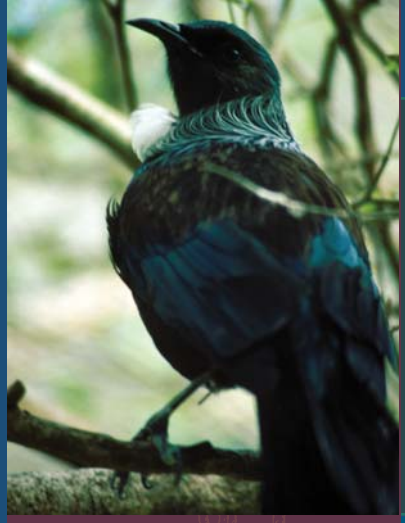

Development of Bird Population Monitoring in New Zealand: Proceedings of a Workshop

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Landcare Research Science Series No. 32

Manaaki Whenua PRESS

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(Compilers)

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Manaaki Whenua PRESS

Lincoln, Canterbury, New Zealand
2006

CATALOGUING IN PUBLICATION

Spurr, E.B.
Development of bird population monitoring in New Zealand: proceedings of a workshop / Eric B. Spurr and C. John Ralph, compilers – Lincoln, N.Z. : Manaaki Whenua Press, 2006.

(Landcare Research Science series, ISSN 1172-269X; no. 32)
ISBN-13: 978-0-478-09384-1
ISBN-10: 0-478-09384-5

1. Bird populations – New Zealand. 2. Birds – Monitoring – New Zealand. 3. Birds – Counting – New Zealand. I. Spurr, E.B. II. Series.

UDC 598.2(931):574.3.087.001.42

Edited by Christine Bezar
Layout design
Typesetting by Wendy Weller
Cover design by Anouk Wanrooy

Published by Manaaki Whenua Press, Landcare Research,
PO Box 40, Lincoln 7640, New Zealand.

Contents

Summary

A workshop on monitoring terrestrial (land) bird populations in New Zealand was held on 11 December 2005, following the Australasian Ornithological Conference, St Mary's Parish Centre, Blenheim, New Zealand. The primary objective of the workshop was to consider options for the design and implementation of a terrestrial breeding bird population survey for New Zealand. It was not an objective to make recommendations for particular options, but some recommendations did emerge:

- The main objective of monitoring terrestrial breeding birds should be to provide reliable, robust, and spatially explicit information on the long-term population trends of bird species inhabiting representative terrestrial habitats throughout New Zealand.
- The whole of the country (including North, South, Stewart and a range of smaller offshore islands) should be covered.
- The full range of terrestrial habitat types should be targeted and habitat information collected at sampling locations.
- All species (both indigenous and introduced) should be recorded regardless of whether or not they are "priority" species.
- A few broad strata should be used and sampled randomly or in some other way.
- Sampling should be encouraged at fixed permanent sites.
- A formal sampling design should be followed but informal (convenience) sampling should be allowed.
- A pilot study should be undertaken using two (near and far) or possibly three distance bands for point counts (and possibly for line transects in open country) of all species detected in selected parts of 1-km squares of the national grid.

Issues that still need addressing include:

- Stratification of habitats and/or geopolitical areas into a few broad strata.
- Dealing with places where access is difficult.
- Location of sampling sites within grid squares (e.g. alone or in clusters?).
- Sampling technique/s (e.g. 5-minute point counts and/or some form of line transect count?).
- Time of day and time of year for sampling.
- Data-handling systems.
- Funding.

These issues should be considered at a subsequent workshop or "virtual" workshop and/or by a small working group in consultation with relevant experts, and a draft breeding bird survey designed and circulated to interested people for comment.

Introduction

New Zealand does not have a comprehensive bird-population monitoring scheme (see Spurr 2005), though it does have some species- or habitat-specific surveys. For example, the Ornithological Society of New Zealand (OSNZ) undertakes a number of bird population studies including an annual national wader survey (http://osnz.org.nz/studies.htm). The Department of Conservation (DOC) also undertakes bird population studies and currently has some 189 ongoing monitoring projects on its books (T. Greene, DOC, Christchurch, pers. comm.). Other organisations in New Zealand (e.g. Landcare Research, Royal Forest and Bird Protection Society, Fish and Game New Zealand, and various territorial local authorities) also undertake bird population monitoring.

A workshop in 2004 recommended the establishment of a nationally coordinated scheme for monitoring bird populations (Spurr 2005). A small working group, comprising representatives from OSNZ, DOC, and Landcare Research, was convened to implement this. As a consequence, a symposium on bird population monitoring was held on 9 December 2005, as part of the Australasian Ornithological Conference, St Mary's Parish Centre, Blenheim, New Zealand (http://osnz.org.nz), and a follow-up workshop on monitoring of terrestrial (land) bird populations was held on 11 December 2005, following the conference.

The primary objective of the workshop was to consider options for the design and implementation of a terrestrial breeding bird survey for New Zealand. It was assumed that such a survey should be part of a comprehensive scheme for monitoring bird populations, consisting of a package of different survey types (e.g. Breeding Bird Survey, Winter Bird Survey, Garden Bird Survey, and Constant Effort Mist-netting of terrestrial birds, as well as surveys of other species groups such as wetland birds and seabirds). An account of the workshop follows.

Format

Twenty-six people attended the workshop (Appendix 1). Several weeks beforehand, participants were provided with a list of background reading on bird population monitoring (Appendix 2), and a draft list of discussion topics (Appendix 3). D.G. Dawson (the Mayor of London's Biodiversity Strategy Manager) also circulated a draft of his conference paper on 'Recommendations for a scheme to monitor common land birds in New Zealand' (see copy of abstract at http://osnz.org.nz/Media/2005_AOC_abstracts.pdf, p. 38).

