# Birds: incomplete counts—five-minute bird counts

## Version 1.0

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## Contents







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# Synopsis

The term 'point count' is used to describe any count conducted by an observer standing at one place from which all birds (of the target species) seen and/or heard are recorded during a fixed period of time (Bibby et al. 2000; Gibbons & Gregory 2006). At its simplest, repeated counts at several places will provide a list of species present within an area, but the method, with some assumptions (especially about detection probability and good sampling design), can be extended to provide estimates of relative abundance (this specification) or estimates of absolute density if coupled with measurements of distance (Gibbons & Gregory 2006; and see 'Birds: estimates of absolute density and abundance—distance sampling'—docdm-534993). Point counts are the most widely used technique for counting birds (Thompson et al. 1998). They are particularly common for counting songbirds in Europe, the United States (Bibby et al. 2000) and New Zealand.

Simply counting all individuals, groups, species and related objects of interest at a point (the subject of this specification) can provide much useful information on the relative abundance of a population, provided appropriate sampling design and analysis principles are followed and the assumptions inherent to measures of relative abundance can be met (see the section on 'Indices of relative abundance' in 'A guideline to monitoring populations'—docdm-870579). Although these counts are sometimes mistakenly viewed as a 'census' or 'population count', they are really indices because not all birds present are detected and an unknown number remain hidden in surrounding vegetation (see Dawson & Bull 1975).

Surveys based on such indices are attractive as they are less expensive and require less effort than more formal estimation methods (Williams et al. 2002) and a range of simple indices can be calculated (e.g. mean number of birds per count, proportion of counts containing a given species). However, indices generally yield weaker inferences because of uncertain and/or untested relationships between indices and actual abundance (e.g. untested assumptions of homogeneity of detection probability across time and space) and (often) poor sampling design (non-random sample point distribution, lack of replicates, etc.) (Thompson et al. 1998; Williams et al. 2002; Gibbons & Gregory 2006). We are aware of only one New Zealand study that has demonstrated a relationship between an index (in this case five-minute bird counts) and the actual density of grey warblers and robins (Gill 1980). This relationship is yet to be verified in other forested habitats or for other species (e.g. Cassey et al. 2007). Therefore, although indices can provide much important information about the relative abundance of a population and, indeed, may be the only viable survey option, their use should be carefully considered and based on the relative importance of cost versus inferential strength (Williams et al. 2002).

Birds, or objects of interest such as nests and burrows, can be recorded by observers either within hearing distance (i.e. unlimited distance) or within a specified radius. If habitat variables are recorded at the same time, inferences can also be drawn about habitat selection and habitat preferences for species or communities (Bibby et al. 2000). Point counts are often preferred over line transects (see 'Birds: incomplete counts—line transect counts'—docdm-580459) as they are generally easier to incorporate within probability-based sampling designs, particularly where survey areas cover a diversity of habitats (Bibby et al. 2000); better suited to densely vegetated habitats and difficult terrain; and more able to cope with birds that are relatively inconspicuous and cryptic (i.e. there is a higher chance of detecting such birds when standing still).

Point counts are less useful where a target species (such as blackbird) flees from an observer or (in the case of robins) is strongly attracted to them. The bias induced by observer disturbance can be severe and is one of the main reasons line transects are preferred over point counts when counting easily disturbed birds (particularly those inhabiting open habitats) that flee from observers. Although there are no universal rules for point counts, careful consideration needs to be given to sampling consistency, sample size, selection and location of points, duration of counts, number of visits to each point (as precision depends on effort) and reduction of observer bias (e.g. through training and attention to observer skill levels).

Point counts have been used to count birds in New Zealand for over 30 years. In 1975 Dawson & Bull published 'Counting birds in New Zealand forests'. The method described in this paper was adopted immediately and has been used ever since. Although researchers have tried other point-count methods, the five-minute bird count remains the most widely used means of determining the status and trend of bird populations within forested habitats.

The method simply involves standing at a station, usually in forest (although the method has been used in other environments), and counting the number and species of birds seen or heard within a 5-minute period.

The five-minute bird count method is attractive as it is less time consuming and demanding than more formal estimation methods. It is possible to calculate simple indices such as average number of birds observed per 5-minute count. More sophisticated analysis is also possible, allowing comparisons between sites and over time.

Researchers have experimented with point counts of 2-, 3- and 10-minute duration. Some attempts have also been made to record birds in two or more distance classes in order to estimate absolute density (e.g. Moffat & Minot 1994) and this approach is attracting renewed interest. However, the basic method described by Dawson & Bull (1975) provides much useful information on the relative abundance of forest bird populations, provided the assumptions and limitations of five-minute bird counts are understood (e.g. there is a relationship between numbers counted and numbers present), the study is well designed, sufficient counts are made, trained observers skilled in bird identification are used, and the data are analysed appropriately.

We recommend researchers use the original method described in Dawson & Bull (1975). This will ensure new studies build on the large body of five-minute bird count data that already exists. It will also allow researchers the possibility of comparing their studies with the hundreds of historical studies for which data still exist (see the '5MBC database'[1]). The five-minute bird count method is described below with minor modifications (and potential future adjustments) flagged to reflect changes that have taken place in practice since the paper was originally written as well as recent

[1] http://www.doc.govt.nz/conservation/native-animals/birds/five-minute-bird-counts/history-of-the-5mbc-project/

additions, such as the need to take daylight saving time into account. Any more-significant changes will compromise comparison with historical datasets.

## Assumptions

- Sample points are distributed over the area of interest according to a probability-based sampling design (simple random, systematic, stratified, etc.). This is particularly important when the distribution of a target species is thought to be patchy or clumped.
- A constant fraction of the individuals present in an area is counted over the timescale and locations of interest, i.e. detection probabilities need to remain consistent across time and space. This is essential if the index is to be used for comparative purposes, such as comparing the number of birds in two areas at the same time or the same area at two different times.
- The relationship between the index and the true abundance or density is linear, i.e. the total number of birds counted is consistently and linearly correlated with the actual density of the population.
- If the index is being used to estimate a parameter (e.g. absolute v. relative abundance), then the index will have been calibrated so an unbiased estimate can be calculated. (Such use occurs rarely.)
- Birds are not knowingly double-counted in any one count at a count station.
- The population remains demographically closed throughout the survey period.

