Bird counts in eucalypt woodland at Koah, Far North Queensland

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Abstract

Few studies have been published about woodland bird assemblages in north-east Queensland. Here we present results of a census of birds in eucalypt woodland at Koah over three two-month periods. A 12.8 ha property was surveyed in three 2-ha plots, birds in each plot being counted for 20 minutes on nine occasions within each two-month period. 20-min 2-ha area searches are a nationally recommended method for censusing woodland birds, but adequate replication is required for local studies. Incidental observations were also recorded over seven years. Assemblage data provided strong discrimination over time and between plots notwithstanding little variation in vegetation between them, but only limited discrimination at the level of species. Fifty-four species were detected in plot surveys and 138 species opportunistically over seven years. The species assemblage differed markedly from that of a similar study 35 km away for reasons that are unclear. Our study suggests that nine replicate counts using this standard protocol is a good level of replication with which to document changes in the avifauna over time and at local scales.

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Introduction

The 20-minute area search as a census method for forest birds was perhaps first introduced to Australia by Loyn (1986). He argued that area searches emphasize more complete sampling of the avian assemblage compared to transect counts, with the time limit providing the constraint that renders searches comparable. This comes, compared to transect surveys, at the expense of strict quantification of bird density. Watson (2004) demonstrated that 2-hectare 20-minute bird searches were more efficient and detected considerably more species than equivalent transect surveys in south-eastern Australian woodland. Similarly, Pascoe *et al.* (2019) found area searches to be more effective than point or transect counts in mulga scrub in central Australia. As a result, the 2-ha 20-min search has been adopted as standard for volunteer observers counting bushbirds in Australia (Birdlife Australia 2023). Analysis of volunteer surveys has shown the power of the method to document regional-scale changes to bird abundance among common species, though not rare or hard-to-detect species (Baker *et al.* 2019). Working in temperate woodland, Szabo *et al.* (2009) also found volunteer surveys of this type to be effective for regional applications, and Mac Nally *et al.* (2009) provide a working example in similar habitat. However, published studies using the technique at local scales appear to be scarce (one example is Stark 2013).

Few studies have been published about woodland bird assemblages in north-east Queensland as

studies in the region have mostly been in rainforest. Notable exceptions are Kutt *et al.* (2012) and Kutt and Vanderduys' (2017) study of woodland birds on Brooklyn Station north of Mareeba. In the present paper we report bird surveys in woodland at Koah (north-east of Mareeba) using three 2-ha plots to sample a 12.8 ha property. It was intended to sample these plots in two-month periods over three years with strong replication within periods, to explore seasonal and annual changes to bird populations. However, a change of employment by SCM meant that only three two-monthly periods were sampled. These are presented here as a preliminary study of woodland birds and an evaluation of the methods' effectiveness in monitoring the bird assemblage.

Methods

The study area is a private allotment of 12.8 ha (16°50'S, 145°30'E), most of which supports remnant woodland contiguous with other forests extending to Dinden Forest Reserve and Bilwon and Kuranda State Forests. About 0.75 ha is cleared and contains a house. Mean annual rainfall is 1128 mm and elevation ranges from 370 to 380 m ASL. Soils are poorly-drained, infertile clays. An intermittent stream, 33 Mile Creek, flows through the property. Remnant vegetation is woodland (borderline open forest) featuring *Corymbia clarksoniana* (Clarkson's Bloodwood), *Eucalyptus portuensis* (syn. *E. acmenoides* complex, *E. mediocris*; White Mahogany), *Melaleuca viridiflora* (Broad-leaved Paperbark), *Callitris intratropica* (Northern Cypress-pine) and *Allocasuarina littoralis* (Black She-oak). The vegetation of the study area, including subtle variations particularly in the ground flora, is described in more detail by Morrison and Franklin (2022).

Three 2-ha plots were established within remnant vegetation, boundaries being marked with flagging tape. Plots were dispersed as widely as possible and separated by between 70 and 175 m. Each plot was buffered from disturbed habitat (road corridor or cleared land) by at least 15 m, more in most directions. Plot A was dissected by 33 Mile Creek and includes a poorly-drained seepage area, whereas Plots B and C were drier and not so dissected, though the creek was close to Plot B. Plot C has a distinctly denser understorey featuring particularly the sprawling shrub or vine *Alyxia spicata* (Chainfruit). Plot A incorporates the ant survey sites 1, 2 and 3 described in detail by Morrison and Franklin (2022); Plot B ant sites 5 and 6, and Plot C ant site 7.

Plots were searched for birds during three two-month periods (Sept.–Oct., Nov.–Dec. 2022 and Jan.–Feb. 2023), in three sessions (approximately two weeks apart) per period. Within each session, each plot was searched for 20 minutes three times over two days, once each between 7.00- 8.00 am, 9.00- 10.00 am and 5.00-6.00 pm respectively with occasional delays due to thick fog, strong wind or rain. The order in which plots were searched within sessions was determined randomly. Thus, there are three periods by three sessions by three searches across three plots, a total of 81 searches. Each search lasted 20 minutes, thus being the standard 2-ha, 20-min search adopted by Birdlife Australia (2023) as the national standard for volunteer bird surveys in bushland. All searches were conducted by SCM, who walked slowly within the plot, stopping to observe and note species and numbers seen, flushed or heard. Birds flying overhead were included only if it was considered they were using the plot to forage or hunt.

Birds were also recorded opportunistically across the entire property from 2016 to 2023.