The workshop started with two invited presentations, one from R.P. Scofield (OSNZ Council) on what the OSNZ thinks it wants from a monitoring scheme for bird populations, and one from T. Greene (DOC) on monitoring bird populations from a DOC perspective (Appendix 4). The workshop then broke into subgroups (break-out groups), each designating a "chair" to facilitate the subgroup's discussion, and a "secretary" to record the group's thoughts. Each subgroup was asked to list the advantages and disadvantages of different alternatives, not necessarily decide upon one or another. Such a "consensus" format entailed respect for alternative opinions, ensuring that each person's viewpoint was captured, not necessarily universally approved. A spokesperson from each subgroup presented the results of the subgroup discussions to the whole group, and representatives from the subgroups were asked to provide a written summary of the results (which could include additional material) after the workshop. These results follow.

Results

Objectives of monitoring

Participants concluded that the main objective of monitoring terrestrial bird populations in New Zealand should be:

- To provide reliable, robust, and spatially explicit information on the long-term population trends of bird species inhabiting representative terrestrial habitats throughout New Zealand.

More specific objectives could be:

- To provide population trend information on common and widespread birds that may act as a barometer for wider environmental change in New Zealand.
- To provide information on the drivers of change (pests, land use, habitat degradation, etc.), complementary to existing and ongoing monitoring and surveillance schemes.
- To provide information to enable policy makers to judge the scale of any environmental changes (both "positive" and "negative"), respond accordingly, and then review those changes through time.
- To establish thresholds that can be used to notify conservation bodies of requirements of further monitoring, research, or conservation action.
- To inform and raise the profile of birds in New Zealand habitats by providing fast data input and data retrieval, providing results for relevant policy development, science planning and the general public, thus ensuring that the information is freely available (but retaining the potential ability to charge for commercial use).
- To inform and raise the profile of biodiversity and biodiversity monitoring in New Zealand, using birds as flagships to communicate with a broad audience, from decision makers to the general public.
- To provide opportunities for training, education, and social involvement (e.g. garden birds, the identification of birds, basic ecology, population trends, threats, and the unique history of New Zealand birds).
- To provide coverage of native and non-native bird species, because both form an integral part of the modern New Zealand environment.
- To provide information to allow New Zealand to report at an international level towards the World Summit on Sustainable Development's commitment "to significantly reduce the current rate of biodiversity loss by 2010 at global, regional, and national levels".

Geographical coverage

Participants agreed that monitoring of terrestrial bird populations should cover the whole of New Zealand, including North, South, and Stewart islands and a range of smaller offshore islands. It was recognised that even coverage would be difficult, given that New Zealand has a relatively small and unevenly distributed human population. Therefore, geographical coverage would have to be stratified in some way, to reflect factors such as availability of contributors, difficulty of access, administrative areas, and habitats (see below). Not all areas (e.g. not all offshore islands) may be able to be monitored. Stratification could be along geopolitical or biogeographical (e.g. habitat) boundaries, or a combination of both. The 73 territorial local authorities are probably too numerous and differ too much in area to be effective as strata. However, ranking them by human population density (as in Appendix 5) might identify a stratum of urban areas (see also http://www.stats.govt.nz). A more appropriate stratification might be the areas administered by the 17 regional authorities; viz. the 12 regional councils (Northland, Auckland, Waikato, Bay of Plenty, Hawke's Bay, Taranaki, Manawatu-Wanganui, Wellington, West Coast, Canterbury, Otago, Southland), the four unitary authorities not included in regional councils (Gisborne District Council, Tasman District Council, Nelson City

Council, and Marlborough District Council), and the Chatham Islands Council. Another basis for stratification may be land tenure classification. Whichever basis for stratification is chosen, it will be important to consider the end-users of the data to ensure that the data are collected in such a way as to be useful to a wide range of users, from regional councils to the Department of Conservation.

Habitats to be sampled

Participants agreed in principle that the full range of terrestrial habitat types should be sampled (assuming that other survey types will focus on other habitats such as wetlands and marine areas). However, given possible constraints on the number of observers available, some stratification of terrestrial habitats (as with geographical coverage) will be necessary, and some habitat types may not be able to be monitored. It was suggested there should be only a few broad habitat strata, because too many strata risk problems as habitats change, or simply having too few samples in some strata. Suggested strata for monitoring, in priority order, were as follows: native forest, exotic forest, open country, and urban. When this was reported back, there was some debate about whether these strata might be too coarse and whether more strata might be needed. Nevertheless, the majority preferred simplicity.

Several potential tools were suggested for stratifying habitats:

- New Zealand Land Cover Database II (LCDB II) (Appendix 6). This uses satellite imagery to classify areas as small as 1 ha according to current land cover. The 42 classes are of greatly differing land area, so simple random sampling would not serve the majority of them (only four classes are more than 5% of the New Zealand land area). A potential grouping might be: open country (about 52% of the land area), native forest (33%), exotic forest (7%), and urban (1%), as illustrated in Fig. 1 in Appendix 6.
- Land Environments of New Zealand (LENZ) (Appendix 7). This is an environmental classification, reflecting the growing conditions for plants. It has 100-m (1 ha) or 25-m (0.0625 ha) precision. The 20 level 1 "environments" might aid the selection of strata. The classification has the advantage of reflecting climate, soil, and landform, but presumably the disadvantage of not well reflecting current habitat. Like the LCDB, the classes are of greatly varying land area. Some grouping might be possible.
- Ecological Regions and Districts of New Zealand. The 79 classes in this classification are possibly too numerous to be effective as strata, but some groupings may be possible.

It was suggested that habitat strata (e.g. the Land Cover Database and Land Environments of New Zealand) could be overlain with geopolitical strata (e.g. territorial local authority and regional authority boundaries) to provide a habitat–geopolitical framework.

There was discussion on the criteria for selection of habitat types to be sampled. Criteria might include many factors; for example, representativeness, accessibility, and various risks to indigenous biodiversity. It was argued that sampling should not be biased towards sites that are not "representative" of New Zealand, nor to "managed" sites (i.e. managed for conservation, with pest control etc. in place), either on the mainland or offshore islands. It was recognised that it will be relatively easy to get the resources to do monitoring in managed sites, because restoration groups will probably be enthusiastic about the scheme and sites such as mainland islands already have resource allocations. However, these should be treated as a special sample rather than part of the formal stratification.