## Advantages

- A robust and well established technique, with a nationally accepted standard method.
- Extremely flexible, efficient and cheap to run, requiring relatively little time and technical equipment.
- May be the only count method that can be used in some situations.
- May be sufficient to describe basic biological patterns.
- May be useful for comparative inference if the assumption about equal detection rates (i.e. consistent detection probabilities) is met.
- Easier, less resource demanding and more flexible than many other bird-counting methods. Large numbers of counts can be conducted, potentially reducing impact of high variance and increasing statistical power.
- Able to be conducted in complex terrain and densely vegetated habitats (e.g. forest and scrub) where movement requires concentration, and a walking transect, for example, would not be practical.
- Multiple species can be counted at the same time.
- Particularly suitable for populations of common forest species, especially those occurring within species-rich habitats.
- Suitable and efficient for use in combination with inventory methods such as slow walks and call playbacks for uncommon species.

## Disadvantages

- Five-minute bird counts, like all index methods, do not detect all individuals of a particular species that are present. The relationship between the counts recorded and the true density of each species is not known and may not be linear; thus, a key assumption may be unwittingly violated.
- Observers differ in their skill levels and abilities and this may affect a study if this is not taken into account when designing the study or if an observer is changed part way through the study.
- Observers need considerable time and practice to become good at identifying birds by their calls.
- Bird conspicuousness differs between species and varies seasonally, with a variety of factors including weather conditions and time of day. The standard methods described below are designed to minimise the effect of these factors during a count. It should also be noted that some factors cannot be controlled for (e.g. density) and consideration should be given to that variability when designing a study.
- If a particular species occurs in high numbers (e.g. flocks of silvereyes), they can exceed an observer's ability to differentiate and accurately count individuals.
- Likely to be a poor method for monitoring rare birds (low efficiency and high variability). Other methods such as call playback (method pending) and targeted search methods will be more appropriate.
- Detection of small changes in bird numbers can be problematic and may require a level of effort beyond the resources available.
- Not as efficient as line transect sampling (i.e. more time required to sample the same area of habitat).
- Assumptions of relative abundance methodologies might be stated, but they are rarely examined.

## Suitability for inventory

Depending on study objectives, five-minute bird counts repeated in a standardised manner over many years can provide information on changes in status and trend in the relative abundance of birds provided:

- The first three assumptions (at least) can be met (see 'Assumptions' section above).
- The implications of not meeting these assumptions (i.e. the amount and direction of bias) on the conclusions of a monitoring programme are understood.

The power of this method is greatest when point counts are repeated annually over relatively long time frames (> 10 years), when sample sizes (number of points) are high (particularly if detection of small changes is required), and when variation in observers, times of day and conditions are minimised. Unfortunately, controlling for observer effects and habitat change is more demanding under long-term monitoring regimes than short-term ones. Some short-term monitoring is confounded by seasonal change or disruptions to bird behaviour by the treatment or management action (e.g. mortality of non-target species in a poorly managed 1080 operation), but other short-term monitoring will be possible given care, good design (experimental controls) and appropriate sampling effort relative to the precision required.

## Suitability for monitoring

The five-minute bird count method is an effective means of assessing the presence of relatively common species, provided they sample a representative portion of the area of interest. Rarer bird species can be detected if five-minute bird counts are combined with other survey methods (e.g. call playback, line transects between each point, etc.). The potential for bias introduced by observer variability, species' behaviour and habitat type needs to be carefully considered.

An inventory of forest bird populations was successfully conducted over a large area of southern South Westland using a combination of five-minute bird counts and line transects between points (O'Donnell & Dilks 1986).

## Skills

Those responsible for survey design must be familiar with the design issues pertinent to the use of relative indices of abundance derived from five-minute bird counts (and point counts generally) on bird populations (Buckland et al. 2001; Williams et al. 2002). These include the critical assumptions and their impact on sampling design, definition of the sampling area and sampling units, the number of points required to detect changes of specific magnitude and their layout within the sampling area. An understanding of each target species' spatial distribution (e.g. clumped or territorial) and potential for stratification is also extremely useful and can markedly improve the precision of abundance estimates. A pilot study is strongly recommended (Thompson et al. 1998). It will provide useful information on the precision resulting from a given level of effort and the likely encounter rate (i.e. power). This will also provide an estimate of the effort required to reach predetermined levels of precision.

For field observers:

- Training is now compulsory for all DOC staff that conduct five-minute bird counts. Experienced staff (those that have been doing this work for many years) still need to undertake training to demonstrate the required competency. Please refer to DOC's 'Natural heritage training programme' for more information.[2]
- Field observers must be very familiar with the target species (identification, behaviours, etc.). If observers do not meet a minimum standard, they should be excluded from the survey.
- Field observers must be consistent in how they follow the designated sampling design and rules of the sampling method.
- Field observers must be able to identify possible violations of assumptions and the consequences for index estimates.

Those responsible for analysis must understand the:

[2] http://www.doc.govt.nz/getting-involved/get-trained/

- Limitations of the data collected
- Importance of calculating realistic variance estimates
- Most appropriate analyses and reporting format for the results
- Potential impact of bias on calculated estimates

# Resources

Five-minute bird counts are relatively simple to conduct in the field. Equipment is straightforward and minimal. The requirements are:

- Sufficient suitably trained observers (especially in bird identification by sight and sound)
- Maps of sample point distribution
- Marked points/stations (using GPS locations and/or tagged sites)
- Binoculars
- Data sheets and a clipboard (or data logger), notebook, pencils
- Plastic thermometer (optional)
- A watch suitable for recording 5-minute periods
- A means of moving between plots (pair of legs or vehicles of various descriptions)
- Appropriate safety and first-aid procedures.

Effort and care are required when designing the sampling programme to ensure the critical assumptions underlying indices of relative abundance are met and sufficient data are collected.

