Proceedings of a workshop on distance sampling,Wellington, May 2000

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Summary

Distance sampling offers a set of techniques that are applicable to a variety of conservation research and monitoring situations, and can provide results of greater robustness with changes in conditions and observers than existing techniques. Distance techniques are already starting to be applied in New Zealand, both within and outside of DOC. The workshop recommends strongly that DOC develop capacity and expertise in distance sampling and associated techniques.

ACTION POINTS

1. Requiring limited resources, using existing staff with management support:

- development of a fact sheet about distance techniques,
- development of field sheets for distance sampling data,
- implementation of DISTANCE software on stand-alone computers where possible,
- development of a key to monitoring and analysis techniques for DOC staff,
- establishment of a group with distance sampling expertise able to advise staff estimating populations,
- development of a page on the DOC Intranet, including the material developed above, and with a link to Rosemary Barraclough's recent report.

2. Requiring significant new resources:

- installation of DISTANCE software on the DOC computer network,
- improving staff expertise by bringing to New Zealand an expert to run training workshops for DOC.

1. Introduction

This workshop came about as a result of an "Expression of new research need" from the Waikato Conservancy in 1998, entitled "Is distance sampling suitable for monitoring changes in bird populations?" Science & Research Unit funded

a project of the same name (Investigation 3245) in 1999/2000 with the objectives of:

- preparing a discussion document on the technique of distance sampling for presentation and discussion at a workshop,
- holding a workshop for persons with expertise and/or interest in the distance sampling technique to discuss the contents of the discussion document, and then to decide how to proceed if it seemed suitable as a potential standard of practice (SOP) for the Department, and
- preparing a report detailing the outcomes of the workshop

Part 1 of the project, the discussion document, was prepared by Rosemary Barraclough and published as Barraclough (2000).

The workshop, part 2, was held at the Conservation Sciences Centre, Wellington, in May 2000. This document is the last part of the project and details the outcomes of the workshop and the subsequent actions to date.

2. Attendees

Rosemary Barraclough, Auckland University, Auckland
Mark Bellingham, Massey University, Palmerston North
Pim de Monchy, Waikato Conservancy, DOC, Hamilton
Sam Ferreira, Auckland Conservancy, Auckland
Terry Greene, Science & Research Unit,Auckland
Tim Holmes, Wanganui Conservancy, Wanganui
Barry Lawrence, Malaghan Road, R.D. 1, Queenstown
Alison Perfect, Waikato Conservancy, DOC, Hamilton
Ralph Powlesland, Science & Research Unit, Wellington
Hugh Robertson, Science & Research Unit, Wellington
Eric Spurr, Landcare Research, Lincoln
Ian Westbrooke, Science & Research Unit, Christchurch

3. Presentations

3.1 ROSEMARY BARRACLOUGH

The term distance sampling refers to a suite of methods that will estimate the absolute density of biological populations, based on accurate distance measurements of all objects near a line or point. Detailed information regarding the theory behind distance sampling, instructions for field design and examples of applications are presented in the book "Distance Sampling: Estimating

abundance of biological populations"(Buckland et al. 1993). Analysis of distance data is via a version of the DISTANCE programme, the latest being number 3.5 (Thomas et al. 1998). This book and programme are both available free from the St Andrews distance website at:

http://www.ruwpa.st-and.ac.uk/distance /

http://www.ruwpa.st-and.ac.uk/distancebook/order.htm i

Distance methods are designed to produce reliable estimates of abundance regardless of varying conspicuousness, provided that certain assumptions are met. This is because distance sampling methods estimate a probability of detection. The three key assumptions on which distance sampling is based are:

- objects on the line or point are detected with certainty,
- objects are detected at their initial location,
- measurements are exact.

However, the secondary assumption of a 'shape criterion' was also described during the meeting. The shape criterion relates to the shape of the detection function (the probability of detecting a subject as a function of distance from the line or point) near zero. To fulfil this shape criterion, detection of objects is certain near the line or point and either stays certain or decreases only slightly for some distance away from the line or point. This initially slow drop-off in the probability of detecting a subject with increasing distance from the line or point, creates a'shoulder' in delectability that is desirable in analysis. If detectability falls sharply just off the line or point, estimation tends to be poor, even if the true model for the data is known (Buckland et al. 1993).

