them.

To quantify birds, mist-netting is not really a good method and will only be useful to compare relative abundances of selected understorey species (see Table 1). If this is planned, the birds need to be marked to avoid double counting recaptures as new captures. The most useful are bird rings, but if these are not available tail feathers can be clipped systematically to identify birds which have already been caught. Clippings should be as small as possible. As birds moult their feathers at least annually, these markings remain temporary. Mark-recapture methods are useful for a wide variety of studies and purposes and can help to estimate abundance of selected species quite precisely or establish local movement pattern (for information about data analysis of capture-recapture data see http://warnercnr.colostate.edu/~gwhite/mark/mark.htm).

A note of caution – locals often ask for mist-nets (as a means of catching birds for food, plumage or for the pet-trade). Never leave mist-nets unattended. When storing them make sure they are as safe as your money and passport. On the other hand, some locals may be afraid of the nets and will not pass by. Make sure you talk to the village people that may encounter the nets, ask them for their permission and explain what you are doing. In some areas with large game, goats, cows or monkeys it may not be advisable to use mist-nets as these animals can easily destroy your expensive nets and may severely injure themselves during the process of entanglement.

3.5. Collecting birds

For a bird survey and monitoring scheme the collection of birds is usually not necessary, but sometimes new species remain undiscovered because birds were not collected. There are all sorts of opinions about collecting birds (see Remsen, 1995; Collar, 2000). Habitat loss, agricultural practice and world-wide climate warming are the real threats to birds, and in comparison the “sacrificing” of a few birds for science means nothing for most species except when they are very rare. But all collecting should be done legally and justified by some clear purpose, such as needs for documenting new-discovered populations and potential new taxa. In many developing countries there exists a sort of split moral – one for indigenous people, one for industrial enterprises and one for (foreign) biologists. Whereas indigenous people hunt birds for a living, and international companies destroy vast pristine natural areas (*i.e.* for mining, dam projects etc.) often, especially foreign, biologists are not being granted collection and export permits for birds. Even the collection of feathers and birds found

dead along roadsides may not be permitted and the export from the country of origin and import into your home country is not easy (*i.e.* concerning species listed under CITES or under health regulations).

However, it is always useful to prepare birds found dead or for a specific scientific question, and local partners can advise on what to do concerning permits. The easiest is usually a cooperation with a museum or university where specimens can be kept before permits have been worked out. It is fair enough that these institutions often want a share of the collected material for their own collections. For preparation techniques see Wagstaffe & Fidler (1968), Harrison & Cowle (1970), Piechocki (1998), Winker (2000) and Hofmann *et al.* (this volume). To see a video on bird preparation, paste mms://137.229.54.15/bts/birdprep.wmv into your browser.

In order to preserve bird skins under field conditions it is best to prepare the skin right away, and to quickly dry it properly (*i.e.* using a kerosene lamp for heating, when it rains). Remove the brain and as much tissue as possible. Salt can be used as a cheap and easily available preservative agent. Thymol can help to prevent bacterial growth and moulding, *i.e.* put some crystals into your air-tight storage containers, and if needed silica gel. If one has no time to make skins in the field or is working in climates with a high humidity, birds can be put into 70 % alcohol (1/3 animal, 2/3 alcohol). When preserving a complete animal without skinning it you need to inject alcohol with a syringe into the internal cavity of the animal and the brain (through the nose). Because the alcohol gets diluted by the fluids of the animal, it is advisable to change it after a few days. Alcohol can wash out certain colours, which is a disadvantage. For transport, the alcohol can be drained and specimens be put into double Ziplock bags. It is also useful to collect a tissue sample (*i.e.* muscle or liver) in the field. This is to be stored in pure 90-95% alcohol or EDTA-buffer. For good practices in tissue conservation: http://www.mip.berkeley.edu/mvz/collections/opportunistic_collection_of_tissue.pdf.

For many research purposes it may suffice to take a blood or feather sample and then releasing the bird (note however, that official permits may still be needed!). Blood samples are useful for genetic studies on various levels not only for speciation but also for population differences (Gaunt, 1999; Dawson, 2005). Stable isotopes found in feathers can give you an indication where a migratory bird grew a feather (Bearhop *et al.*, 2000; Wassenaar & Hobson, 2001). A small drop of blood is taken from the wing vein or in species with soft legs (like swans, geese and ducks) or young birds from the leg vein and placed in small vials containing buffer (200-300 µl blood in storage buffer containing 10% EDTA, 1% SDS, 0.5% NaF, 0.5% thymol and 100 mM Tris, pH 7.4 (Wink, 2006) or alternatively DMSO-buffer (SSDE) consisting of 20% DMSO, 0.25M EDTA pH 8.0 saturated with NaCl). These samples can be stored at ambient temperatures, but longer-term storage at -20°C (or lower) is recommended. Care should be taken, that syringes or buffer do not contain heparin, as this will inhibit the PCR reactions. The procedure should be learned from another ornithologist that has used the method before. Veterinarians often do not have experience extracting blood from birds.