Species to be sampled

Participants agreed that the survey should target all terrestrial bird species, assuming that other surveys will focus on other specialist bird groups such as wetland and seabirds. There was debate about whether the survey should then focus on "key" terrestrial bird species or species groups. However, the majority of participants felt that ALL species encountered by observers should be recorded, whether or not they were "priority" bird species.

The rationale for including all bird species was that:

- Habitat strata would provide for the emphasis on terrestrial birds, including indigenous and introduced species.
- Terrestrial habitats might be better than wetland habitats to monitor some wetland bird species (e.g. pūkeko, which are more visible in pasture than in swamps).
- We cannot predict which bird species will be an issue in the future; some species may become pests; others may decline and become new foci for conservation; yet others might increase significantly, allowing for national reporting once populations increase.
- We do not know yet which bird species will have sufficient data to best "characterise" each habitat type. The consensus was to avoid the idea of focusing on "indicator species" as, almost by definition, we have little insight into which species are indicating what. If we did, we wouldn't need this monitoring.
- We do not know yet which bird species will have sufficient data to provide adequate statistical power to detect changes in populations. The survey should be designed to gather sufficient data to detect changes in common species (this is ambitious enough). Rarer species will need specialist monitoring or increased sampling, and this is beyond the immediate scope of this scheme.

It was suggested that species could be grouped retrospectively into assemblages that characterise certain habitat types, should it be necessary to report on population trends in say "bird species characteristic of beech forest", etc.

Sampling strategies

Participants agreed there should be a formal sampling strategy, but also agreed that deviations to the formal strategy be allowed (see below). It was recommended that sampling should be at fixed, permanent sites, which are better able than non-permanent sites to track trends over the years. Random location of fixed sites would ensure that the results are representative. However, it was pointed out that random placement of sampling sites would require much more travel time, and result in less data than some other forms of sampling. One solution suggested was a recently developed method of probability sampling, Generalised Random Tessellation Strata (GRTS), which might overcome the difficulties of traditional random or systematic sampling. GRTS allows for inclusion probability to vary and dynamic adjustment of sample size. It requires much computation, but routines are available to do this (see http://www.epa.gov/nheerl/arm/analysispages/software.htm).

Some participants suggested that in addition to formal sampling, informal (or convenience) sampling be allowed from observer-selected locations. This might attract more participants than a formal sampling scheme. Convenience locations could include easily accessible sites along roads, tracks, or intensive grids in managed areas. Such an observer-selected sampling framework might be more attractive to those who wished to study particular areas (e.g. restoration sites or places that the observer visits regularly). A pilot study would reveal the extent to which participants are prepared to be directed to formal sampling locations.

It was suggested that the basic sample unit could be the 1-km squares of the national mapping grid. However, there was no recommendation on how the actual sample points (or lines) should be placed within the squares.

It was recommended that habitat information be collected at the places sampled, allowing the study of habitat, including the defining of species assemblages that characterise certain habitat types. Several methods have been used in New Zealand (e.g. the "FORMAK" monitoring manual) and around the world (e.g. $1/10^{th}$ acre circular plots), which might provide a starting point.

Survey techniques

Three main techniques were discussed: point counts (5-minute counts), fixed-width line-transect counts, and distance sampling (from points or along transects). Distance sampling by estimating distance to each individual bird was not considered feasible for a general survey because of a lack of observer confidence and recruitment. However, recording birds in two or three distance bands was considered feasible. Participants favoured keeping the method simple, to allow more people to be involved.

Some participants considered that different methods should be used in forested and open habitats, because the detectability of birds varies between the two habitat types, and that it was best to use the method most suited to each habitat. However, others thought that it would not always be possible for an observer to decide whether a habitat was forest, scrub, or open, because many, if not most, habitats are a mixture.

Point counts were recommended for forest habitats, because they are safer for observers in difficult terrain, and observers are not distracted during the count by having to pay attention to where they are walking. The point-count methodology could be based on the current 5-minute point count with the addition of sampling in two or three distance bands (see spatial scales, below). This would allow comparison between 5-minute point-count and point-based distance-band sampling, and more importantly allow backwards comparison between future counts and the thousands of 5-minute bird counts made over the last 30 years (see http://www.doc.govt.nz/Conservation/001~Plants-and-Animals/007~Five-minute-bird-counts/index.asp).

Some participants preferred the use of line-transect counts with fixed-width distance bands in open habitats. They felt that line-transect counts were more efficient because all detections are recorded (versus ignoring birds between points), and were better than point counts for detecting birds at zero distance from the line or point (i.e. g(0)). However, others challenged this. Some of the group felt that 5-minute counts should not be used in open habitat because they thought they were not designed for that purpose, but others noted that elsewhere in the world point counts are used in all habitats. Some of the group felt that 5-minute counts were too short for some semi-cryptic / low-activity birds, for example kererū and kākā in forest habitats, but others noted that they are already being used for these species in some parts of the country. Some of the group also felt that observers would not want to be "standing around" in open areas too much, but would rather be kept on the move and doing something. It was noted that observers were unlikely to feel like cooperating in the scheme if they were sent to far-flung points and did not do anything in between points. It may take some effort to get to points for apparently a small amount of data (which would be most pertinent to points sampled in remote forest areas). Later in the discussion some participants suggested that perhaps observers could be given a choice between point counts and line-transect counts in open habitats. To accommodate both methods, it was suggested that point counts could be conducted at the start and end of line-transect counts. Because of expense and logistics, double-observer sampling methods were ruled out, as was mark–recapture double-observer distance sampling.

Calibration of any new survey techniques with the existing 5-minute point-count methodology was seen to be an important issue for consideration and a potential research topic before implementation of any scheme. Any new methods of counting must also be phased in over time, and run in parallel for a while so that a statistical calibration can be made.