Another secondary assumption that was highlighted was related to randomness in the sampling design. It is necessary that the lines or points be positioned randomly within the study area.

However, all the assumptions may be relaxed under certain circumstances.

The advantages of distance sampling include:

- estimation of the absolute density for a population, even when not every individual is detected per unit area,
- the same estimation of density for a population can be calculated from data collected by two different observers, even if one of these observers misses a lot of subjects away from the line or point,
- only a relatively small percentage of individuals need to be detected within the sample area, possibly as few as 10-30%,
- the size of the sample area can be unknown,

- it is very efficient for sampling large areas, as the same minimum number of detections are required for a very large area as for a small area.

Some of the problems associated with the technique were also presented. These include:

- detecting all birds on or close to the line or point, especially when the species is small in dense vegetation, or the species is cryptic,
- subjects moving in response to the presence or movement of the observer (towards or away) before being detected by the observer,
- estimating distance in forest to unseen individuals detected by sound,
- detecting all individuals when the species is at high density,
- individuals being counted more than once.

Solutions were generally suggested for each of the issues raised (Barraclough 2000). However, a violation of the key assumption of subjects moving in response to the observer before being detected is presently frequently unresolvable when the subject is a bird and the habitat is forest.

Examples of both problematic and good data were also presented at the meeting. Problematic examples illustrated the problems associated with lack of training (poor search technique), inadequate field technique (not marking the visible interval boundaries for point-transects), and violation of the assumptions. These examples emphasised the absolute importance of observers being well trained, and the role of a pilot survey in identifying problems in training, field design, and unexpected species- or habitat-related issues that would prevent a successful and useful survey. It was also emphasised that the application of distance sampling methods would have to be considered somewhat on a species by species basis, to ensure that the assumptions are reasonably met while dealing with the idiosyncrasies of the one or more target species.

Generally the minimum number of sightings needed is 60-80, but fewer distance measurements are sometimes acceptable if the measurements are accurate. The situations appropriate for the use of point counts versus line counts were discussed, and recommendations were made regarding the form of the point-transect (as per Barraclough 2000).

3.2 TERRY GREENE

Terry's involvement in distance sampling began in 1994 with trying to assess kaka abundance in the Waihaha block of Pureora Forest Park by having people recording kaka sightings and calls from hill and ridge tops. Since then he has been developing the distance sampling technique to monitor kaka in the Waipapa block. Although initial surveys appear promising, there are a number of significant problems still to be dealt with. These include: diurnal conspicu-

ousness, distance estimation in tall forest, and difficulties in detecting birds at or near to point count site.

Terry and his team plan to carry out distance sampling of kaka in spring 2000 in the Waipapa block using 131 point counts (300 m apart) on a randomly placed systematic grid using the following methods:

- major habitat types within Waipapa will be sampled in proportion to the area they cover,
- the counts will be carried out from one hour after sunrise through to 11:00 to maximise the diurnal conspicuousness of kaka,
- the counts will be carried out in good weather only,
- count points will be approached quietly and any departing birds noted,
- observers will spend 2-3 minutes at each point before starting a count,
- the counts will be of 10 minutes duration, divided into 2-minute intervals,
- birds will be recorded as to whether they are seen or heard,
- distances will be determined to the nearest metre using a range finder, up to 100 m, and
- following the count a search for cryptic birds will be made up to 20 m from the count site.

3.3 MARK BELLINGHAM

Mark related his experience of distance sampling for his PhD study entitled "Biodiversity planning for native forest remnants in the lowlands of northern New Zealand". His study was carried out in the Rodney district, and he used the composition of bird communities in native forest patches as an indication of faunal biodiversity. Mark used distance sampling along line transects to determine absolute densities. Birds were counted in summer 1998/99 in 11 patches varying from 2 to 1000 ha in size.All species encountered were surveyed, and the fieldwork was carried out in summer to coincide with the breeding season and to minimise count variability from seasonal bird movements and post-breeding flocking by silvereyes. Each patch was surveyed until 100+ observations were obtained for the commoner species (fantail, grey warbler, silvereye, tui, chaffinch, blackbird, song thrush, myna and eastern rosella). From this study it appears that the minimum patch sizes for native birds breeding in native forest are:

- 3-5 ha for fantail and grey warbler,
- >5 ha for silvereye,

- >1000 ha for North Island tomtit.