4. Documentation

4.1. Labels

When collecting samples make sure they are properly labelled, a collection number is not enough. A proper label should at minimum contain date (write out the month *i.e.* 11 Dec 2009, not 11.12.2009 as this may be read 11/12/2009 which could be interpreted as 12 Nov 2009, always write the complete year as 09 could mean 1909, 1809 or 2009), exact location including country, species, collector, collection number. Never trust that you will remember to do this later.

http://olla.berkeley.edu/ornisnet/?q=node/5 gives detailed tools and guidelines for geo-referencing. If possible, note longitude and latitude (*i.e.* read from your GPS or map).

4.2. Proper documentation

Field notes should always be detailed, with date, time of day, weather observation (that may influence your survey results, *e.g.* heavy rainfall) and, if possible, number of individuals encountered, and, if discernible, their sex and age. If you see a group of peacocks, for example, note number of males, females, immatures and juveniles. If you encounter birds that you do not know, try to take a photograph, take a sound recording or immediately make a small sketch of what it looked like. If you don't have enough time in the field or you can't write things down whilst you are observing birds, MP3 players can serve as dictaphone. However, always think about the time it will take to transcribe the information from your recordings. One can only guess how many recordings have been made in ornithological research without ever having been analyzed. Modern digital cameras offer a unique possibility for improving field identification. For instance, when a mixed feeding party of birds passes through the vegetation, take as many photographs as you can, and by zooming in afterwards you can identify birds that you did not immediately have time to identify (or later blow up the images on your computer screen). In this way you may sometimes be able to reliably identify every bird in the party.

It is often useful to enter data in forms prepared in advance, as this may facilitate later data entry into your database. The forms should mirror the structure of the database you intend to use. Enter your data as quickly as possible.

When working in wet climates, working with normal paper is a challenge as at the end of your expedition you may end up with a heap of 'papier mâché'. Fortunately there are solutions, *i.e.* "Write in the Rain" notebooks and copying paper (Darling Corporation, http://www.riteintherain.com). These items are not cheap but are well worth the investment. If you use pencil you can drop them in a river and will still be able to read what you have written.

4.3. Database and data analysis

This should be in place before you start the survey, as they are very much linked. Good guidance can be found in Bibby *et al.* (1998, 2000) and Voříšek *et al.* (2008). The statistical approaches for estimating bird abundance from bird counts and taking detectability into account (*i.e.* Kéry, 2008) are well beyond the scope of this chapter. Whenever in doubt, consult a professional ornithologist or statistician before you start fieldwork.

5. Case studies

5.1. Case study 1 from a tropical cloud forest (The Chelemhá, Guatemala)

Combined line-point counts are often used in the tropics. Almost any method is biased to sample the entire bird community (Terborgh *et al.*, 1990; Poulsen, 1994; Remsen, 1994; Remsen & Good, 1996). Therefore, a combination of several methods is sometimes essential to get a complete species list and estimate relative abundance. In Guatemala, it proved essential to combine point counts with transects, since a large part of the bird community would have been missed if using only one method (Renner, 2003). To circumvent losing some essential species, point counts were combined with transects counts: point count sites were established each 25 m along transects. At each 25 m mark, all birds sighted or heard within a nominal distance of 100 m were recorded for five minutes. After the five minutes, the distance to the next point count locality was slowly followed in the shortest possible way covering the distance in about the same time. Transects were 150 m apart totalling 3,300 m. The local cloud forests, the major habitat in Chelemhá, fortunately do not have a very dense understorey, hence only minor efforts were needed to establish the point-transects. The bordering secondary vegetation, however, was very dense, and establishing trails to count birds was impossible (the dense secondary vegetation was a wall consisting of 2 cm thick stems of plants only 20 cm apart at the time of monitoring). The Guatemalan authorities and the land owner were interested in the results of the bird survey but because the area was a non-use forest reserve, all cutting of vegetation was banned. The establishment of point sites and transects was therefore a trade-off between scientific desire (random) and conservation (using existing trails as much as possible and minimizing the impact on the area). To diminish effects of detectability (Hines, 2006; MacKenzie *et al.*, 2002, 2003), all point counts/transects were visited three times a year. The data were used to establish relative abundance of all bird species and to determine presence of species (Magurran, 1988; Rosenzweig, 1995). Results showed that while more species were present in secondary forest, all species of conservation concern were only present in natural forest (Renner, 2003, 2005).

5.2. Case study 2 from cloud forests in the mountains of the tropical Andes

Because of the steepness of the terrain, impenetrable vegetation and lack of trails it was difficult to standardise the sampling and to obtain reliable bird density data (Bibby *et al.*, 2000). Rather than trying to get absolute quantitative data from one or two study plots, the study aimed to obtain semi-quantitative data for comparing the community composition of samples over several sites and habitats.