Differences in observer ability, and observer ability over time, need to be acknowledged. One suggestion was that observers could be calibrated in a separate study or during observer training in methodology. However, some participants considered this wasn't realistic. Another suggestion that has been used commonly elsewhere, was to use observer as a covariate during analysis, although this would apply only where observers were rotated from place to place so that observer and place were not confounded.

A pilot study, or an analysis of previously gathered data, was recommended to show whether useful information could be gathered by the particular survey method and stratification being proposed. Given the desirability for simplicity, some people advocated confining the pilot study to point counts, with two or three distance bands.

Spatial scales

Two spatial scales were considered: the distance around points or transect lines (i.e. distance bands) and the distance between points or transect lines. For the distance around points, participants suggested three main options:

(a) Unlimited distance, recording all birds detected
(b) Recording birds within 25 m (near) and beyond 25 m (far)
(c) Recording birds in distance bands of 0–25, 25–100, and >100 m.

It may be possible to determine the most appropriate band width during a pilot trial, although there is a considerable literature on this subject.

For the distance between points, some participants recommended a minimum of 200 m; i.e. if points were clustered, the first point would be located randomly or in some other way, and then subsequent points in the cluster would be 200 m apart, either in a line, grid, or circuit. Other participants considered 100 m separation sufficient. It was not agreed on how many points should be in a cluster. One suggestion was 12 (a number that one person could count in a morning). In France, points are located in clusters of 10.

Temporal scales

Two timescales were considered: time of day and time of year. Participants agreed that the selection of suitable temporal scales for monitoring landbird populations should consider the level of understanding of the bird populations and species to be monitored. For example, daily activity patterns such as singing behaviour are likely to impact on detectability, and the time of year that breeding occurs will directly influence overall activity (e.g. incubating birds are likely to be absent from counts).

Time of day

Some participants argued that counts should be done only in the morning, while others argued that counts could be done throughout the day. No agreement was reached. Some participants also argued that the time window in which counts should be done will be different in forest versus open habitats, but others disagreed. A number of things were agreed. For example, field datasheets should include the time of arrival at the site and the time of commencement of the count. Counting should start immediately on reaching the site, where possible, so long as the approach has been not too strenuous

in that it could influence the observer's ability to detect birds. Multiple counts at a given site should be made at approximately the same time of day (i.e. plus or minus half an hour).

Time of year
Participants suggested two time periods for counts for a breeding bird survey, related to the peak time of breeding for New Zealand birds: early spring (September in the North Island, October in the South Island) and late spring (December in the North Island, January in the South Island). It was also suggested that counts be made in winter, allowing collection of data on the seasonality of breeding birds. Further discussion will be needed.

Data-handling systems

Participants recommended that existing systems should be reviewed before deciding on an appropriate data management system. Data-recording systems suggested for initial review were Artportalen (a Swedish multi-taxa system currently being assessed by Landcare Research) and eBird (a system currently used in the USA, Canada, and some other countries). A data-analysis system suggested for review was the programme TRIM (used in the UK and other countries in Europe).

Organisation and structure

Some participants considered that the OSNZ was an obvious candidate to manage a scheme for monitoring bird populations in New Zealand. However, a current lack of resources and funding to operate such a scheme, and to manage the data produced, prohibits the society from doing so. OSNZ would like to fulfil this role in the future but initial organisation may need to be undertaken by a multi-partner steering group comprising representatives from the following:

Ornithological Society of New Zealand (OSNZ)
Department of Conservation (DOC)
Landcare Research (LCR)
Ministry for the Environment (MfE)
Royal Forest and Bird Protection Society
Universities
Regional councils
Ecological restoration groups
Interested individuals

It was anticipated that OSNZ, DOC, Landcare Research, and MfE would undertake the major roles in organising the scheme. A multi-partner approach capitalises on the various strengths within each organisation. However, there are a number of issues to be resolved for this approach to be effective, in particular ownership of the data, maintaining institutional support over time, conflicting stakeholder needs, and interagency suspicion and fear (OSNZ, a voluntary organisation, has a particular fear of being marginalised by the professional organisations). None of these issues are irresolvable. Transparency and equal partnerships were seen as vital to solving these issues.

A first step in initiating a bird-population monitoring scheme would be the production of a proposal or business case with a full budget detailing both set-up and ongoing costs. It was envisaged that the scheme should start with one employee. This employee would likely be "nested" within one of the supporting organisations (DOC, Landcare Research, or MfE) but would operate as an independent entity. In the long term, a bird-population monitoring scheme might operate as an independent unit with multiple employees.

Having a dedicated employee was seen as an excellent investment in training and recruitment as well as enabling the day-to-day managing of the project. It was suggested that the FORMAK training scheme could be incorporated into the landbird-population monitoring survey, but this needs further discussion.

Recommendations

The workshop did not set out to make recommendations for the structure of any New Zealand landbird-population monitoring survey, but to identify the options for consideration. Nevertheless, some recommendations did emerge:

- The main objective of population monitoring of terrestrial breeding birds should be to provide reliable, robust, and spatially explicit information on the long-term population trends of bird species inhabiting representative terrestrial habitats throughout New Zealand.
- The whole of the country (including North, South, Stewart and a range of smaller offshore islands) should be covered.
- The full range of terrestrial habitat types should be targeted and habitat information collected at sampling locations.
- All species (both indigenous and introduced species) should be recorded regardless of whether or not they are "priority" species.
- A few broad strata should be used and sampled randomly or in some other way.
- Sampling should be encouraged at fixed permanent sites.
- A formal sampling design should be followed but informal (convenience) sampling should be allowed.
- A pilot study should be undertaken using two (near and far) or possibly three distance bands for point counts (and possibly for line transects in open country) of all species detected in selected parts of 1-km squares of the national grid.

Issues that still need addressing include:

- Stratification of habitats and/or geopolitical areas into a few broad strata.
- Dealing with places where access is difficult.
- Location of sampling sites within grid squares (e.g. alone or in clusters?).
- Sampling technique/s (e.g. 5-minute point counts and/or some form of line transect count?).
- Time of day and time of year for sampling.
- Data-handling systems.
- Funding.