Sufficient resources should also be set aside for the cost of data entry, analysis and subsequent reporting of results. Computer access will be required.

# Minimum attributes

Consistent measurement and recording of these attributes is critical for the implementation of the method. Other attributes may be optional depending on your objective. For more information refer to 'Full details of technique and best practice'.

DOC staff must complete a 'Standard inventory and monitoring project plan' (docdm-146272).

Minimum attributes to record:

- Study information: Record where, when and why the study was undertaken, the location of the study area (polygon) and the sample area, the precise methods used, where the data are stored and access arrangements.
- Station information: Record location of stations (eastings and northings), point names and strata (if required)—and include a good quality map. Note the sampling effort (i.e. number of times any given point is visited).
- Observation information: Record the observer's name and contact details, date of survey, time over which survey conducted (start/finish times) and weather conditions (temperature, wind,

noise, sun, precipitation type, precipitation value, cloud—see Dawson & Bull 1975 for standardised categories).

- Count information: Record number of each species seen or heard from the point. An example of the minimum data requirements and layout is provided in 'Case study A'.
- Covariates such as habitat variables associated with survey points, altitude and stratum (treatment/non-treatment) should also be recorded, but this information is optional.

Use the '5MBC standard field sheet' to record data.[3]

## Data storage

A blank template of a '5MBC spreadsheet for data entry' is available.[4] This spreadsheet allows storage of data in a format that is consistent with other five-minute bird count studies in New Zealand and suitable for analysis. The template includes questions about the study so the relevant metadata (information about the study) can be recorded and stored with the data.

Collate, consolidate and store survey information securely, also as soon as possible, and preferably immediately on return from the field. The key steps here are data entry, storage and maintenance for later analysis, followed by copying and data backup for security. If data storage is designed well at the outset, it will make analysis and interpretation much easier. Before storing data, check for missing information and errors, and ensure metadata are recorded.

Metadata about five-minute bird count studies can be emailed to 5MBC@doc.govt.nz for inclusion in the 'List of 5MBC studies'.[5] Send the information recorded in the first and second tabs of the '5MBC spreadsheet for data entry', i.e. the study metadata and the standard conditions. This information will be recorded and made publicly available so that interested people can find information about what five-minute bird count studies have taken place.

Storage tools can be either manual or electronic systems (or both, preferably). They will usually be summary sheets, other physical filing systems, or electronic spreadsheets and databases. Use appropriate file formats such as .xls, .txt, .dbf or specific analysis software formats. Copy and/or backup all data, whether electronic, data sheets, metadata or site access descriptions, preferably offline if the primary storage location is part of a networked system. Store the copy at a separate location for security purposes.

## Analysis, interpretation and reporting

Seek statistical advice from a biometrician or suitably experienced person prior to undertaking any analysis.

[3] http://www.doc.govt.nz/conservation/native-animals/birds/five-minute-bird-counts/resources/
[4] http://www.doc.govt.nz/upload/documents/conservation/native-animals/birds/5mbc-blank-spreadsheet.xls
[5] http://www.doc.govt.nz/conservation/native-animals/birds/five-minute-bird-counts/find-5mbc-studies/

Enter data into a copy of the '5MBC spreadsheet for data entry'. Save it into your file system and back it up.

Enter and look at your data immediately after you collect it. Many errors in data collection can be picked up in this way. Explore your data by graphing it.

The questions you wanted to answer when planning the study will help you work out what to do next. Distribution maps of presence/absence can be drawn. Averages can also be calculated. For example, the average number of species seen or heard within a 5-minute count, the average number of robins (or any other species) seen within a 5-minute period, and the frequency with which species are noted in counts within a given survey period. Appropriate variance measures (e.g. standard deviations, standard errors and 95% confidence intervals) must also be calculated. The most appropriate means of calculating 95% confidence intervals will depend on the distribution of the data (see Fowler et al. 1998). For example, a correction factor derived from the *t* distribution (mean ± ($t$ × S.E.)) will usually be appropriate—as long as the real sample size is > 10, then the distribution of means is likely to be normal). These averages (and their confidence intervals) can be graphed for comparison against the average number for other observation periods, such as other seasons or years. Comparisons should not be made between different species, i.e. robin averages can be compared with other robin averages, but not with tomtit averages, as the factors influencing detectability of each species are likely to vary widely.

Statistical modelling procedures can be used to distinguish between sources of variation, specifically variation in counts resulting from differing environmental or sampling conditions and the variation in the actual number of birds observed. For count data or for data with a Poisson distribution (quite likely for five-minute bird counts), this will often require a log or square root transformation respectively.

At its simplest, what may suffice is analysis of the differences between two means (e.g. when comparing the status of bird populations before and after a pest control operation) derived from the same sample units using, for example, paired *t*-tests (unpaired *t*-tests for different sample units) or simple linear models. If a different set of sample points is used on multiple sample occasions (and sample units are independent through time), an analysis of variance (ANOVA) may be more appropriate. When monitoring population trends through time using the same sample units (spatially and temporally correlated data often with a non-normal distribution), mixed models will likely provide the most suitable approach. Detailed analysis requires specialist skills; researchers should seek advice on the best ways to analyse trends.

Studies should be written up in report format as this will allow others to read and build on what you have found. Too many five-minute bird counts have not been written up and the information obtained has been lost.

A database is being developed by DOC to allow centralised, standardised, and reliable storage of nationwide five-minute bird count data. The database currently contains over 80 000 counts, mostly from older studies (1970s and 1980s). You can see a list of the datasets that are in the '5MBC database' online.[6] In future we hope to be able to enter the data from more recent studies or you may be able to enter data directly. In the meantime, store your own data where you can find it and keep it safe.

Many community groups participate in Formak, a forest assessment kit developed by P.A. Handford and Associates Ltd. (Handford 2000). The package includes advice and assistance on designing and conducting five-minute bird counts and other monitoring. The Formak website[7] allows members (particularly community groups) to enter, analyse, store and share data but we recommend data entry and analysis follow this specification.

