Landbirds on Lord Howe Island, NSW

Survey report 2, September 2014



Prepared for the Lord Howe Island Board

by the Canberra Ornithologists Group

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Summary

This report describes a survey in September 2014 of landbirds on Lord Howe Island conducted by the Canberra Ornithologists Group (COG). The survey was the second of what is intended to be an annual assessment of the status of landbirds on the island. The survey will be repeated each September for at least the next three seasons (2015–2017). This and further surveys have been commissioned by the Lord Howe Island Board as part of the necessary monitoring processes associated with a plan to eradicate rodents from the island.

The purpose of the survey is to provide baseline information on the numbers and distribution of landbirds on Lord Howe Island. Point counts were chosen as the preferred method for the island survey. The data collecting protocol used is one we believe best fitted the limitations of time and effort available in the field. Transects surveys were conducted on five evenings, concentrating on the most important ground feeding species present in the settlement area.

As for the 2013 survey, forty-eight paired sites were selected across the survey area. The sites were stratified to represent various vegetation types and habitat zones with seven transects selected within the settlement area. From experience gained during the 2013 survey, four teams of two observers surveyed all paired sites in three days with all of sites resurveyed over the following three days.

The mean abundance, mean reporting rate, frequency and group size for each of the 16 species recorded during the survey was calculated. In addition, the 16 species were analyzed using a generalized linear mixed model allowing both fixed and random effects to be taken into account. Maps of species distribution for 14 species with sufficient data are compared with the observations obtained in 2013.

The most common bird was the Golden Whistler followed by the Silvereye. A noticeable reduction in all indices occurred for the next four most frequently reported species – Blackbird, Pied Currawong, Magpie-lark and Welcome Swallow.

In general, the habitat influences appear to be reasonable and generally reflect what we know about the biology of the species. The suggested potential differences between *Years* for some species (Buff-banded Rail, Magpie-lark, Welcome Swallow and Blackbird) need further exploration and additional observations before it can be suggested that we have detected truly significant differences between years.

The protocol for this baseline survey provides a rigorous survey method for obtaining data, giving statistically sound measures of significant changes in population numbers and distribution of species over time – particularly any changes occurring before and after the proposed rodent eradication for mid 2016.

Introduction

This report describes a survey in September 2014 of landbirds on Lord Howe Island (latitude 31° 33´S and longitude 159° 05´E). The survey was the second of intended annual assessments of the status of landbirds on the island conducted before the proposed rodent eradication program occurs. The survey will be repeated each September for at least the next three seasons (2015–2017).

This and the further surveys were commissioned by the Lord Howe Island Board as part of the necessary monitoring processes associated with a plan to eradicate rats and mice from the island. This eradication is now scheduled for mid 2016.

The purpose of the surveys is to provide baseline information on the numbers and distribution of landbirds on Lord Howe Island. Landbirds are here defined as those species that are either breeding residents on the island or visitors that are land-based. Specifically, all seabirds are excluded but shorebirds are not.

A rigorous survey method was required to provide data that can give a statistically sound measure of significant changes in population numbers and distribution – if they occur.

As indicated in the first report (Fullagar *et al.*, 2014) point counts were chosen as the preferred method for the island survey. Much of the vegetation is dense and often difficult to access; repeated line transects would have been difficult to follow in such circumstances. Point counts are easier to incorporate in a formally designed study, easier to locate and lay out, and they provide a more reproducible data set. As well, point counts are more efficient than transect counts because they allow for more data points (Bibby *et al.*, 1997).

We investigated the power of available statistical analyses achievable with this method of population assessment (Nicholls unpublished) and adopted the data collecting protocol we believe best fitted the limitations of time and effort available in the field. As an additional data set we did, however, use a simple transect procedure to assess the abundance of six species within the most closely settled area of the island. These transects were walked at dusk using the network of sealed roadways.

For a review of the historical records of birds on Lord Howe Island see Fullagar *et al.*, 2014.

Methods

Choice of survey sites

For practical reasons, determined by the time available for surveying and the number of teams we could muster, only the northern part of Lord Howe Island was included.
Mt Lidgbird and Mt Gower were excluded, as were Erskine Valley and any of the mountain slopes below the peaks beyond Mutton Bird Point and Little Island (see Figure 1).

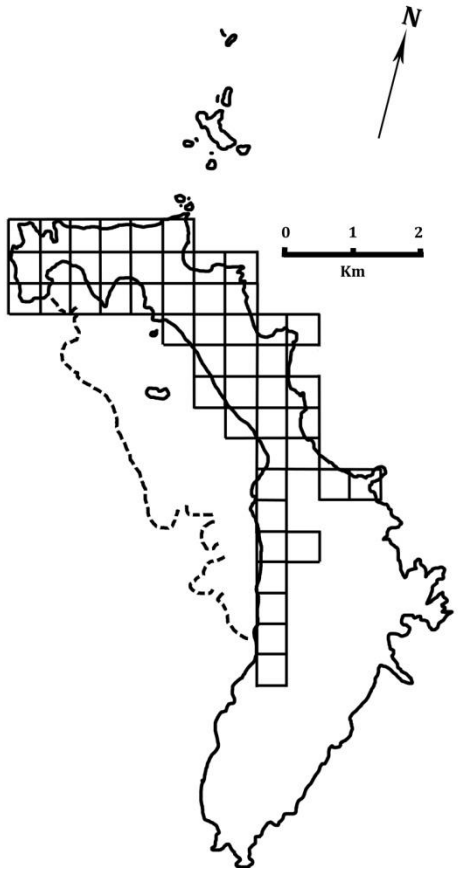


Figure 1. Grid cells, based on point counts, used for surveying distribution of landbirds on LHI, September 2014

The same forty-eight grid cells (see Figure 1) used in 2013 were surveyed again and each grid cell was allocated two count sites. The count sites were stratified to represent the various vegetation types and habitat zones. For a description of paired sites defined by vegetation and habitat classification (see Fullagar *et al.*, 2014).

Point count protocol

Our protocol involved four teams of two observers surveying over six days. Surveying was restricted to between sunrise and late morning. From experience gained during the 2013 survey it was possible to increase the number of sites surveyed per day. Each team had sufficient time to survey eight sites per day. All 96 sites could then be surveyed in three days with a repeat of all 96 sites over the following three days. Unlike 2013, the final day was not required. It is essential to retain this final day as a back-up in case of inclement weather.

The paired sites were a minimum of 100 metres apart but were similar in topography and vegetation (see Appendix A in the 2013 report for site details of geo-location, vegetation code, vegetation group and habitat zone, Fullagar et al. 2014) Three sites 19, 25 and 26

were repositioned to allow for easier access but all three remained in the same vegetation and habitat classification, see Appendix A for new geo-coordinates.

The count protocol at each site was to record the abundance of each species seen or heard within a 50-metre radius over a 10-minute period, with observers moving within the plot area if required. Team members would survey a pair of sites independently and simultaneously before swapping sites and again counting for 10 minutes.

All sites were visited four times, giving a total of 384 counts. No site was resurveyed by the same observer. Repeatability of counts at a site could be tested by comparing counts at sites on the same day and on different days. Such analyses have not been undertaken to date.