These issues should be considered at a subsequent workshop or "virtual" workshop and/or by a small working group in consultation with relevant experts, and a draft breeding bird survey designed and circulated to interested people for comment.

Acknowledgements

This report was funded by the Foundation for Research, Science and Technology, under Non-Specific Output Funding associated with C09X0209. We thank the conference organisers for assistance with planning the workshop; contributors to the workshop for their input of ideas and comments on the draft manuscript; J. Innes, J. McLennan, and B. Warburton for additional comments on the draft manuscript; and C. Bezar for editorial input.

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Appendices

Appendix 1. Workshop attendees

Name	Affiliation
Barraclough, Rosemary	Massey University
Bevers, Cees	Oecologia & Massey University
Blackwell, Grant	Otago University
Brunton, Dianne	Massey University
Cassey, Phillip	Birmingham University (UK)
Dawson, Dave	City of London (UK)
Efford, Murray	Landcare Research
Fewster, Rachel	Auckland University
Greene, Terry	DOC
Gregory, Richard	RSPB (UK)
Hamilton, Graeme	Birds Australia
Hartley, Lynette	DOC
Holdaway, Richard	OSNZ Scientific Committee (Chair)
Nilsson, Johan	Artportalen (Sweden)
Noble, David	Bird Census Unit, BTO (UK)
O'Donnell, Colin	DOC
Onley, Derek	Private contractor
Parker, Kevin	Massey University
Ralph, C. John	US Forest Service (USA)
Robertson, Chris	Private contractor, OSNZ Atlas
Scofield, Paul	Christchurch Museum, OSNZ Council
Spurr, Eric	Landcare Research
Taylor, Graeme	DOC Banding Office, OSNZ Scientific Committee
Westbrooke, Ian	DOC
Weston, Mike	Birds Australia
Wilson, Kerry-Jayne	Lincoln University

Appendix 2. Reading list

Overviews

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Swedish Species Gateway (http://artportalen.se/default.asp)
New Zealand forest monitoring and assessment kit (www.formak.co.nz)
TRends and Indices for Monitoring data (TRIM)
(www.cbs.nl/en-GB/menu/themas/milieu-natuur-ruimte/natuur/methoden/methoden/trim/default.htm)

Garden bird surveys

Big Garden BirdWatch (www.rspb.org.uk/birdwatch/)
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Great Backyard Bird Count (www.birdsource.org/gbbc/)
Birds Australia (www.birdsinbackyards.net/surveys/backyard-birds.cfm and www.birdata.com.au)

Appendix 3. Discussion topics for subgroups to consider

1. Objectives of bird survey (not necessarily exclusive)
- Population trends?
- Inventory?
- Site evaluation?
- Distribution?
- Habitat relationships?
- Other?

2. Which habitats and scale?
- Forest, farmland, urban, other habitats?
- Compare habitat classification schemes available to choose from
- North Island, South Island, and/or offshore islands?

3. Which bird species or species groups?
- Terrestrial, freshwater, native and/or introduced, other?
- All species or selected indicator species?

4. Sampling strategies
- 1-km grid squares vs. some other basis for sampling
- Systematic vs random vs stratified random vs roadside random sampling
- Stratifying by habitat type, observer density, and/or geopolitical regions?

5. Survey techniques
- Point counts, point distance, fixed-width transect counts, transect distance, area searches, other?
- Double observer, counting in timed intervals (or distance intervals?), and/or double sampling?

6. Temporal scales
- Start at sunrise or 9 a.m. (or some other time)?
- Finish by 9 a.m., midday, 4 p.m. (or some other time)?
- Start immediately arrive or after waiting for 1 min, 2 min, etc.?
- Count for different lengths of time (e.g. 3 min, 5 min, 10 min)?
- Count firstly early Oct–mid-Nov, secondly mid-Nov–late Dec, or other times?

7. Spatial scales
- Bounded or unbounded point counts/transect counts?
- What distance between points for point counts (100 m, 200 m, etc.)?
- Different numbers of points in a grid square (10, 12, or some other number?)
- What length of transect (e.g. 200 m, 1 km, 2 km)?
- What width of transect (10 m, 25 m, 50 m each side of transect)?
- Record distance to bird (actual distance, or distance bands of different width?)
- What distance band-widths (e.g. <10 m, 10–25 m, 25–100m, >100 m, or other)?
- What area for area search (e.g. 1 ha, 2 ha, 3 ha)?

8. Data-handling systems
- Data-entry systems (for current and historical data, restricted and open data)
- Data storage systems
- Data analysis and feedback systems
- Existing systems and costs of implementation (e.g. Artportalen, BirdTrack, and eBird)

9. Organisation and structure
- How to complement strengths of various organisations and agencies involved?
- Personnel and equipment needed/available (staff, offices, computers, etc.)?
- How to provide training and support for regional organisers and volunteers?
- How to fund the scheme?

10. Other survey types (if time)
- Winter Bird Survey
- Garden Bird Survey
- Constant-Effort Mist-Netting
- Other

Appendix 4. Abstracts of invited keynote addresses

Keynote address 1: A monitoring scheme in New Zealand: what the OSNZ thinks it wants

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The Ornithological Society of New Zealand (OSNZ) is an organisation that exists ultimately to gather and publish information on the birds of New Zealand. In the wake of the imminent completion of the second atlas project the society's Scientific Committee has been reassessing its monitoring needs to ensure that OSNZ should be a major body gathering and publishing information on the birds in New Zealand. The Scientific Committee has concluded that Web-based methods of data entry and dissemination are the way of the future, but Web-based methods have huge logistic problems inherent in their maintenance, and in the analysis – problems that most overseas organisations have ignored in concentrating on early Web presence rather than content. OSNZ believes that Web-based monitoring of New Zealand birds should be developed according to best practice, to develop the simplest and most useable platform to suit local purposes, which are not necessarily, or even likely to be, consistent with the basis for surveys and monitoring done elsewhere. Furthermore OSNZ believes that before any scheme is launched by OSNZ, the membership should be fully consulted, and the results of that consultation incorporated in the development of the platform and in survey and monitoring objectives that are both valid scientifically and feasible for the membership. It is also crucial to consider the outcome of any survey or information-gathering scheme or process, and especially the analytical methods required to achieve that outcome, before any scheme is adopted.