# Case study A

**Case study A: assessing the accuracy of five-minute bird counts on robin populations**

## Synopsis

Five-minute bird counts were tested on two populations of robins of known size in the Eglinton Valley in Fiordland from 2005 to 2009. Two 100 ha areas of red and silver beech forest were monitored at Knobs Flat and Walker Creek. Sampling was done in August (pre-breeding) and March (post-breeding). In general, indices derived from five-minute bird counts were able to follow trends in both robin populations with reasonable accuracy. Significant failures did however occur. The August five-minute bird counts at Knobs Flat did not pick up a known decline in numbers of robins in 2007 and 2008 or an increase in 2009. Likewise, the March five-minute bird counts did not pick up a known increase in the numbers of robins at Knobs Flat. These failures could be attributed to behavioural and seasonal changes, especially when robin populations were much reduced in size. Interpretation of population trends derived from five-minute bird counts should therefore proceed with some caution. The collection of complementary demographic data to help explain observed trends is highly recommended.

## Objectives

- To assess the accuracy and precision of indices of abundance derived from five-minute bird counts on two populations of robins of known size over a 5-year period.

## Sampling design and methods

The study was conducted in the Eglinton Valley in Fiordland. The Eglinton is a wide, U-shaped, open valley with the lower slopes dominated by red and silver beech (*Nothofagus fusca* and *N. menziesii*) forest. There are few understorey plants except for a ground cover of mosses (Sedgeley

[6] http://www.doc.govt.nz/upload/documents/conservation/native-animals/birds/5mbc-database-current-datasets.xls
[7] http://www.formak.co.nz/

& O'Donnell 1999). Two 100 ha grids were established in 2003 at Walker Creek and Knobs Flat with 50 m spacing (Fig. 1).

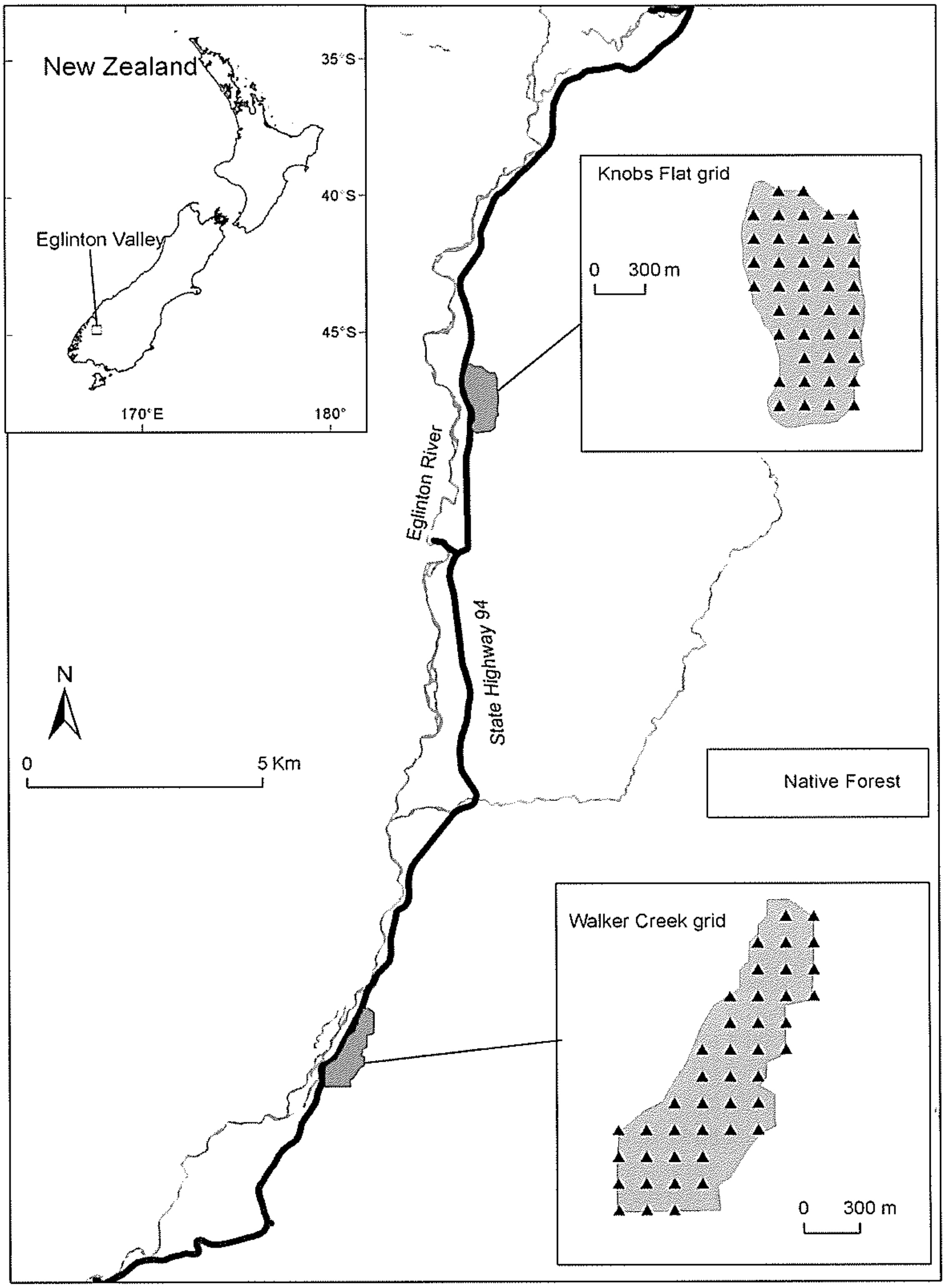


Figure 1. Location of the two study sites: Knobs Flat and Walker Creek.

Five-minute bird counts were conducted at sample points spaced systematically (with a random first start) at 150 m intervals (Fig. 2). Robins (along with all other forest bird species) were identified and recorded regardless of distance from the observer. Counts were conducted in August (pre-breeding) and March (post-breeding) over a 10-day period. Points were visited four times each season apart from the first year when they were only visited twice. Points were repeatedly visited as the overall study area was not large enough to allow extra independent sampling units. This means that repeat visits to each point are potentially temporally correlated. The mean per point and then the overall mean count for robins for each site was calculated along with appropriate confidence intervals.