Only experienced observers were chosen for the field work. All team members were well-trained, expert bird watchers with considerable previous involvement with similar style field work.

In the field the location of the paired sites was arrived at by GPS. Due to difficulties of terrain and differences in vegetation it was often not possible to survey the exact pre-determined point. Observers were requested to survey as near as they could to the allocated point. On arrival a waypoint reading was taken of the actual point surveyed and subsequently compared with the allocated central point of the site. The average distance between these two locations was 8 metres so the survey site was still well within the appropriate vegetation group and habitat zone.

Statistical treatment of site counts

Several summary parameters were used as population indices and these will become useful for comparison with data collected in future.

- *Mean abundance* (A). The average number of individuals of a species seen per observation and defined as the sum of the number of individuals reported divided by the total number of observations (384).
- *Mean reporting rate* (R). Defined as the number of recorded occurrences divided by the total number of observations (384).
- *Frequency* (F). The site occupancy rate or incidence rate defined as the number of sites on which a particular species was recorded divided by the total number of sites (96).
- *Group size* (G). Defined as the sum of the number of individuals divided by the number of observations in which a species was recorded.

Statistical model

A generalized linear mixed model was the starting point for the analysis of the combined (2013 and 2014) data. We need to account for the non-normal distribution of the counts and the structural components of the survey design. We assume that the counts are drawn from Poisson distributions. The fixed effects explored are *Vegetation Group* (a three-level factor) derived from the *Vegetation type* (see Table 1, Fullagar *et al.*, 2014) and *Year* to test if there has been any detectable change over the twelve-month interval between surveys. The random effects include, *Site* (Site no.), *Zone* (in which the Count site is located), *Observer* (Observer identity) and *Day*, when the survey was performed. All models were fitted using the R software (R Core Team, 2014) and the package 'lme4' (Bates *et al.*, 2014). Confidence intervals were derived from the models using functions from the packages 'mle4' and 'boot' (Canty and Ripley, 2014).

Due to the difficulty in collecting reliable abundance data for Silvereyes, only presence or absence data are available. Appropriate models fitted to these data assume a binomial error structure and a logit link function.

Transect surveys

The same seven transects covered in September 2013 of variable length (ranging from 570 to 970 metres) were walked at a slow pace by a single observer twice (in one direction and then return) on five days. The transects followed sealed roads. To reduce the variability of speed of travel, each transect was set a specific duration for survey with a walking pace set at 2 km/hr.

Figure 2 provides a map of the Lord Howe Island core settlement area, showing the location of transects A–G. The green pointers indicate junctions, where more than one transect starts or finishes. The yellow pointers indicate transect end points. See Appendix B for a description of the start and finish points for each transect.

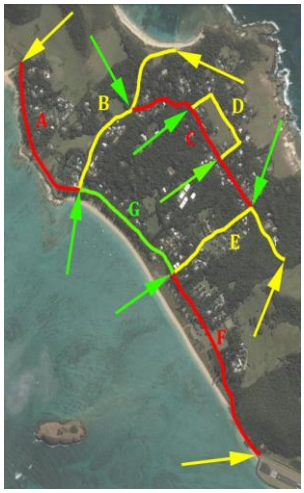


Figure 2. Map of core settlement area, LHI, with location of transects A–G

None of the observers walked the same transects twice with each observer covering five of the seven transects (see Table 1). For practical purposes only six species were targeted for the transect counts. The purpose of the transact counts was to survey most of the ground-feeding species present in the settlement area.

Table 1. Allocation of observers to transects, LHI core settlement, September 2014*

Observer	*Transects*						
	A	B	C	D	E	F	G
Ob1	0	0	2	2	2	2	2
Ob2	2	0	0	2	2	2	2
Ob3	2	2	0	0	2	2	2
Ob4	2	2	2	0	0	2	2
Ob5	2	2	2	2	0	0	2
Os6	2	2	2	2	2	0	0
Ob7	0	2	2	2	2	2	0
Length (m)	*750*	*970*	*900*	*570*	*820*	*970*	*670*

*Note: Observer not necessarily the same for 2013 and 2014.

Statistical analysis of transect data

There are two groups of potential predictors of the abundance of the observed species. The first group characterizes the observations in terms of physical characteristics of the transect (*Length*), the direction of the traverse (*Out* or *Return*) and the duration of the count (*Duration*) or the average speed of travel (*Speed*). These physical characteristics are all connected.

More individuals would be expected to be observed on longer transects, or during longer travel times or slower speeds of travel; there is no *a priori* reason to think that direction of travel should influence the number of individuals observed. Also, in this group is the *Year of observation* which potentially reflects changes over time scales of a year or more. The second group of predictors includes *Observer identity*, *Transect identity* and *Date of observation*.

It is recognized that there are observer differences in terms of ability to detect individuals of different species. It is also recognized that transect differences will favour more individuals on some transects relative to other transects and some days will be better than others for making observations.

We are not primarily interested in the effects of the second group of predictors but may need to account for the variability in observations that can be attributed to these factors. We do this by considering *Observer identity, Transect identity* and *Date of observation* as random effects. Of the first group *Year of observation* is of primary interest; the others may need to be accounted for to reduce the unexplained variation.

The response variable – the number of individuals per species observed per transect survey – can be considered a Poisson variable where the variance is equal to the mean. To model the observed data we need to fit a Generalized Linear Mixed Model to account for the variance structure of the residuals and the presence of both random and fixed effects. Models were fitted using R (R Core Team, 2014) and the package "lme4" (Bates *et a*l., 2014). Estimates of the mean number of individuals observed per transect and confidence intervals were derived from parametric bootstrapping techniques based on functions supplied with the package "nlme" based on the package "boot" (Canty and Ripley, 2014).

Species names

Species names used in this report follow current preferred internationally accepted nomenclature (see Appendix C). For simplicity, some of the common names have been shortened to conform with island usage.

Survey dates and weather conditions

The 2014 survey was conducted between 8 and 13 September. Teams were in the field soon after dawn each day and ready to start by about 0600. Teams often worked through until late morning. The time to complete a set of counts varied mostly due to the time taken to reach all allotted count sites.

The first day of the survey started overcast with a fresh breeze but soon improved to sunny and warm conditions. The next two days were fine and clear with a light breeze but became overcast in the afternoon of the third day of the survey with the passage of a weather front. The front produced rain overnight leading to a late start on the fourth day under cloudy and windy conditions that cleared as the day progressed. The remaining two days of the survey were sunny and warm. Some weather observations for the week are shown in Table 2.

Table 2. Selected daily weather observations, LHI, 7–14 September 2014

Date	*Day*	*Min °C*	*Max °C*	*Rain (mm)*	*Direction*	*Max. wind speed (km/h)*
7	Sun	14.4	18.8	0	E	46
8	Mon	14.8	18.7	0.2	E	41
9	Tue	15.5	19.2	0	N	30
10	Wed	16.3	20.2	0	WS	69
11	Thu	12.4	19.8	16.8	WSW	52
12	Fri	16.7	20.2	0	WSW	41
13	Sat	13.1	19.1	0	E	33
14	Sun	9.4	19.9	0	N	22

Source: Bureau of Meteorology website

Results and discussion

Site counts

The maximum number of times that any one species could be recorded was 384: the sum of 96 count sites each with four visits. Table 3 shows the distribution of the counts in the vegetation groups and habitat zones.