A comparison was made of species present at forest edges (50-100 m wide) versus those in the forest interior. There was a higher overall density of birds at the edges, with 67% of birds being exotic at the edges versus 67% of birds being native in the interior. Also, there was a significant decline in exotic bird species presence and absolute densities with patch size. This appears to confirm our preconceptions that exotic birds are mainly edge species in native forests. In contrast most native species increased in density with patch size, but there was no change for tui.

Issues identified from the use of distance sampling from this research were:

- distance sampling was an efficient use of sampling effort;
- distance sampling can be used for a number of bird species at one time;
- the reliability of distance sampling can be improved by reducing the width of bird recorded distance on each side of the transect line (+20 m). This increases the proportion of birds seen versus birds heard and therefore reliable distance estimates;
- by using a restricted sampling area, specific sites e.g. forest edges can be sampled;
- reliable absolute density estimates could be compared between species and forest patches; and
- in small forest patches of less than 3 ha, distance sampling is effectively territory mapping.

3.4 SAM FERREIRA

Sam described bird survey data that he has looked at from northern Te Urewera (independent 5-minute counts at 210 counting stations), Boundary Stream (clustered 5-minute counts - 10 counting stations on one transect), historic surveys on Hauturu (Little Barrier) Island (fixed width transects - 20 x 500 m) and reported his own application of distance sampling on Hauturu Island. The approach was to evaluate each project's objectives and whether these were attained using the methods described for each.

The objective for the Northern Te Urewera Restoration project was to measure changes and relate these to restoration activities. Five-minute count data from Te Urewera Forest Park were analysed to determine species richness, evenness, diversity and total density. Five-minute bird counts were carried out in winter at 210 sites, the sites being situated on spurs and ridges. Richness (number of species/count), density (number of individuals/count) and diversity ($H=E p_i \ln p_i$, where p_i = density of species i/total density) have increased from 1997 to 1998 and 1999, but evenness ($E = H/\ln s$ where s is the total number of species) was not. The methods used resulted in numerous zeros, but significant trends could be illustrated.

The bird surveys for Boundary Stream Mainland Island had a similar objective to that of the Northern Te Urewera Project, i.e. to record changes and relate these to restoration activities. The dataset was more robust, with historical data augmented by 3 transects each containing a cluster of 10 counting stations where the standard 5-minute bird count was applied. The sampling unit was each transect. The historic data are restricted by having only one repetition, but overall transects were producing results that were making ecological sense. One problem was the potential double counting of the same individual. Nonetheless, Sam was able to evaluate the objective with the aid of historic data.

Historic surveys of birds on Hauturu Island have been conducted since 1975 with the objective to record changes in the bird community following the removal of cats. It was expected that bird densities would increase. A fixed width transect (20 x 500 m) survey method was used with about 15 minutes spent on each from which individuals per hectare could be estimated. The data were representative of forest bird communities, but having only one transect in each habitat type did not allow estimates of variation in community variables within that habitat type. One significant problem was not detecting birds while walking the transect. Nonetheless, the data showed a remarkable stability in the bird community over the past 25 years, and therefore that such data were useful in evaluating the objective.

The objective of work started on Hauturu in 2000 is initially to delineate seasonal habitat-specific fluctuations in forest bird communities, and secondly to monitor long-term changes in community composition. Three transects have been marked out in each of five habitats, each transect consisting of 11 point count sites 50 m apart, with birds counted up to 25 m from each point. The counts along each transect are carried out four times each session, and the transect is the sample unit. The study design allows estimates of variation between transects to be determined, as well as between different time periods on the same transect. Also, in due course, the data will enable an evaluation of seasonal habitat-specific variation in species richness and density. Sam uses volunteers to carry out the counts, and puts each person through an intensive training and testing programme before they are allowed to contribute data to the study. Preliminary analyses indicate that evenness and diversity are not affected by season.