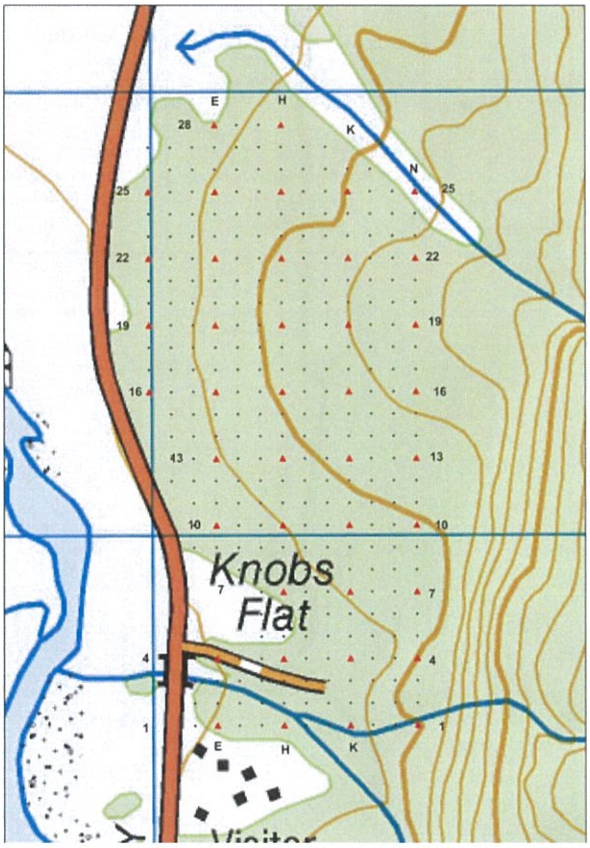


Figure 2. Knobs Flat grid points.

The five-minute bird count data was then modelled using a repeated measures approach which allows for the auto correlation of data that is collected each year at the same points and can incorporate weather and site covariates. The variables that were considered important were wind, temperature, noise precipitation, sun and cloud.

All robins inhabiting the two 100 ha study areas were banded over the breeding season and individuals were monitored for productivity and breeding success. All sightings of birds were mapped and from this a territory map was drawn for the area (Fig. 3). The actual number of robins on the grid was assessed at the time bird counts were conducted. The ratio of males to females was calculated for the August counts as it was considered likely to affect the call counts during the breeding season. The March ratio is considered less important as it is the end of the breeding season and there are many juveniles present (difficult to sex).

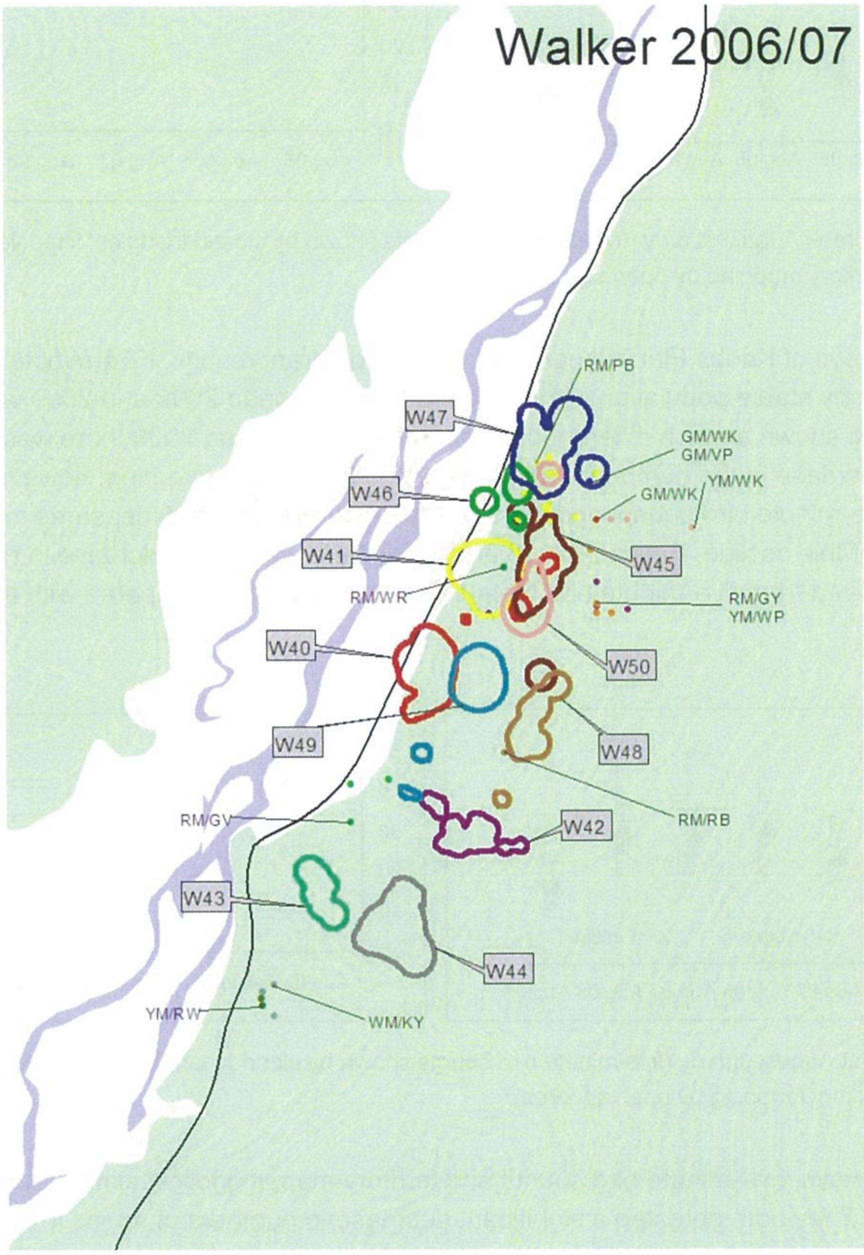


Figure 3. Sample territory map for the Walker Creek birds.