Table 3. No. of counts in three vegetation groups in five habitat zones, LHI*

Vegetation group	*Habitat zone*					***Total counts***
	1	*2*	*3*	*4*	*5*	
Lowland forest	104	24	32	16	32	**208**
Palm forest	8	56	8	0	32	**104**
Open	0	32	4	32	4	**72**
Total surveys	**112**	**12**	**44**	**48**	**68**	**384**

*For a definition of vegetation group and habitat zone see Report 1.

Abundance, reporting rate, frequency and group size

Table 4 shows the abundance, reporting rate, frequency and group size, irrespective of vegetation or habitat, for 16 birds recorded in 96 count sites on Lord Howe Island. The reporting rate is given in descending order.

As occurred in 2013, the most common bird in terms of reporting rate and abundance was the Golden Whistler. The number of Silvereye individuals in a survey plot was difficult to estimate given their flocking behaviour, their often quick passage through the survey plots and the fact that they were usually detected only by calls. For the Silvereye, only occurrence was analyzed and no estimate of abundance or group size was possible.

Again, as we found in the previous year, a noticeable reduction in all indices occurred for the next four most frequently reported species – Blackbird, Pied Currawong, Magpie-lark and Welcome Swallow – but for the rest all summary indices, except group size, were much smaller. Welcome Swallow was not included in the 2013 analysis.

Table 4. Abundance, reporting rate, frequency and group size for 16 bird species recorded at 96 count sites, LHI, 2014

Species name	*Abundance*	*Reporting rate*	*Frequency*	*Group size*
Golden Whistler	1.83	0.76	0.85	2.42
Silvereye		0.70	0.86	
Blackbird	0.42	0.23	0.47	1.79
Pied Currawong	0.36	0.23	0.53	1.52
Magpie-lark	0.29	0.16	0.34	1.82
Welcome Swallow	0.41	0.15	0.26	2.84
Sacred Kingfisher	0.12	0.10	0.27	1.15
Emerald Dove	0.13	0.09	0.27	1.36
Woodhen	0.09	0.07	0.20	1.33
Buff-banded Rail	0.08	0.05	0.11	1.63
Swamphen	0.07	0.04	0.07	1.86
Song Thrush	0.03	0.03	0.07	1.00
Masked Lapwing	0.03	0.02	0.06	1.44
White-faced Heron	0.02	0.02	0.06	1.17
Bar-tailed Godwit	0.04	0.01	0.01	7.00
Red-necked Stint	0.00	0.00	0.01	1.00

Table 5 shows the 2014 reporting rate, abundance and frequency for the most commonly reported species – the Golden Whistler, and the two species of greatest concern: the Woodhen and the Pied Currawong. The three indices for observations within the plot area are presented defined by vegetation and habitat zone.

Table 5. Reporting rate, abundance and frequency for the Golden Whistler, Woodhen and Pied Currawong, defined by vegetation group and habitat zone, LHI, 2014

Golden Whistler

	Reporting rate			*Abundance*			*Frequency*		
Vegetation group	*1*	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*
Habitat zone									
1	0.89	0.88		2.14	1.63		0.26	0.02	
2	0.96	0.89	0.03	2.38	2.54	0.03	0.06	0.14	0.01
3	1.00	0.63	0.25	2.47	0.88	0.25	0.08	0.02	0.01
4	0.88		0.25	2.38		0.44	0.04		0.03
5	0.91	0.81	0.25	2.25	1.69	0.25	0.08	0.08	0.01

Woodhen

	Reporting rate			*Abundance*			*Frequency*		
Vegetation group	*1*	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*
Habitat zone									
1	0.00	0.00		0.00	0.00		0.00	0.00	
2	0.08	0.04	0.00	0.08	0.05	0.00	0.02	0.02	0.00
3	0.03	0.00	0.00	0.03	0.00	0.00	0.01	0.00	0.00
4	0.50		0.16	0.75		0.22	0.04		0.03
5	0.06	0.22	0.00	0.06	0.28	0.00	0.02	0.05	0.00

Pied Currawong

	Reporting rate			*Abundance*			*Frequency*		
Vegetation group	1	2	3	1	2	3	1	2	3
Habitat zone									
1	0.26	0.25		0.36	0.25		0.17	0.02	
2	0.13	0.23	0.00	0.17	0.29	0.00	0.02	0.06	0.00
3	0.31	0.00	0.00	0.34	0.00	0.00	0.06	0.00	0.00
4	0.50		0.09	1.44		0.19	0.04		0.02
5	0.25	0.50	0.00	0.28	0.91	0.00	0.06	0.07	0.00

Results were similar to the previous year for the Golden Whistler. The lowest reporting rate and abundance was in vegetation group 3 (Pasture, Dune, Golf course) within habitat zone 2 (Settlement) while the highest frequency was in vegetation group 1 *(Drypetes/Cryptocarya*) within habitat zone 1 (North Hills).

For the Woodhen, the highest reporting rate and abundance was in habitat zone 4 (Suburban) within vegetation group 1 (*Drypetes/Cryptocarya*). The highest reporting rate and abundance for the Pied Currawong was in habitat zone 4 (Suburban) within vegetation group 1 (*Drypetes/Cryptocarya*).

Generalized linear mixed model

Data from the 2013 and 2014 surveys have been combined and analyzed. Note that the model for Silvereye is fitted to the presence–absence data while for all other species the model is fitted to the abundance data. The results of the generalized linear mixed model are presented as follows:

- the significance of the fixed effects *Vegetation group* and *Year*, and the interaction between these two variables.
- the magnitude of the random effects
- the estimated abundances and confidence intervals derived from the appropriate model
- species-related information on issues with the fitting and interpretation of the model (see pp. 14–15).

Table 6 shows the significance of the fixed effects *Vegetation group* and *Year*, and their interaction for each of the species for which there are sufficient non-zero observations.

Table 6. Significance of fixed effects

Species	*Vegetation group*	*Year*	*Interaction*
Golden Whistler	<0.001	0.88	0.1
Silvereye	<0.001	0.74	0.52
Blackbird			<0.001
Pied Currawong	0.0002	0.99	0.7
Magpie-lark	0.57	0.03	0.06
Welcome Swallow			0.02
Sacred Kingfisher			0.67
Emerald Dove	<0.001	0.21	0.46
Woodhen	<0.001	0.23	0.79
Buff-banded Rail	0.52	0.02	0.37
Song Thrush			
White-faced Heron			

In Tables 6 and 7, cells left blank represent random effects considered to be insignificant and equal to zero.

The variance estimates for the random effects from the final model are fitted (see Table 7).