Avian community data were obtained during transect walks. All visual and acoustical records of birds within 50 m (Schieck, 1997) were noted while walking very slowly and quietly through the terrain and as "randomly" (with frequent changes in direction) as topography and vegetation permitted (Fjeldså, 1999; Herzog *et al.*, 2002). Species accumulation curves level out rapidly (much more so than with point sampling!) and high correlations between relative species abundance data obtained this way and by point-counts in the same area suggests that observations made during "random" walks are not significantly more biased than those obtained by more standardised point counts (Fjeldså, 1999). The main advantages of this "random-walk" approach are the broad sampling of the study area, time-efficiency (all bird observations being used, unlike in point counts; see below) and relative observer independence (Sauer *et al.*, 1994) compared to timed-species-count methods.

At each study site, data were collected within 1-1½ km² and over 2-4 days. Variation in the extent of study plots is not of a magnitude that requires adjustment for area differences. Study sites of this size will represent habitat mosaics (of different associations of forest trees, tree-fall gaps, landslides and glades) but the study plot was large enough to find most birds on the move, singly or in mixed feeding parties. Walking speed varied (as the vegetation is sometimes nearly impenetrable) but was usually ca. 500 m per hour. On average, 0.4 birds were identified per minute. This rate could be raised by walking faster, but the data will then be more biased towards easily detectable species.

The observed species richness is constrained by sample size, and for comparison it is necessary to estimate species richness by extrapolation. Such estimators reach their own asymptote much sooner than sample-based rarefaction curves, they level off and approximate empirical asymptotes well.

The simplest approach (which can be applied currently, during field work) is to use the Chao 1 formula (Colwell & Coddington, 1994):
$S1 = Sobs + a2/2b$ (*Sobs* being the number of species recorded, *a* being the number of singletons = number of species recorded only once, *b* the number of doubletons).

A more sophisticated estimation can be done later using Colwell's software EstimateS (http://viceroy.eeb.uconn.edu/estimates). Ranked abundance curves can be constructed from the total list of observed birds along the route, assuming that the attentive observer is able to detect all birds (at least those which are active) within 50 m from a transect. In most cases, about 500 bird

identifications will provide a good sample for describing the bird community within a study plot.

John MacKinnon and Karen Phillips on birdwatching in forest:*…" Watching birds in tall forests is not easy. You may walk for an hour without seeing anything then suddenly be surrounded by so many twittering birds that you cannot focus on any. A bird may be so high up and so obscured by foliage that you cannot get a good view. In the rain, water on your lenses may blur your vision… leeches are an accepted irritation"…*

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WINK, M. 2006. Use of DNA markers to study bird migration. *Journal of Ornithology* 147: 234-44.

WINKER, K. 2000. Obtaining, preserving, and preparing birds. *Journal of Field Ornithology* 71: 250-297.

7.2. Useful Internet links

Birdlife International.
http://www.birdlife.org/regional/index.html

Sound archives.
http://www.bl.uk/soundarchive
http://www.birds.cornell.edu
http://www.xeno-canto.org/africa/index_static.html
http://www.xenocanto.org/index_static.html
http://www.xeno-canto.org/asia/index_static.html
http://www.xenocanto.org/australasia/index_static.html

Bird collections.
http://www.museum.lsu.edu/~Remsen/AVECOLlections.html
http://www.scricciolo.com/European_Bird_Collections_C%20S%20Roselaar.pdf
http://olla.berkeley.edu/ornisnet/ (American Bird collections, ORNIS)

Bird species.
http://avibase.bsc-eoc.org/avibase.jsp

Online access to bird collection data.
http://www.gbif.org, http://neotropical.birds.cornell.edu/portal/home
http://www.zmuc.dk/VerWeb/Tanzanian_Vertebrates/TanzVert.index.html

Bird monitoring.
http://monitoringmatters.org

South-African Bird Atlas.
http://sabap2.adu.org.za/index.php

Guidelines to the use of wild birds in research.

http://www.nmnh.si.edu/BIRDNET/GuideToUse/Guidelines_2d_edition.pdf

European Bird census council.
http://www.ebcc.info/index.php?ID=365

Waterproof paper.
http://www.riteintherain.com (Darling Corporation)

Tissue collection.
http://www.mip.berkeley.edu/mvz/collections/opportunistic_collection_of_tissue.pdf

Bird preparation.
http://www.uaf.edu/museum/bird/personnel/KWinker/Winker%20specimen%20preparation%20J%20Field%20Ornithol%202000.pdf
http://www.springerlink.com/content/100125/

Data analysis of capture-recapture data.
http://warnercnr.colostate.edu/~gwhite/mark/mark.htm

7.3. Books

Voříšek *et al.*, 2008. A Best Practice Guide for Wild Bird Monitoring Schemes. http://www.ebcc.info/index.php?ID=365

Sutherland *et al.*, 2004. Ecological Census Techniques, see section on “Gratis Book Scheme”.
http://assets.cambridge.org/97805218/44628/frontmatter/9780521844628_frontmatter.