Sam's key point was that the aims of the survey should always dictate the survey method that is adopted. In the four case studies evaluated, the methods used did not affect the ability to evaluate objectives, because the objectives were related to identifying trends.

3.5 TIM HOLMES

During Tim's work in Namibia, he investigated using distance sampling to monitor springbok numbers. Because of rough terrain, vehicle use was restricted to roads, with springbok being noted up to 300 m on either side of the transect. Because of the biases involved in this survey (transects not located randomly), distance sampling had to be abandoned.

3.6 HUGH ROBERTSON

Hugh has had considerable experience at carrying out and analysing 5-minute counts. In addition, in 1978, while assisting Dave Dawson of Ecology Division (DSIR), he was involved in indexing bird numbers in agricultural and horticultural land using a technique similar to distance sampling. The technique involved making point counts at marked sites with two distances being flagged (50 m and 200 m), individual birds being recorded as occurring in the inner or outer band. The counts were of 5 minutes duration, but with the results recorded separately for the first 2 minutes from the following 3 minutes. In addition, birds were also counted along a transect while moving between point count sites. Hugh noted that there was large observer variation in the percentage of birds detected in the two bands.

Hugh is considering using distance sampling to determine kiwi density. This would involve using a systematic layout of microphones, with leads running back to a computer to determine distance to calling birds using the different times that calls reach microphones to determine calling position. At present, territory mapping involving marking and resighting of marked individuals or radio-telemetry is required to determine absolute density of kiwi populations.

3.7 ERIC SPURR

Eric is involved with John Innes in a study of the impacts of magpies on the abundance of other bird species in farmland using distance sampling. Paired treatment and non-treatment study areas are situated in five different regional council areas. Each study site has 36 randomly located point count sites, the sites being at least 200 m apart. Two observers are involved in making the 5-minute counts in each regional council area, each count site being counted before and after magpie control. Each bird is determined to the nearest metre from the observer up to a maximum of 100 m, with distances of 50 and 100 m being flagged. The main problem encountered to date is the impact of the observer on birds - magpies invariably fly away once the observer appears.

3.8 PIM DE MONCHY

The Waikato outcome monitoring team has carried out distance sampling while moving along Foliar Browse Index transects (Payton et al. 1999). Some distance sampling assumptions are violated as a result, chiefly the randomness of transects, but also the absolute detection at g(0). Kereru have been sampled for three consecutive summers in 22 forests of the Waikato. The method of detection was recorded (seen, heard, flying or display diving). Approximately 400-500 measurements or "hits" have been obtained if data from all forests in all years are combined. Analysis may require that data are clumped according to forest management type (no possum control, 3-5 year aerial 1080 possum poisoning, or intensive bait station control of possums and rodents) in order to obtain 60-80 measurements per sample. Preliminary analysis of 1997/98 data suggests that kereru are present at a density of 0.49 birds per

hectare (±60%), when averaged across all forests in the Conservancy. Further analysis of existing data will be undertaken prior to October 2000 if time permits.

3.9 BARRY LAWRENCE

Barry described his methods and experience of using distance sampling to monitor mohua (yellowheads) in the Caples and Dart Valleys. The objective of the study is to be able to detect a 40% or greater reduction in mohua numbers following beech masting, and a 30% or greater increase in numbers outside this period. The birds are monitored along 1 km long transects up valleys during October. Any groups heard within 100 m of the line are located and their perpendicular distance to the line determined. Violations of the distance sampling technique are that not all mohua are certain to be detected on the zero line, and the transects are not randomly located.