Table 7. Variance estimates for random effects

Species	*Count site*	*Habitat zone*	*Observer*	*Day*
Golden Whistler	0.4255		0.2285	
Silvereye	1.7379		0.1829	0.258
Blackbird	0.7675	1.7202		
Pied Currawong	1.119		0.1026	
Magpie-lark	0.6845	2.684	0.0728	
Welcome Swallow	1.35		0.1334	
Sacred Kingfisher				
Emerald Dove	0.6093	0.4455		
Woodhen		3.029		
Buff-banded Rail	3.25	34.35		
Song Thrush				
White-faced Heron				

Table 8 provides an estimated number of individuals found at count sites for three vegetation types. For four species, data are significantly different between years. For Silvereye, the estimated values are the probability of observing Silvereye not the number of individuals.

Table 8. Estimated number of individuals derived from the final fitted model

Species	*Year*	*Vegetation type*		
		Lowland forest	*Palm forest*	*Open*
Golden Whistler		2.21 (0.86 – 4.78)	2.05 (0.83 – 4.57)	0.29 (0.13 – 0.57)
Silvereye		0.87 (0.48 – 0.98)	0.78 (0.33 – 0.96)	0.49 (0.10 – 0.89)
Blackbird	2013	0.30 (0.02 – 2.02)	0.22 (0.13 – 2.00)	0.01 (0.01 – 0.04)
	2014	0.26 (0.02 – 1.74)	0.24 (0.01 – 1.33)	0.05 (0.00 – 0.26)
Pied Currawong		0.35 (0.08 – 1.42)	0.33 (0.05 – 1.43)	0.06 (0.02 – 0.28)
Magpie-lark	2013	0.32 (0.00 – 1.90)	0.32 (0.00 – 1.90)	0.32 (0.00 – 1.90)
	2014	0.21 (0.00 – 1.22)	0.21 (0.00 – 1.22)	0.21 (0.00 – 1.22)
Welcome Swallow	2013	0.03 (0.01 – 0.11)	0.01 (0.00 – 0.04)	2.40 (0.21 – 13.9)
	2014	0.03 (0.01 – 0.16)	0.07 (0.00 – 0.39)	3.05 (0.23 – 17.4)
Sacred Kingfisher				
Emerald Dove		0.15 (0.03 – 0.62)	0.22 (0.03 – 1.02)	0.00 (0.0 – 0.02)
Woodhen		0.09 (0.00 – 0.46)	0.26 (0.00 – 3.22)	0.04 (0.00 – 0.44)
Buff-banded Rail	2013	0.17	0.17	0.17
	2014	0.08	0.08	0.08
Song Thrush				
White-faced Heron				

Golden Whistler

From 503 records of Golden Whistler there were generally 2 individuals per count in the forest and 0.3 individuals in the Open group habitat. The interaction is not significant; the difference between years is not significant but the difference between habitats (Forest versus Open) is significant.

Silvereye

Note that a different mixed model is fitted to the Silvereye data due to the recording of presence or absence, not abundance. We collected a total of 522 records of Silvereye. The fixed effects interaction and the main effect *Year* were not significant. *Observer*, *Count site* and *Day* were significant random effects. The probability of recording Silvereye in the forest is nearly twice that of recording it in the Open vegetation.

Blackbird

From 163 records there was a significant fixed effect interaction so the two main effects are retained in the model. The significant random effects were *Count site* and *Habitat zone*. The interaction is due to small increases in the recorded abundance in the forests compared with an apparent sixfold increase in the Open vegetation in 2014 compared with 2013. The model is apparently not very stable and confidence intervals are not available.

Pied Currawong

Pied Currawong were recorded across all vegetation groups and less abundantly or frequently in the Open group. The interaction is not significant and the differences between the two years were not significant. The recorded abundance is positively associated with forest compared to that recorded in the open habitats.

Magpie-lark

There is some evidence from the 128 records that the fixed effects interaction is significant, but this model is not well fitted and the model without the interaction has been used to evaluate the random effects. Of the fixed main effects only *Year* was significant. There was an apparent reduction in the abundance in 2014 compared with 2013.

Welcome Swallow

From 103 recorded sightings there were a greater abundance of Welcome Swallow in the Open vegetation. The interaction is significant, hence the main effects have not been tested as they have to be retained in the model. The random effects are *Observer* and *Count site*. The interaction appears to be driven by the apparent tenfold increase in abundance recorded in the Palm forest in 2014 compared with 2013, whereas there was less than a doubling over the same period in the Open vegetation.

Sacred Kingfisher

The Sacred Kingfisher was recorded on 66 occasions and in all vegetation groups. The models are unstable and, while the evidence points towards there being no interaction between the fixed effects, we are unable to estimate the significance of *Year* or *Vegetation*

group. Confidence intervals are not available as estimates of the means for either of the main effects are not reliable.

Emerald Dove

From 77 records, there was only one record of the Emerald Dove from the Open vegetation group. *Vegetation group* is the only significant fixed effect (see Table 6); the significant random effects are *Habitat zone* and *Count site* identity (see Table 7).

Woodhen

This species was recorded 46 times. Only *Vegetation group* of the fixed effects is significant, and *Habitat zone* is the important random effect. The evidence points to greater abundance in the Palm forest relative to the other two vegetation groups.

Buff-banded Rail

There appears to be sufficient data (52 records) to permit modelling the abundances, but the distribution is uneven. Rails were only recorded in habitat zones 2 and 4. As a consequence the fitted models are unstable. The evidence points to no significant *Vegetation group* effect and an apparent reduction in abundance of the Rail from 2013 to 2014. Due to the unstable nature of the model it is not possible, at present, to estimate confidence intervals for the estimated means given in Table 8.

Swamphen

There are only 33 records of Swamphen across the two surveys. This is below the 5% cut off suggested by Cunningham and Olsen (2009) and therefore no model has been fitted. No records were made in the Lowland forest or Palm forest.

Song Thrush

Of the 21 records, twenty are from the Palm forest and one from the Open vegetation.

Masked Lapwing

Of the 23 records of this species, 22 were in the Open vegetation group.

White-faced Heron

The number of records of White-faced Heron was low: 8 out of a total of 684. This is well below the 5% cut off point used by Cunningham and Olsen (2009).

Bar-tailed Godwit

This species was recorded three times, all from the Open vegetation group.

Red-necked Stint

This species was recorded only once in the two years of surveys and that record was in 2014 – from a *Count site* in the Open vegetation group.

It is recognized that generalized linear mixed models can be difficult to fit. In the present study the number of random effects contributes to the complexity of the models. The small number of individuals recorded also adds difficulties to the parameter estimation. For some species the estimated confidence intervals are clearly very wide and appear to be well outside the observed data. This reflects some of the complexities of these models. With additional data from more years, some of these difficulties can be expect to diminish.

A Poisson distribution has been assumed for the error structure. This is a reasonable first approximation. Additional work is needed to explore some alternative error structures and alternative random effects specifications.

In general, the habitat influences appear to be reasonable, and generally reflect what we know about the biology of the species. The suggested potential differences between years for some species (Buff-banded Rail, Magpie-lark, Welcome Swallow and Blackbird) need further exploration and additional observations before it can be suggested that we have detected truly significant differences between years.

To allow for a statistical comparison of the survey data pre- and post-rodent eradication, fixed effects such as *Vegetation type* and *Year* of survey together with random effects such as *Count site*, *Observer* and *Day* differences need to be taken into account.