## Results

August territory mapping and five-minute bird counts at Walker Creek show a slightly declining robin population with marked declines in 2006 and 2008. The fitted values show a very similar pattern and trend with larger confidence intervals (i.e. lower precision) giving a more accurate picture of the variability of the data when the impact of measured covariates is included (Fig. 4).

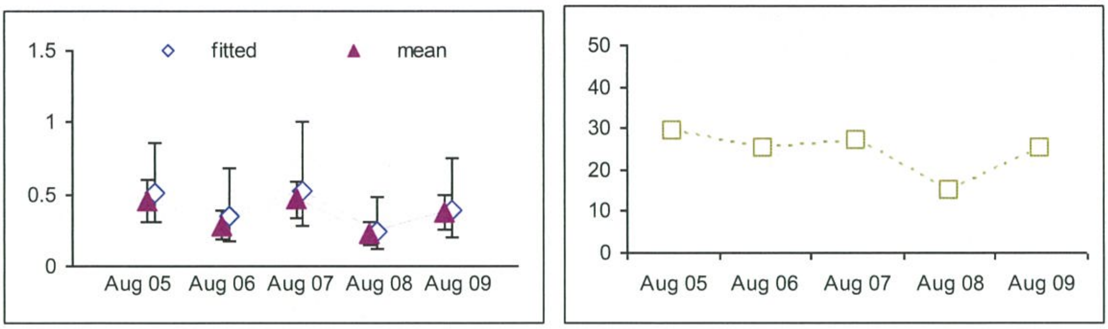


Figure 4. Walker Creek August survey (five-minute bird counts shown by closed triangles, fitted values by open diamonds, and territory mapping by open squares).

In contrast, surveys of Knobs Flat in August show quite different results. Five-minute bird counts indicate a relatively stable population with a sharp decline between 2008 and 2009 whereas the territory mapping shows a much different pattern. Between 2006 and 2008 there was a considerable decrease in the number of robins detected by territory mapping; however, the figures derived from five-minute bird counts and the fitted values from repeated measures modelling give little indication of this decline. Between 2008 and 2009 there was a real increase in robin numbers but the data derived from five-minute bird counts detected a decline compared with the previous 2 years (Fig. 5).

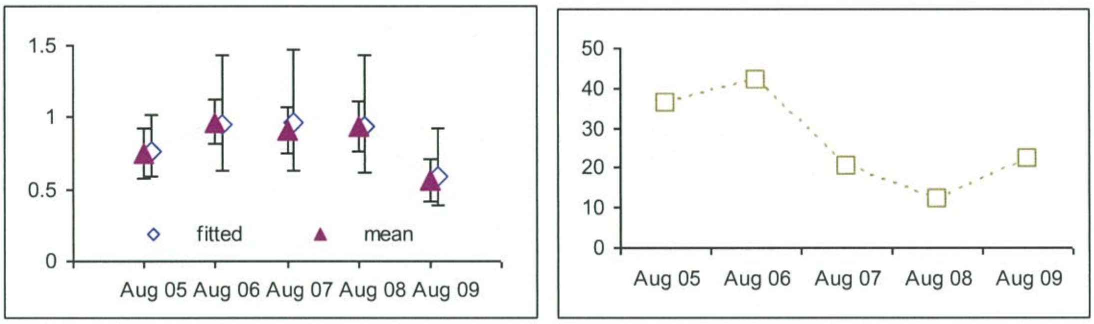


Figure 5. Knobs Flat August survey (five-minute bird counts shown by closed triangles, fitted values by open diamonds, and territory mapping by open squares).

In the March surveys, five-minute bird counts and territory mapping follow similar trends for Walker and Knobs Flat. They both detected a significant decrease in numbers of robins in 2008 followed by an increase in 2009 (Figs 6 and 7). The main anomaly is that territory mapping detected a 35% increase in 2006 at Knobs Flat whereas the five-minute bird count gave no indication of this (Fig. 6). The trends for mean and fitted values are generally similar apart from 2007 at Knobs Flat where the modelled mean is greater than the simple mean. The fitted values for the five-minute bird count showed much higher variability (large confidence intervals) reflecting the variability in this survey that is not reflected in the means.

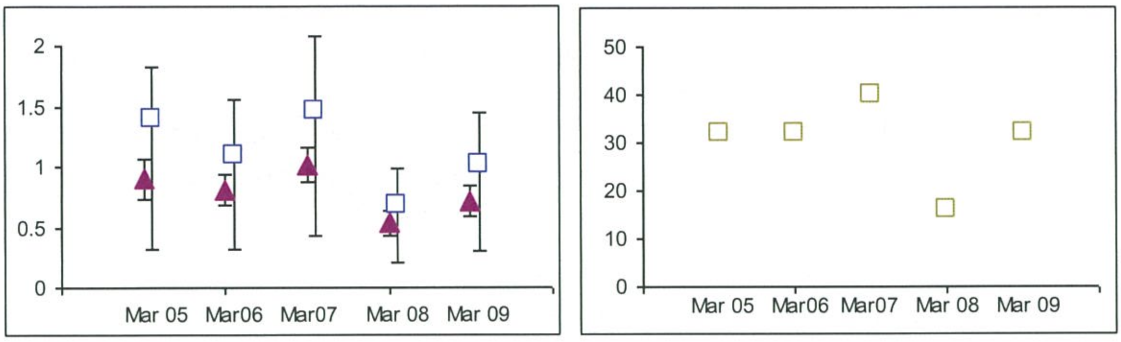


Figure 6. Walker Creek March survey (five-minute bird counts shown by triangles, fitted values shown by diamonds, and territory mapping by squares).