4. General discussion

There was a discussion about whether to abandon 5-minute counts (index of abundance) in favour of distance sampling counts (absolute density estimate), particularly for common species. While it was agreed that people should be encouraged to use the distance sampling technique when appropriate, it was recognised that some workers would probably continue to carry out 5-minute counts in order to compare with historical data. It was also noted that a distance 'snap-shot' count could be incorporated into existing 5-minute count regimes at the conclusion of the standard count. It was recommended that DOC staff be encouraged to use the distance sampling technique because it could cope with changes in observers, seasonal variation in species conspicuousness, and habitat condition with time, and was useful for monitoring animals other than birds.

Given that the group was advocating the use of the distance sampling technique when appropriate, it recognised the following:

- the need for the Department to improve its expertise in the methods of the technique, sample design, and the computer storage and analyses of the data,
- the urgent need for staff access to the programme DISTANCE (available free from the Internet) on the DOC computer network for analysis of distance sampling data, and
- a national archiving system for distance sampling data.

A field data sheet for distance sampling data needs to be developed and provided to DOC staff.

It was considered that the most efficient means of improving staff expertise in distance sampling was to bring an expert to New Zealand to run one or more training workshops. Steve Buckland was mentioned as a suitable expert. He has co-authored a book on the subject (Buckland et al. 1993).

With regard to a national archiving system for distance sampling information, it was recognised that ideally the data should be recorded according to a standard format. A format is available through the DISTANCE analysis package for the entry of data. In addition, the format for archiving should include contextual information, such as date, location, observer, and habitats. Archived data should be saved in the DME system with a standard name structure, and as a paper copy too.

The group commented on the need for a key to guide the selection from a variety of monitoring and analysis techniques for DOC staff so that they could determine which technique should be used to monitor changes in abundance of animals or objects under particular circumstances. Such a key is available in Thompson et al. (1998).

It was considered that the key needed re-formatting as a flow chart. Also, it was determined that there is a need for a group of DOC staff to provide advice to staff developing projects that involve determining relative or absolute density of a population. The advice (peer review) should be available at all stages of the process, from developing objectives, designing the experimental methods, through to which statistical test to use for the analyses.

Rosemary observed that a number of behavioural characteristics could make some species poor subjects for survey through distance sampling methods. The characteristics included either positive or negative reaction to the presence of an observer before the observer has the opportunity to detect the individual. Very rare species will also frequently prove poor subjects, due to the number of detections generally required for analysis. In such cases, another survey technique should be considered. At this point it was also suggested that a list of either known populations on which distance sampling could be further field trialed or where distance techniques could be calibrated alongside other absolute survey methods would be useful. This is because, although the techniques have been proven to work, it would be beneficial to take every opportunity to explore their appropriate application in a variety of New Zealand situations, and on New Zealand species. This has been done for tuatara and saddlebacks (Cassey 1997, Cassey & Ussher 1999).

The group identified as a priority the need to promote the use of distance sampling by DOC staff. We considered that one way of achieving this would be to develop a fact sheet about the technique. This sheet could contain:

- a brief introduction to the technique indicating its usefulness in determining absolute density,

- mention that the results obtained were more robust than those from 5-minute counts because they were not so influenced by changes in conspicuousness due to factors such as habitat, or different observers, and because they are based upon a calculation of a probability of detection,

- key assumptions associated with the use of the technique,
- the number of measurements (60-80) required for statistical analyses,
- the criteria for suitable species or objects,
- mention of the importance of always marking the distance interval boundaries when using point transects,
- mention of the importance of always piloting the survey to explore problems in field technique, species behaviour, and cost effectiveness,
- the address of the web site containing information about distance sampling,
- the reference to the distance sampling book and where it can be purchased,
- the reference to the distance sampling discussion document by R. Barraclough and where it can be obtained,
- information on how to be included on an email list for information about distance sampling,
- mention that a spreadsheet template is available into which distance sampling data should be entered for analysis in DISTANCE, and
- a list of names of people to contact with enquiries about distance sampling, such as designing and piloting such a study.

To improve the availability of information about distance sampling, a page on the DOC Intranet could be developed and contain:

- links to the PDF version of Barraclough (2000),
- names of the people attending this workshop as contacts about distance sampling,
- the flow chart of techniques,
- the fact sheet about distance sampling,
- the template for data entry for analysis in DISTANCE.

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