Species distribution

Figures 3–6 show the 2014 frequency distribution of 14 species across the lowlands of Lord Howe Island. These distribution maps are based on the relative occurrence of each species derived from the accumulated site counts. Site counts have been distributed within a grid pattern extending across the survey area (see Figure 1). Distribution maps were not prepared for two species with too few data: Bar-tailed Godwit and Red-necked Stint. White-faced Heron and Welcome Swallow were omitted from the 2013 report, but in this report the 2013 and 2014 distribution maps for these species are shown.

The size of each dot corresponds to the number of times each species is recorded as present within each grid cell. In each cell there are two count sites, giving a possible score of eight if the species is seen on every count in the cell. The smallest dot indicates one or two occurrences, with increasing dot size (doubling in size with each increment) for three or four and five or six occurrences, leaving the largest dot to indicate a maximum of seven or eight out of the possible eight counts.

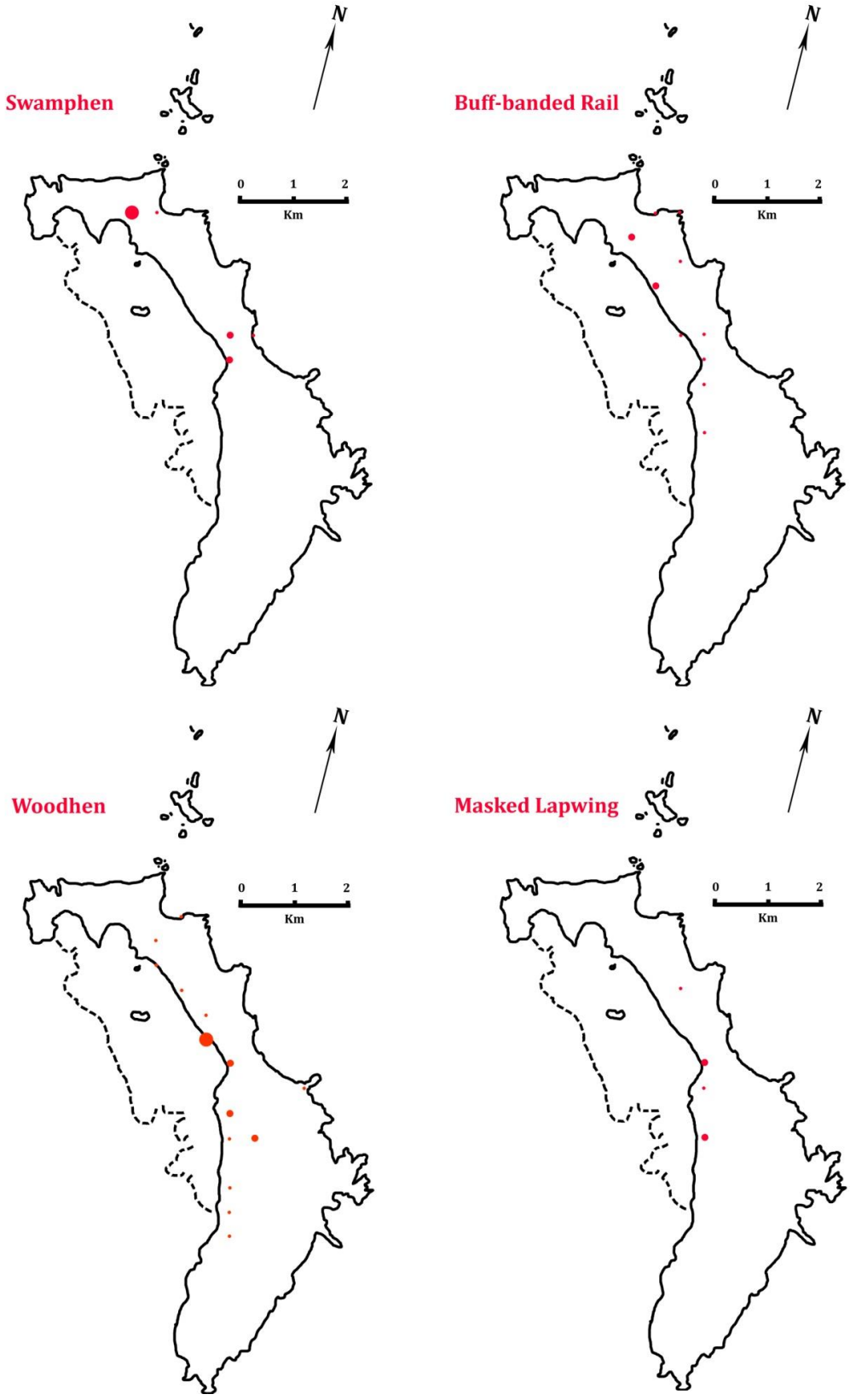


Figure 3. Distribution of Swamphen, Buff-banded Rail, Woodhen and Masked Lapwing, September 2014, across northern LHI, by frequency of occurrence at count sites