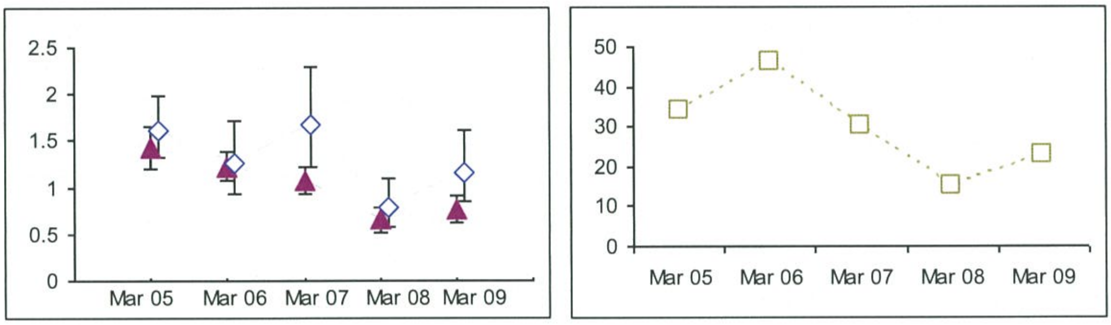


Figure 7. Knobs Flat March survey (five-minute bird counts shown by triangles, fitted values shown by diamonds, and territory mapping by squares).

## Limitations and points to consider

Five-minute bird counts are commonly used to detect changes in relative abundance in response to management actions. Although territory mapping showed significant declines in Knobs Flat robin numbers in 2007 and 2008, five-minute bird counts failed to detect these decreases. The ratio of males to females in these years was greater than 2:1 (Table 1) and as single males tend to call more frequently as they look for a mate to breed with, it is likely that the five-minute bird counts were only detecting a behavioural change (increased calling by males) rather than a real increase in numbers. As females are more vulnerable to predation when nesting (O'Donnell 1996), male dominated populations will occur when predation rates are high and populations are reduced to low levels.

Table 1. Ratio of robin males to females in Walker Creek and Knobs Flat, Eglinton Valley.

| Year | Walker Creek | Knobs Flat |
|---|---|---|
| Aug-05 | 1.67 | 1.64 |
| Aug-06 | 1.50 | 1.76 |
| Aug-07 | 1.80 | 2.33 |
| Aug-08 | 1.60 | 3.00 |
| Aug-09 | 1.38 | 2.40 |

Interestingly, the male to female ratio at Knobs Flat in August 2009 was also above 2:1 and estimates derived from five-minute bird counts suggested a population decline. However the number of birds counted using territory mapping actually increased. Robins were not calling at the beginning of August 2009 at Knobs Flat when the surveys were being completed as the weather had been cold and the birds delayed nesting until September, hence the low count for the five-minute bird count.

These results demonstrate the challenges of using indices such as five-minute bird counts over relatively short time spans without knowledge of demographic structure and timing of the breeding season, and the difficulty in interpreting results of indices at different sites. If five-minute bird counts had been used as the only indicator of population health at Knobs Flat, the major drop in numbers would have been missed as would the recovery of the population in 2009.

Similar results for territory mapping and five-minute bird counts were obtained for March counts with the exception of Knobs Flat in 2006 where territory mapping showed an increase in numbers which five-minute bird counts failed to detect. The numbers of robins in March are likely to be higher than the August counts due to the presence of juveniles but they may not be recorded in the five-minute bird counts as they are less vocal and territorial. Many of these juveniles will ultimately emigrate or perish in the following winter. Thus, if counts are done at this time of year the increased variation must be taken into account. The declines in the population in March 2008 at Knobs Flat and Walker Creek were detected by both count methods as was the recovery in March 2009.

### Timing of bird counts

Overall it appears that March five-minute bird counts provided a good measure of the observed trend in actual numbers of robins. However, survival of robins over the following winter and inter-annual variations in productivity are not taken into account, increasing the noise surrounding the derived trends. On the other hand, if counts of robins are done in August then there is potential for behavioural changes (such as a sex-biased population where single males call more frequently and the variations in the timing of the breeding season) to affect five-minute bird counts. Thus, the limitations and inherent biases of indices of abundance derived from five-minute bird counts must be understood and results interpreted with caution. This is particularly important where monitoring is carried out over relatively short time spans and where the demographic parameters for the species being monitored are poorly understood.

### Costs

Five-minute bird counts at both Knobs Flat and Walker Creek were usually completed within a 10-day period in both August and March using a minimum of two or three skilled observers. Count data could also be collected and indices of abundance calculated for a wide range of other species at the same time. Territory mapping, although much more accurate, is considerably more expensive requiring a sustained colour banding programme, a substantial commitment in staff time and a concentration of resources on a single species.

## References for case study A

Dawson, D.G.; Bull, P.C. 1975: Counting Birds in New Zealand Forests. *Notornis 22*(2): 101–109.

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# Full details of technique and best practice

## Planning a study

### Choosing the locations of the points

Care should be taken to ensure the counting points (commonly called stations) are representative of the study site. Researchers should avoid putting points along tracks or roads, as such points will seldom be representative of the wider habitat. For example, tracks tend to skirt scrubby vegetation or swamps and go up ridges to avoid difficult travel in valleys and gorges. Use a random, probability-based sampling design (random sampling, systematic sampling, stratified sampling, etc.) to maximise inference and provide accurate variance estimates.

For ongoing monitoring, we recommend that the points are permanently marked and the same points are revisited each survey.

### How many counts are enough?

For statistical purposes, the number of count points (or lines of count points) should be as high as possible. From a practical point of view, one observer in one day can count around 20 stations (with a maximum of 40), depending on the terrain and distance between stations (and lines) (Spurr & Powlesland 2000).

Generally, for a given number of counts, it is better to have more points visited less frequently than fewer points visited more frequently (i.e. assuming that greater precision will result if variation between lines contributes substantially to the total variance). A pilot study, followed by an appropriate power analysis, is recommended to help determine the design trade-offs and number of counts and design trade-offs that will be required. These are usually contingent upon local factors and chosen analysis methods. Similarly, if stations are located on transects lines, it is better to have more rather than fewer lines; for example, having 10 lines of 4 stations is better than 4 lines of 10 stations (Spurr & Powlesland 2000).