Keynote address 2: Monitoring bird populations: a DOC perspective

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The Department of Conservation (DOC) has some 189 ongoing bird-population monitoring projects on its books. The objectives of these projects are to monitor changes in ecological status and integrity, monitor management actions, and provide fundamental understanding of bird populations. Parameters measured include distribution (e.g. mapping presence/absence), actual abundance (complete counts), indices of abundance (mainly 5-minute counts), and demographics (e.g. survival and recruitment). The types of bird population monitoring data that DOC needs include distribution and inventory (e.g. what species are present where), status and trend (robust across time and space), response to management interventions (such as pest control, translocation, habitat restoration), and research (e.g. for population modelling). Improvements needed to current DOC monitoring practices include (a) appropriate field methods for particular situations, (b) appropriate statistical techniques, (c) proper design to account for variation, (d) monitoring for long enough to determine factors influencing trend, and (e) robust tools for predicting long-term consequences of management. Without improvements to monitoring DOC will not be able to provide robust data to the National Heritage Monitoring Scheme (NHMS), GRASP, BIOWEB, Pest Spread, or predictive population models (e.g. for kiwi). Any national bird population monitoring programme must therefore be (a) robust, and provide comparable, defensible data, (b) user friendly and resource efficient, and (c) able to make use of and inform local-scale and past monitoring effort.

Appendix 5. Territorial local authorities in New Zealand

Ranked by population density. Excludes Chatham Islands and offshore islands

Local authority	Area (ha)	Population	Population density/ha	Cum. area (ha)	%	Cum. pop.	%
North Shore City Council	12,979.1	185,262	14.274	12,979	0.051	185,262	4.851
Hamilton City Council	9,420.4	116,223	12.337	22,399	0.089	301,485	7.894
Christchurch City Council	45,314.4	324,297	7.157	67,714	0.268	625,782	16.386
Auckland City Council	65,833.4	380,154	5.774	133,547	0.529	1,005,936	26.341
Wellington City Council	28,990.5	167,190	5.767	162,538	0.644	1,173,126	30.718
Tauranga District Council	16,859.1	91,836	5.447	179,397	0.711	1,264,962	33.123
Napier City Council	10,564.4	55,137	5.219	189,961	0.753	1,320,099	34.567
Manukau City Council	55,158.0	284,001	5.149	245,119	0.971	1,604,100	42.004
Waitakere City Council	36,738.7	168,465	4.585	281,858	1.117	1,772,565	46.415
Papakura District Council	11,856.9	40,380	3.406	293,715	1.164	1,812,945	47.472
Kawerau District Council	2,193.6	6,951	3.169	295,908	1.173	1,819,896	47.654
Porirua City Council	18,224.5	47,292	2.595	314,133	1.245	1,867,188	48.893
Hutt City Council	37,672.6	95,106	2.525	351,805	1.394	1,962,294	51.383
Palmerston North City Council	33,600.7	73,125	2.176	385,406	1.527	2,035,419	53.298
Invercargill City Council	49,136.0	50,118	1.020	434,542	1.722	2,085,537	54.610
Nelson City Council	44,429.2	43560	0.980	478,971	1.898	2,129,097	55.751
Upper Hutt City Council	53,970.1	36684	0.680	532,941	2.112	2,165,781	56.711
Kapiti Coast District Council	73,118.1	42,543	0.582	606,060	2.402	2,208,324	57.825
Dunedin City Council	334,181.7	118,038	0.353	940,241	3.726	2,326,362	60.916
Rodney District Council	249,328.5	77,385	0.310	1,189,570	4.714	2,403,747	62.942
New Plymouth District Council	220,928.3	66,573	0.301	1,410,498	5.590	2,470,320	64.686
Horowhenua District Council	106,349.6	29,580	0.278	1,516,848	6.011	2,499,900	65.460
Waipa District Council	147,355.7	40,509	0.275	1,664,203	6.595	2,540,409	66.521
Rotorua District Council	261,490.8	68,772	0.263	1,925,694	7.632	2,609,181	68.322
Whangarei District Council	285,527.2	68,478	0.240	2,211,221	8.763	2,677,659	70.115
Franklin District Council	218,796.2	51,951	0.237	2,430,018	9.631	2,729,610	71.475
Wanganui District Council	237,258.5	43,683	0.184	2,667,276	10.571	2,773,293	72.619
Western Bay of Plenty DC	212,023.9	38,478	0.181	2,879,300	11.411	2,811,771	73.627
Matamata-Piako DC	175,403.6	29,403	0.168	3,054,704	12.106	2,841,174	74.397
Waimakariri District Council	221,663.9	36,645	0.165	3,276,367	12.985	2,877,819	75.356
Timaru District Council	273,813.3	42,315	0.155	3,550,181	14.070	2,920,134	76.464
Hauraki District Council	118,784.8	16,662	0.140	3,668,966	14.541	2,936,796	76.900
Hastings District Council	521,686.0	68,757	0.132	4,190,652	16.608	3,005,553	78.701
South Waikato District Council	181,673.5	23,268	0.128	4,372,325	17.328	3,028,821	79.310
Waikato District Council	318,902.7	39,870	0.125	4,691,228	18.592	3,068,691	80.354
Thames-Coromandel DC	257,728.6	28,008	0.109	4,948,956	19.613	3,096,699	81.088
Manawatu District Council	262,402.1	27,393	0.104	5,211,358	20.653	3,124,092	81.805