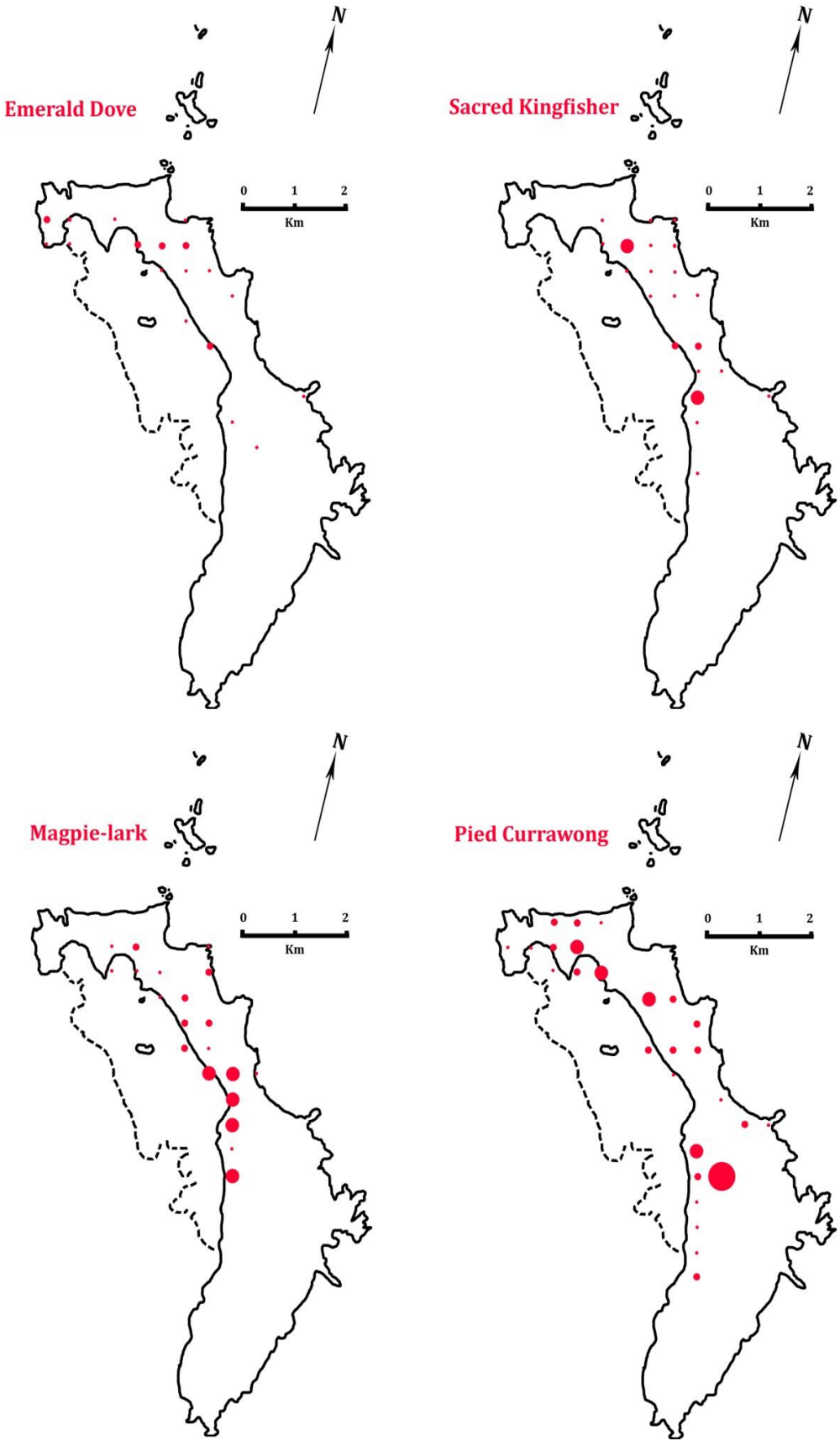


Figure 4. Distribution of Emerald Dove, Sacred Kingfisher, Magpie-lark and Pied Currawong, September 2014, across northern LHI, by frequency of occurrence at count sites

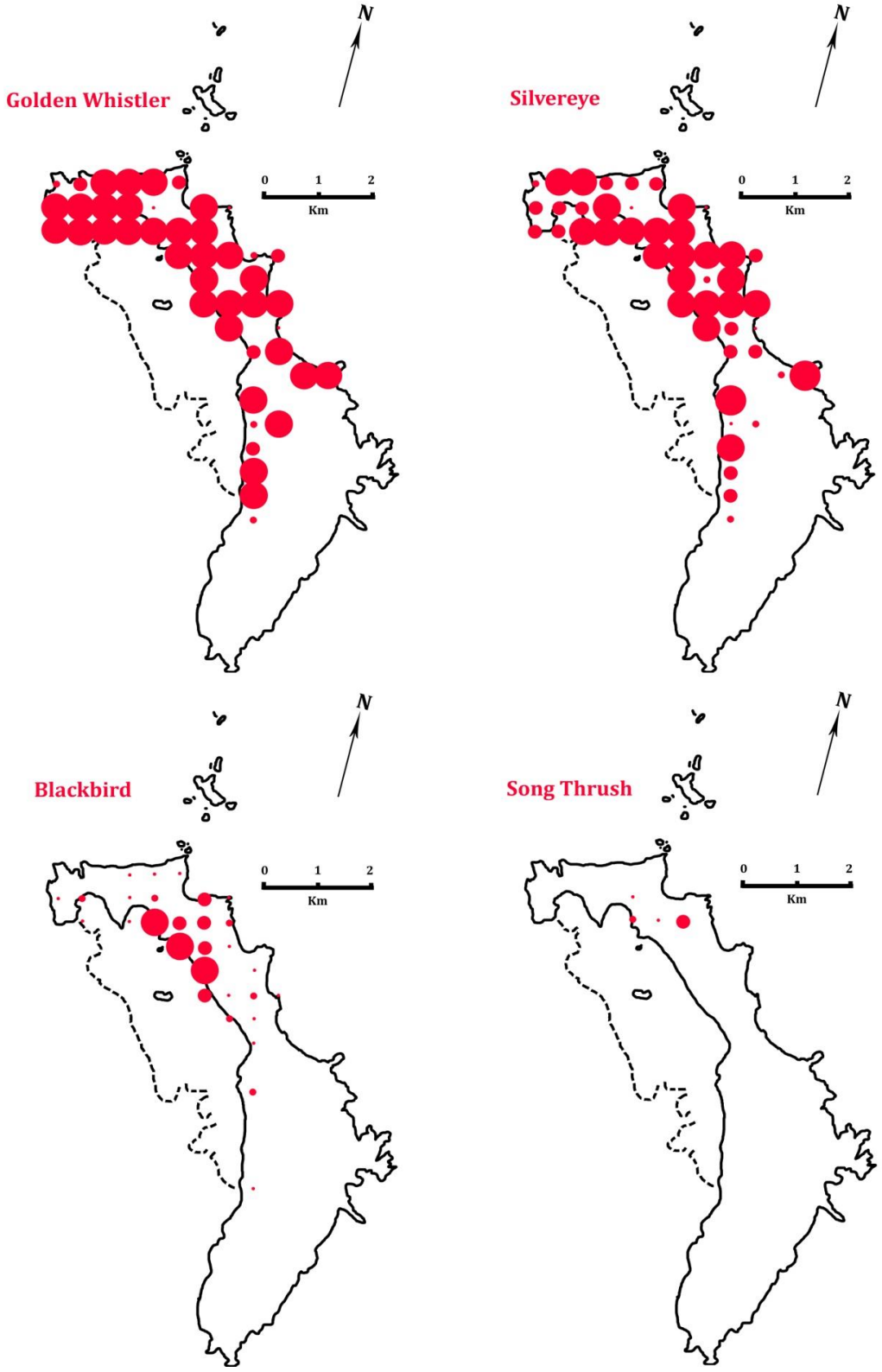


Figure 5. Distribution of Golden Whistler, Silvereye, Blackbird and Song Thrush, September 2014, across northern LHI, by frequency of occurrence at count sites