When planning a study, researchers should be aware that small changes are much more difficult to detect than large changes. For species with an average of one bird per count, more than 50 counts will be required in each time period to detect large changes (> 50%) in forest bird populations. More than 200 counts will be needed to detect a 25% change, and more than 1000 to detect a 10% change (D. Dawson, pers. comm.; and see Dawson 1981).

Table 2. The minimum number of five-minute bird counts that need to be undertaken to detect a difference of 2.5%, 5%, 10%, 25% and 50% between two samples (after D. Dawson, pers. comm.).

| | Difference you need to detect | | | | | |
|---|---|---|---|---|---|---|
| Average number of birds recorded per count | | 2.5% | 5% | 10% | 25% | 50% |
| | 10 | 2000 | 500 | > 10 | 20 | - |
| | 1 | 20 000 | 5000 | > 1000 | 200 | 50 |
| | 0.1 | - | 50 000 | > 10 000 | 2000 | 500 |
| | 0.01 | - | - | - | 20 000 | 5000 |
| | 0.001 | - | - | - | - | 50 000 |

### Training observers

As discussed in Dawson & Bull (1975), observers will differ in their ability to see, hear and identify birds, and in their judgement as to the number of birds present. Good training will help reduce some of this variability. Researchers should be aware that observers' abilities may increase or decrease with time, e.g. if high frequency hearing deteriorates with age.

## Conducting the count

A single observer (with suitable training on the sampling method itself and bird identification) visits a single point or a series of points on a line that have been distributed throughout the sample area according to some probability-based design. The points should be separated by at least 200 m, particularly if they are distributed on lines or within a grid. Ideally they should be 200 m inside the edge of the forest or habitat of interest.

On arrival at each station, the observer needs to stand quietly and immediately begin recording the presence of all individuals detected for exactly 5 minutes. The number of every species of bird observed should be recorded. Generally, many more birds are heard than seen, and observations are usually divided into whether a bird is first detected by hearing it or seeing it. Birds seen and heard should add to give the total number of birds detected. Any birds that are not identified should be recorded as 'Unknown' in the appropriate category. No bird should knowingly be counted twice within a single count.

If an individual bird was included in a count from a previous station it should be counted again. This is because each count is treated as a separate entity (i.e. independent). No birds should be assumed to be present without some visual or auditory clue to their presence (e.g. a flock of silvereyes is noted as the number heard calling rather than the number the observer guesses such a frequency of calling would represent). If a bird calls in one place and later one of the same species calls some distance away, they are taken as two individuals unless there is evidence that the first bird moved to the second place.

If more than one person is present during a count at a station, for example during training, only the experienced person's counts should be used for that observation.

Observations should be recorded on '5MBC standard field sheets', either at the time or transcribed at the end of each day onto the forms from field notebooks. We recommend that each form includes the necessary instructions for both doing the count and recording auxiliary information. Having this information on every data sheet ensures consistency of data collection between observers and ensures the data can be meaningfully interpreted in years to come. In future, researchers will also be able to repeat the study using exactly the same methods.

## Recording information about each point

Wherever possible, record the location of points using a GPS with seven digit northings and eastings and the appropriate map projection (e.g. NZ map grid). It is also important to record the altitude at each station. It is optional to record vegetation measures (important when investigating habitat relationships). To date, no standard method of recording vegetation associated with five-minute bird count stations has been followed consistently (and we have not specified one in this Toolbox). Refer instead to the Toolbox sections on standardised vegetation monitoring methods (method pending).

## Reducing variability

As with other counting methods that rely on passive detection cues (distance sampling, double observer, etc.) there is a large amount of variation in the number of birds observed from one count to the next. This variation can obscure the real changes in bird numbers that the study is designed to detect. The number of birds counted is influenced not only by the number of birds present, but also (perhaps most importantly) by bird behaviour (calling v. quiet), along with other factors such as species of bird, habitat structure, topography, weather, time of day, season, and ability of observers (Spurr & Powlesland 2000).

Make every effort to reduce the variability between counts by paying attention to the factors described below. Collect information on the factors that may influence variability, including weather, time of day and observers. As discussed earlier, statistical modelling procedures may potentially be used during the analysis to distinguish sources of variation in counts.

## Standardising conditions

### Time of day/year

Counts should only take place on fine, calm days between 1.5 hours after sunrise and 1.5 hours before sunset to avoid changes in conspicuousness associated with sunrise and sunset. In mid-winter a suitable counting time is between 0930 and 1530 (NZ Standard Time) and in mid-summer it is between 0730 and 1930 (NZ Summer Time). Consider which season best suits your study objectives. Try to choose survey times that do not coincide with the flowering times of key plant species. This will avoid the problem of large variations in numbers as birds flock to a food source.

Counts should not be made during strong winds or heavy rain because these conditions affect both the behaviour of birds and the ability of observers to detect them.

### Which birds to include

Dawson & Bull (1975) recommended a cut-off distance of 200 m when counting, with birds beyond this distance not recorded. However, most observers find it very difficult to judge the distance to individual birds, particularly birds that are only heard (a significant issue for distance sampling as well; see Alldredge et al. 2007). Most researchers, therefore, have used unbounded counts. We recommend unbounded counts, as these have become the norm. This leaves the problem of what to do about birds that the observer hears calling from a very long way away. We recommend these birds are not included in the count, but a rule on this point needs to be established at the start of each study.

Dawson & Bull (1975) state that birds flying overhead and judged not to belong to the vegetation type should be recorded, but the record may be circled to indicate this. We believe this recommendation was because Dawson & Bull were designing counts to record birds associated with particular forest types. Counts are conducted for numerous reasons and it seems sensible to record all birds without making judgement calls about what vegetation types they belong in. We therefore recommend that birds flying overhead are recorded, but not circled.

# References and further reading

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# Appendix A

The following Department of Conservation documents are referred to in this method:

| | |
|---|---|
| docdm-534993 | Birds: estimates of absolute density and abundance—distance sampling |
| docdm-580459 | Birds: incomplete counts—line transect counts |
| docdm-870579 | A guideline to monitoring populations |
| docdm-146272 | Standard inventory and monitoring project plan |