Local authority	Area (ha)	Population	Population density/ha	Cum. area (ha)	%	Cum. pop.	%
Masterton District Council	229,877.6	22,926	0.100	5,441,236	21.564	3,147,018	82.405
Gore District Council	125,163.9	12,372	0.099	5,566,400	22.060	3,159,390	82.729
Far North District Council	732,383.0	58,065	0.079	6,298,783	24.963	3,217,455	84.250
Banks Peninsula DC	115,805.6	8,874	0.077	6,414,589	25.422	3,226,329	84.482
South Taranaki District Council	357,553.7	27,222	0.076	6,772,142	26.839	3,253,551	85.195
Whakatane District Council	444,344.3	32,955	0.074	7,216,487	28.600	3,286,506	86.058
Carterton District Council	118,010.3	6,897	0.058	7,334,497	29.068	3,293,403	86.238
Kaipara District Council	311,709.9	17,811	0.057	7,646,207	30.303	3,311,214	86.705
Gisborne District Council	835,492.5	44,115	0.053	8,481,699	33.614	3,355,329	87.860
Southland District Council	640,497.3	31,884	0.050	9,122,197	36.153	3,387,213	88.695
Taupo District Council	695,483.8	34,557	0.050	9,817,680	38.909	3,421,770	89.600
Otorohanga District Council	206,358.9	9,402	0.046	10,024,039	39.727	3,431,172	89.846
Selwyn District Council	655,635.3	27,969	0.043	10,679,675	42.325	3,459,141	90.578
Stratford District Council	216,334.7	8,991	0.042	10,896,009	43.182	3,468,132	90.814
Ashburton District Council	618,669.6	25,344	0.041	11,514,679	45.634	3,493,476	91.477
Tararua District Council	436,064.7	17,586	0.040	11,950,744	47.363	3,511,062	91.938
Grey District Council	351,688.6	13,635	0.039	12,302,432	48.756	3,524,697	92.295
Central Hawke's Bay DC	332,790.9	12,837	0.039	12,635,223	50.075	3,537,534	92.631
South Wairarapa DC	245,735.6	8,754	0.036	12,880,959	51.049	3,546,288	92.860
Rangitikei District Council	447,917.6	15,369	0.034	13,328,876	52.824	3,561,657	93.263
Marlborough District Council	1,249,332.0	42,483	0.034	14,578,208	57.776	3,604,140	94.375
Tasman District Council	1,453,799.0	44,880	0.031	16,032,007	63.537	3,649,020	95.550
Opotiki District Council	310,394.8	9,219	0.030	16,342,402	64.767	3,658,239	95.792
Waitaki District Council	71,203.4	20,934	0.029	17,063,605	67.626	3,679,173	96.340
Clutha District Council	640,497.3	17,388	0.027	17,704,103	70.164	3,696,561	96.795
Waitomo District Council	354,649.1	9,618	0.027	18,058,752	71.569	3,706,179	97.047
Queenstown-Lakes DC	936,670.3	25,152	0.027	18,995,422	75.282	3,731,331	97.705
Ruapehu District Council	672,966.7	15,201	0.023	19,668,389	77.949	3,746,532	98.104
Wairoa District Council	411,967.2	9,129	0.022	20,080,356	79.581	3,755,661	98.343
Kaikoura District Council	204,641.6	4,401	0.022	20,284,998	80.392	3,760,062	98.458
Waimate District Council	358,222.4	7,128	0.020	20,643,220	81.812	3,767,190	98.644
Central Otago District Council	995,866.2	14,952	0.015	21,639,086	85.759	3,782,142	99.036
Buller District Council	795,421.5	10,440	0.013	22,434,508	88.911	3,792,582	99.309
Hurunui District Council	866,043.0	10,821	0.012	23,300,551	92.343	3,803,403	99.593
Westland District Council	1,188,019.0	10,371	0.009	24,488,570	97.052	3,813,774	99.864
Mackenzie District Council	743,920.5	5,184	0.007	25,232,490	100.000	3,818,958	100.000

Appendix 6. Land cover classes of New Zealand (after LCDBII)

LCDBII name	Land area (ha)	% NZ
Afforestation (imaged, post-LCDB 1)	85,076.23	0.31
Afforestation (not imaged)	49,501.81	0.18
Alpine Grass/Herbfield	224,379.28	0.83
Alpine Gravel and Rock	698,145.58	2.61
Broadleaved Indigenous Hardwoods	539,555.97	2.01
Built-up Area	163,437.55	0.61
Coastal Sand and Gravel	51,249.30	0.19
Deciduous Hardwoods	84,191.98	0.31
Depleted Tussock Grassland	250,465.47	0.93
Estuarine Open Water	92,498.83	0.34
Fernland	51,710.20	0.19
Flaxland	6,449.70	0.02
Forest Harvested	234,714.10	0.88
Gorse and Broom	203,083.32	0.76
Grey Scrub	72,401.73	0.27
Herbaceous Freshwater Vegetation	88,674.42	0.33
Herbaceous Saline Vegetation	19,215.97	0.07
High Producing Exotic Grassland	8,885,791.96	33.13
Indigenous Forest	6,456,944.02	24.07
Lake and Pond	357,526.72	1.33
Landslide	16,991.50	0.06
Low Producing Grassland	1,652,286.93	6.16
Major Shelterbelts	12,766.41	0.05
Mangrove	26,032.86	0.10
Mānuka and or Kānuka	1,186,105.56	4.42
Matagouri	29,534.70	0.11
Mixed Exotic Shrubland	63,238.56	0.23
Orchard and Other Perennial Crops	58,325.48	0.21
Other Exotic Forest	132,339.54	0.49
Permanent Snow and Ice	110,972.30	0.41
Pine Forest – Closed Canopy	977,403.41	3.64
Pine Forest – Open Canopy	482,766.72	1.79
River	81,935.50	0.31
River and Lakeshore Gravel and Rock	179,736.99	0.67
Short-rotation Cropland	333,718.86	1.24
Subalpine Shrubland	385,284.63	1.44
Surface Mine	9,773.61	0.04
Tall Tussock Grassland	2,394,694.20	8.92
Transport Infrastructure	6,519.35	0.02
Urban Parkland / Open Space	40,164.06	0.15
Vineyard	25,400.32	0.09
Other	21,457.28	0.08
Total	26,843,031.18	100.00