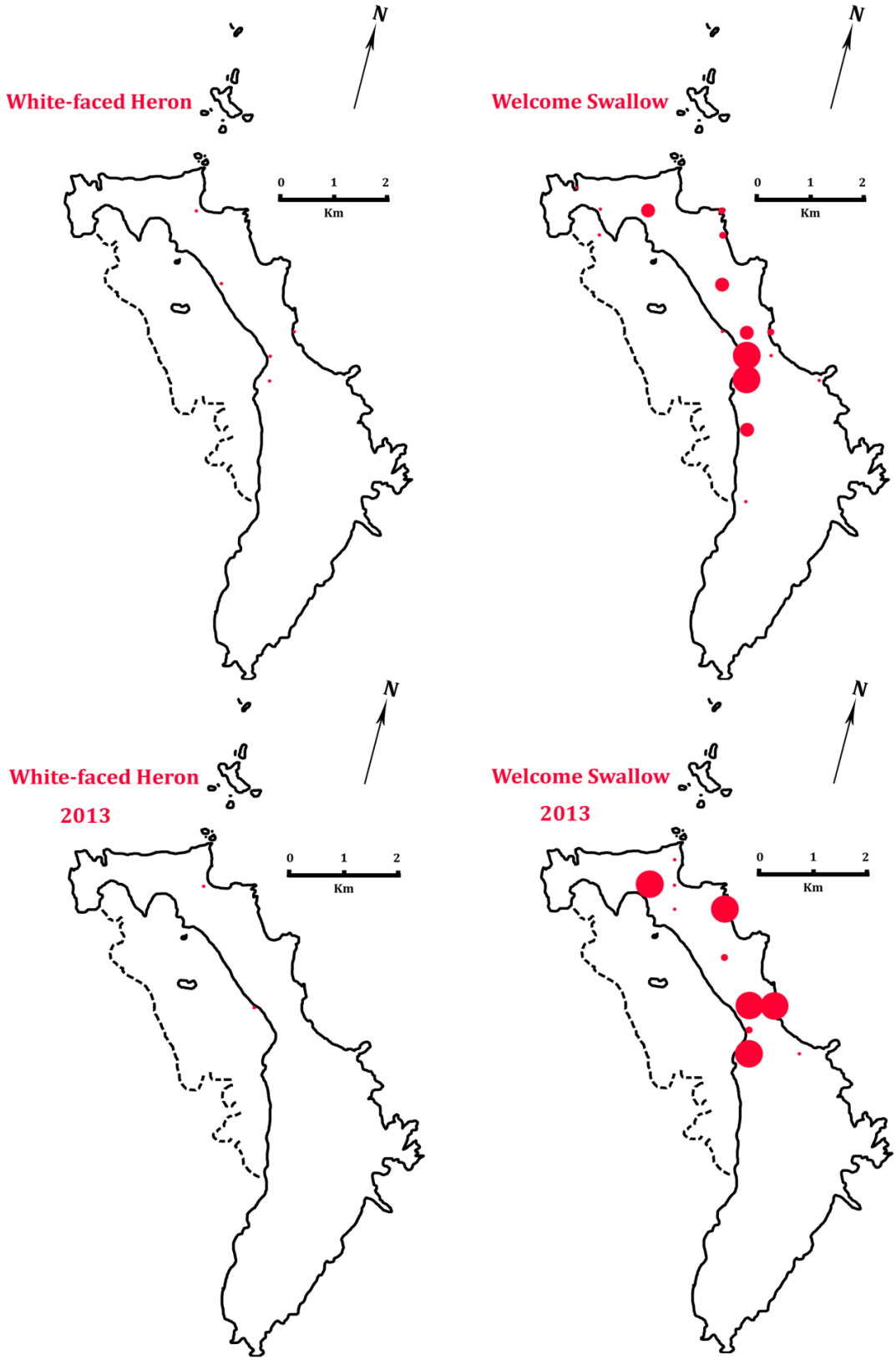


Figure 6. Distribution of White-faced Heron and Welcome Swallow, September 2013 and 2014 (upper), across northern LHI, by frequency of occurrence at count sites

Transect counts

In five days, seven observers recorded a total of 70 observations of the numbers of six species on the transects. As the speed of travel may influence the number of individuals counted – the faster the speed the fewer the number observed – the speed of travel for each transect was standardized to 2 km/hr in 2014.

In 2013, before standardization was applied, the average speed was 3.21 km/hr (range 1.94–4.47). In 2014, however, the average speed was 1.90 km/hr (range 1.54–2.16). Consequently, the variance in the speed of travel was significantly reduced (2013 variance 0.42, SD $\pm$ 0.64; 2014 variance 0.01, SD $\pm$ 0.11).

Song Thrush

No main fixed effects are significant (see Table 9). The magnitude of the estimates of the variances associated with the random effects are small, so the significance of these random effects were assessed by dropping each random effect one by one. The least significant random effect was removed and the remaining two tested by dropping each in turn. The selected final model had no fixed effects with only *Day* as the random effect. This model estimates the mean number of individuals per transect as 0.5 (95% confidence interval is 0.18 to 1.07).

Common Blackbird

Only *Direction* is significant, with the mean number of individuals recorded on the return traverse about four times greater that the outward observation. All three random effects are significant and retained in the model. The mean number of individuals seen on the outward journey is 9.4 (3.6 to 20.5) and for the return trip 13.6 (5.2 to 29.5). Note that there is a level of complexity here that is not fully clear. The confidence intervals are wide and substantially overlap, suggesting that there is no difference. However, a comparison of the two models, one with *Direction* and one without, clearly suggest otherwise. If one ignores the fixed effect, the estimated mean number of individuals is 10.4 (4.3 to 25.9).

Sacred Kingfisher

There is evidence that *Year* and *Duration* have an effect on the number of individuals observed (see Table 9); if *Year* is fitted then *Duration* does not contribute significantly to the model. The estimated number of individuals per transect in 2013 was 0.07 (0 to 0.18) and in 2014, 0.38 (0.16 to 0.67).

Woodhen

There is no evidence that *Year*, *Duration* or *Direction* are associated with the number of Woodhen recorded (see Table 9). *Transect (Identity*) is the only significant random effect. Based on this simple model the estimated number of Woodhen per transect is 0.22 (0.02 to 0.67) individuals.

Buff-banded Rail

There is no evidence that *Year*, *Duration* or *Direction* are associated with the number of Buff-banded Rail recorded (see Table 9). The two random effects, *Transect (Identity)* and *Day* appear to be significant while *Observer* is not significant. The estimated number of individuals per transect is 1.77 (0.36 to 5.63).

Emerald Dove

The only significant fixed effect is *Direction*. *Year* and *Duration* are not significant. *Transect (identity)* and *Day* have been retained as the random effects. The estimated number of individuals seen per transect on the outward count was 1.26 (0.49 to 2.54) and on the return count 0.50 (0.17 to 1.03) individuals.

Table 9 provides details of the significance of the fixed effects on the number of individuals of target species observed on the urban transects. The fixed effects were *Year* (2013, 2014), *Direction* (out, return) and *Duration*.

Table 9. Significance of fixed effects on the no. of individuals of target species observed on urban transects

Effect	*Song Thrush*	*Common Blackbird*	*Sacred Kingfisher*	*Woodhen*	*Buff-banded Rail*	*Emerald Dove*
Year	0.94	0.50	0.025	0.94	0.84	0.43
Direction	1.00	<0.001	0.45	0.51	0.15	<0.001
Duration	0.08	0.94	0.010	0.46	0.51	0.15

For most species there appears to be little difference in the abundance of the primary species recorded on the urban transects. The notable exception is the Sacred Kingfisher – more individuals were observed in 2014 compared with 2013. It remains one of the least abundant species recorded and, as such, it would be judicious to note the change but not draw inferences about annual variation at this stage.

Bird atlas data

Between 1 October 2013 and 28 January 2015 there were 4003 records entered on the Birdlife Australia database. These observations comprised 505 counts from 16 observers. There are 25 official BLA survey sites (LHI01-LHI25). The count protocol for the 25 Birdlife Australia sites can be found at

http://birdlife.org.au/documents/ATL-LHI-Lord_Howe_Bird_Monitoring_Site_Guide.pdf

The protocol for the remaining counts is unknown, with many counts simply designated "Lord Howe Island". Ignoring site LHI25, which is a count between Lord Howe Island and Ball's Pyramid, there were 2987 records from 413 counts. These counts were conducted by nine observers of which Observer # 68784 provided 86.5% of the observations from 90% of the surveys.