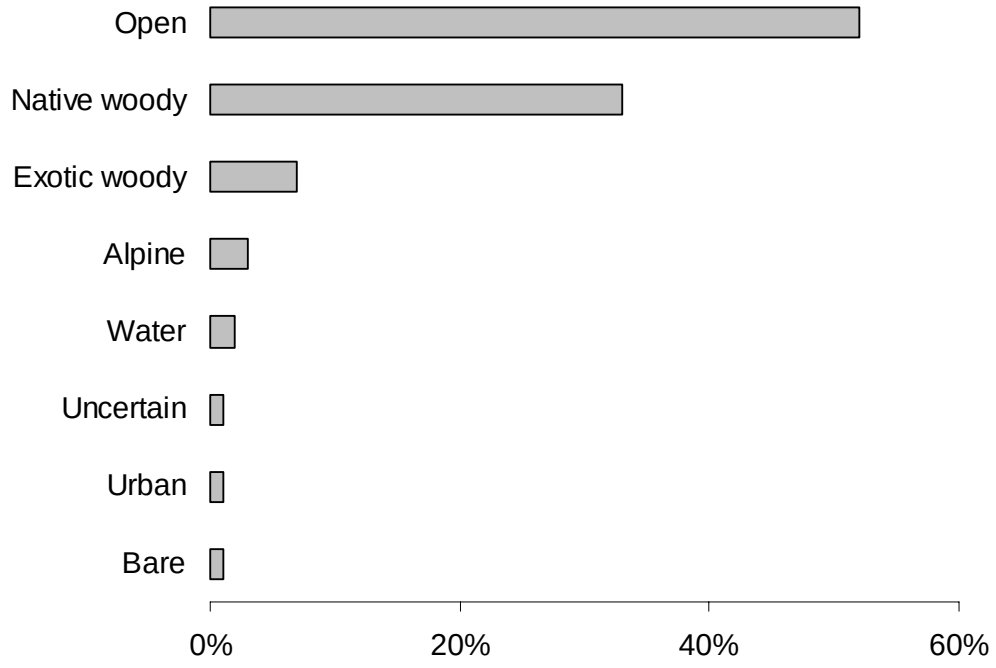
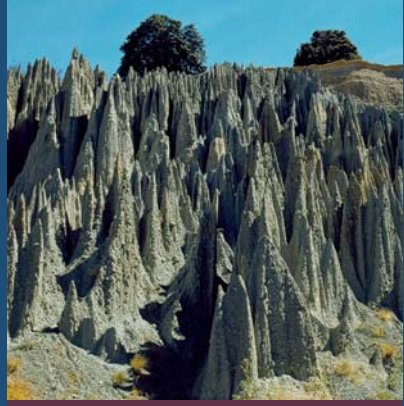
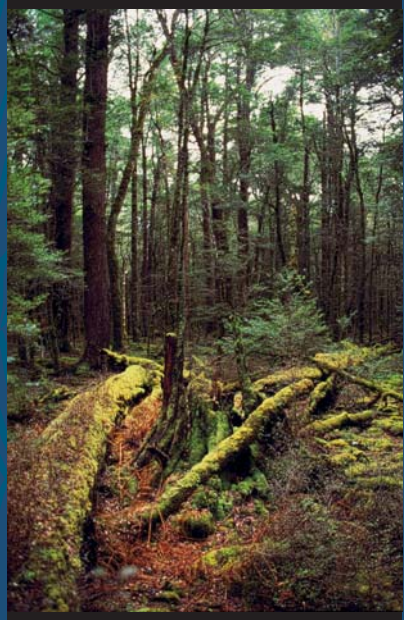


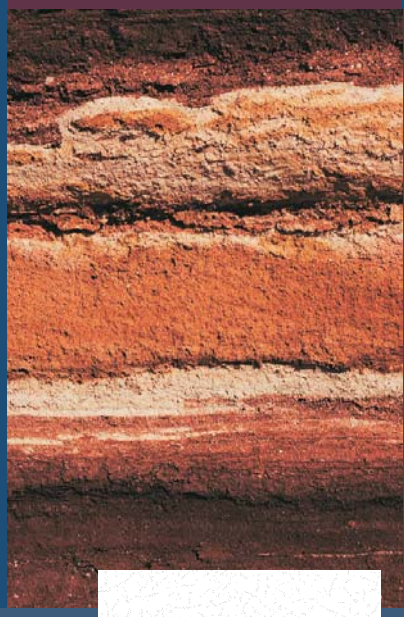
Fig. 1 Aggregated land cover classes of New Zealand (LCDBII)

Appendix 7. Land Environments of New Zealand (LENZ)

LENZ level 1 name	Land area (ha)	% NZ
Northern lowlands	1,860,000	7.3
Central dry lowlands	693,000	2.7
Western and southern North Is. lowlands	639,000	2.5
Northern hill country	2,104,000	8.2
Central dry foothills	1,327,000	5.2
Central hill country and volcanic plateau	5,253,000	20.5
Northern recent soils	344,000	1.3
Central sandy recent soils	137,000	0.5
Central recent poorly drained soils	123,000	0.5
Eastern dry recent soils	297,000	1.2
Central cold recent soils	163,000	0.6
Southern lowlands	312,000	1.2
Western South Is. recent soils	229,000	0.9
Eastern South Is. Plains	2,052,000	8.0
Western South Is. foothills and Stewart Is.	1,423,000	5.6
Central mountains	3,252,000	12.7
Southeastern hill country and mountains	3,276,000	12.8
Southern Alps	1,931,000	7.5
Ultramafic soils	34,000	0.1
Permanent snow and ice	159,000	0.6
Total	25,608,000	99.9







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ISBN 0-478-09384-5

Manaaki Whenua PRESS