Between October 2013 and January 2015 counts were conducted regularly between October 2013 and July 2014 (see Table 10) with peaks in December 2013 and January 2014 and again in March 2014. There were virtually no surveys from August 2014 onwards. The majority of counts from other observers occurred in March 2014.

Table 10. No. of counts conducted by month from Observer #68784 compared with the no. conducted by eight other observers, October 2013–January 2015

	2013			*2014*											*2015*	***Total***
Ob-server	*O*	*N*	*D*	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*J*	
#68784	30	37	80	79	38	33	40	19	10	8	0	0	0	0	0	0	***374***
Others	8	0	1	0	0	23	4	0	0	0	3	0	0	0	0	0	***39***

Table 11 gives the number of counts conducted at 24 Birdlife Australia sites between October 2013 and January 2015. The number of counts at LHI01-LHI12 sites are given above, while the number at LHI13-LHI24 sites are given below.

Counts at sites LHI03, LHI17 and LHI18 were made more frequently than at other sites, whereas counts at sites LHI08 to LHI12 and LHI19 to LHI24 were the least frequent.

Table 11. No. of counts conducted at 24 Birdlife Australia sites, October 2013–January 2015

Observer	*LHI01*	*LHI02*	*LHI03*	*LHI04*	*LHI05*	*LHI06*	*LHI07*	*LHI08*	*LHI09*	*LHI10*	*LHI11*	*LHI12*
# 68784	18	13	45	19	22	20	10	6	6	10	7	5
Others	4	3	7	2	0	1	5	2	2	2	0	0

Observer	*LH13*	*LHI14*	*LHI15*	*LHI16*	*LHI17*	*LHI18*	*LHI19*	*LHI20*	*LHI21*	*LHI22*	*LHI23*	*LHI24*
# 68784	20	20	14	10	49	57	7	7	6	1	1	1
Others	0	1	0	1	3	5	0	0	1	0	0	0

The large contribution by one observer and few observations by the remaining eight observers is evident in the BLA data. If similar survey efforts are applied pre- and post-eradication, then observations of the type provided by the current BLA data set is unlikely to be of use in modelling the eradication effects on the bird community of Lord Howe Island.

This is because counts conducted at different frequencies, in different ways by different observers, and not necessarily stratified to account for habitat differences, will not allow statistical inferences to be made with confidence.

Acknowledgements

The survey was conducted under an arrangement between the Lord Howe Island Board and the Canberra Ornithologists Group. The report was compiled by Peter Fullagar and Chris Davey with statistical input from A O (Nick) Nicholls. With his intimate knowledge of the flora and fauna of the island, Ian Hutton was responsible for the arrangements and logistical support on the island and he provided invaluable input. The survey teams were David and Kathy Cook, Michael Robbins, Christine Ledger, Gail Newmann, Ian Hutton, Peter Fullagar and Chris Davey all, apart from Ian Hutton, members of the Canberra Ornithologists Group.

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APPENDIXES

Appendix A. Geolocation, vegetation code, vegetation group and habitat zone for three sites whose position was moved from that in 2013

Site number	*Geolocation*		*Vegetation code*	*Vegetation group*	*Habitat zone*
	Latitude	*Longitude*			
19	31 31 00.1	159 02 52.7	1	1	1
25	31 30 49.1	159 03 21.5	1	1	1
26	31 30 49.3	159 03 25.8	1	1	1

Appendix B. Description of start point and turning point for all transects (A–G)

See Figure 2 for a map of the Lord Howe Island settlement area showing the seven transects. The protocol for these transect counts is also included here.

Description of each transect location

A. Intersection of Neds Beach Road and Lagoon Road to the bridge at Old Settlement Creek.

B. Intersection of Neds Beach Road and Lagoon Road to Neds Beach bathing huts.

C. Intersection of Anderson Road and Neds Beach Road to the corner at the top of Middle Beach Road.

D. Intersection of Anderson Road and Muttonbird Drive up to and along Skyline Drive down McGees Parade to the intersection with Anderson Road.

E. Intersection of Middle Beach Road and Lagoon Road up Middle Beach Road to Anderson Road turning right (S) and down Anderson Road to Bowker Avenue walking track (which is a little difficult to see but is on the W or right hand side of the road and marked by a small triangular trail marker).

F. Intersection of Middle Beach Road and Lagoon Road to the gate at the corner of the air-field at Windy Point.

G. Intersection of Ned's Beach Road with Lagoon Road to the intersection of Middle Beach Road and Lagoon Road (beside the LHI Museum).

Protocol for transect counts

1. Count only the six species of birds (Buff-banded Rail, Woodhen, Sacred Kingfisher, Emerald Dove, Blackbird and Song Thrush). Include all seen or heard on a slow walk from the defined start point to the defined finish point (outward count) and, as a new count, on the return walk to the start point (return count). Keep these two counts separate.

2. Count in the evening not before 17:00 in September – later in mid-summer.

3. Indicate which transect you have counted and include your name and the date.

4. Record the start and finish time for your outward count and your return count.

5. Count all individuals you detect both sides of the road. There is no particular limit on distance but it would be reasonable not to include calls from birds or sightings that are, say, more than 25 metres from the roadside. Do not worry that you might count the same individual or individuals that could have been be seen on another transect at the transect intersections. Just include them as part of your transect count, if you spot them.

Appendix C. Bird species recorded at 96 survey sites, LHI, 2014

Species nomenclature and names follow those recommended by the latest IOC listing (see Gill and Wright, 2006, revised 2013 as version 3.5). For some species we use a simplified alternative in this report.

Name used in this report	*IOC recommended name, if different*	*Scientific name*	*Subspecies*
White-faced Heron		*Egretta novaehollandae*	
Woodhen	Lord Howe Woodhen	*Gallirallus sylvestris*	
Buff-banded Rail		*Gallirallus philippensis*	
Swamphen	Purple Swamphen	*Porphyrio porphyrio*	
Masked Lapwing		*Vanellus miles*	*novaehollandiae*
Bar-tailed Godwit		*Limosa lapponica*	
White Tern[1]		*Gygis alba*	*candida*
Sooty Tern [1]		*Onychprion fuscatus*	*kermadeci*
Black Noddy[1]		*Anous minutus*	
Emerald Dove	Pacific Emerald Dove	*Chalcophaps longirostris*	*rogersi*
Sacred Kingfisher		*Todiramphus sanctus*	*vagans*
Pied Currawong		*Strepera graculina*	*crissalis*[2]
Golden Whistler	Australian Golden Whistler	*Pachycephala pectoralis*	*contempta*[2]
Magpie-lark		*Grallina cyanoleuca*	
Welcome Swallow		*Hirundo nigricans*	
Silvereye		*Zosterops lateralis*	*tephropleurus*[2]
Blackbird	Common Blackbird	*Turdus merula*	
Song Thrush		*Turdus philomelos*	
Red-necked Stint		*Calidris ruficollis*	

Notes: 1. Seabirds, so not analyzed

2. Endemic subspecies