For the purpose of data analysis, searches were first summed for each plot for each session (i.e. summed across the early morning, mid-morning and late afternoon searches), yielding a "Day" set of three 20-min 2-ha searches. To evaluate the effects of time period and plot on Plot-Day counts, these counts were arranged in an array of Plot-Day counts by species, with counts square-root transformed to reduce the impact of particularly abundant species on subsequent analysis. The similarity between Plot-Days was calculated using the Bray-Curtis coefficient which is appropriate for a dataset with numerous zeros (see Table S2) (Clarke & Warwick 2001). The effect of period and plot and their interaction was evaluated using permutational Anova (Anderson *et al.* 2008) with 9999 permuations and with both period and site treated as fixed effects. Significant effects were then illustrated using Multi-Dimensional Scaling, the gold-standard for analysis of biological communities (Clarke & Warwick 2001) – in which data are presented in two or three dimensions showing relative similarity of bird assemblages. Differences in the abundance of species across

periods and plots were evaluated for species present on a minimum of 10 of the 27 Days.

A full list of species is provided in Supplementary Table 1 along with notes on occurrence, breeding and behaviour. A summary of count data is presented in Supplementary Table 2, whilst the Plot-Day data is provided in Supplementary Table 3.

Results

Across the 81 20-min 2-ha searches, 882 individuals of 54 species of bird were recorded, 46 species being recorded in more than one search. The number of species recorded in individual searches ranged from one to 12 with a mean of 6.2, and in Plot-Days from six to 20 with a mean of 12.6. A species accumulation curve (Fig. 1) suggests that substantially more species would be detected with further surveys.

There were significant differences in the bird assemblage between plots (P = 0.0005) and two-month periods (P = 0.0003), but the interaction term was not significant (P = 0.62). This may be interpreted as meaning that, whilst plot bird assemblages differed, they changed similarly over time.

Sept.-Oct. surveys were most different to the other two-month periods (Fig. 2A). Periods differed most obviously by the absence of the migratory Spangled Drongo and Leaden Flycatcher in Sept.-Oct. and the lesser number of Grey Fantail and Little Shrike-thrush at that time (Table 1). The bird assemblage at Plot B was intermediate between the quite distinct assemblages of Plot A and C (Fig. 2B), this corresponding with a a continuum of diminishing moisture from A to C. Plot A featured a particular abundance of Grey Fantail, White-browed Robin and Peaceful Dove, and Plot B a particular abundance of Spangled Drongo. Four species, Bar-shouldered Dove, Fairy Gerygone, Eastern Yellow Robin and White-throated Honeyeater were abundant in all plots and all time periods, though Bar-shouldered Dove was less prominent in Plot C, and it and White-throated Honeyeater were especially abundant in the Jan.-Feb. period (Table 1).

An additional 82 species were recorded on the property incidentally over seven years, bringing the property total to 138 species. Of these, 21 were assessed as being resident, 37 as seasonal visitors, 9 as irregular but fairly frequent visitors, 36 as occasional visitors (3–10 observations) and 35 as vagrants (1–2 observations only) (Table S1). Evidence of breeding on the property was noted for 55 species (Table S1). 33 Mile Creek was often used by mostly aquatic species as a flyway over the property, birds flying over (up to *c.* 500 m above) or sometimes under the woodland canopy and occasionally roosting along the creek (see Table S1). The property is *c.* 5 km west of the nearest rainforest (some gallery rainforest might be closer).

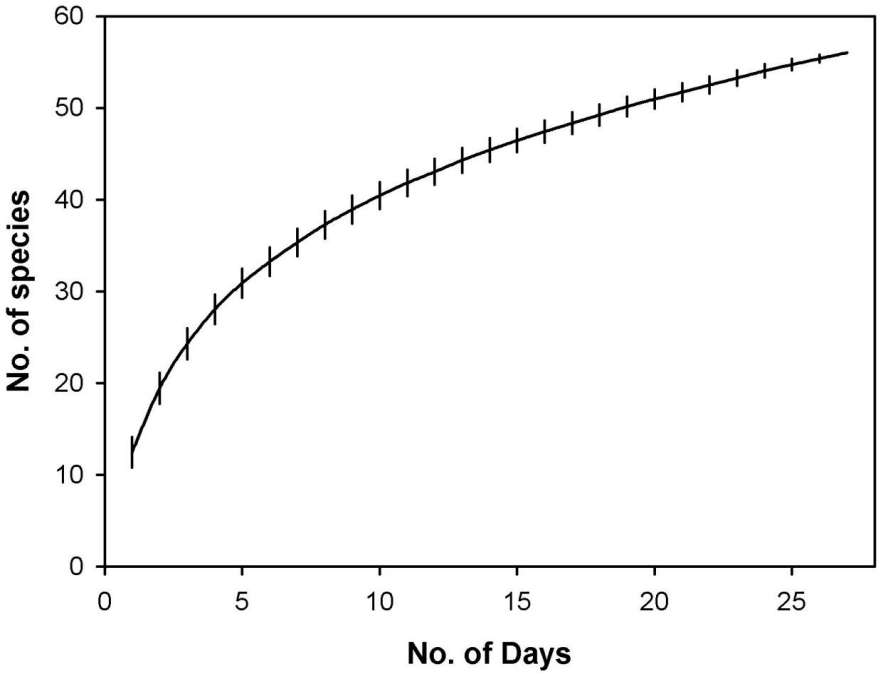

Figure 1. Species accummulation with a randomised order of survey Plot-Days (curved line), ± standard deviation (vertical bars).

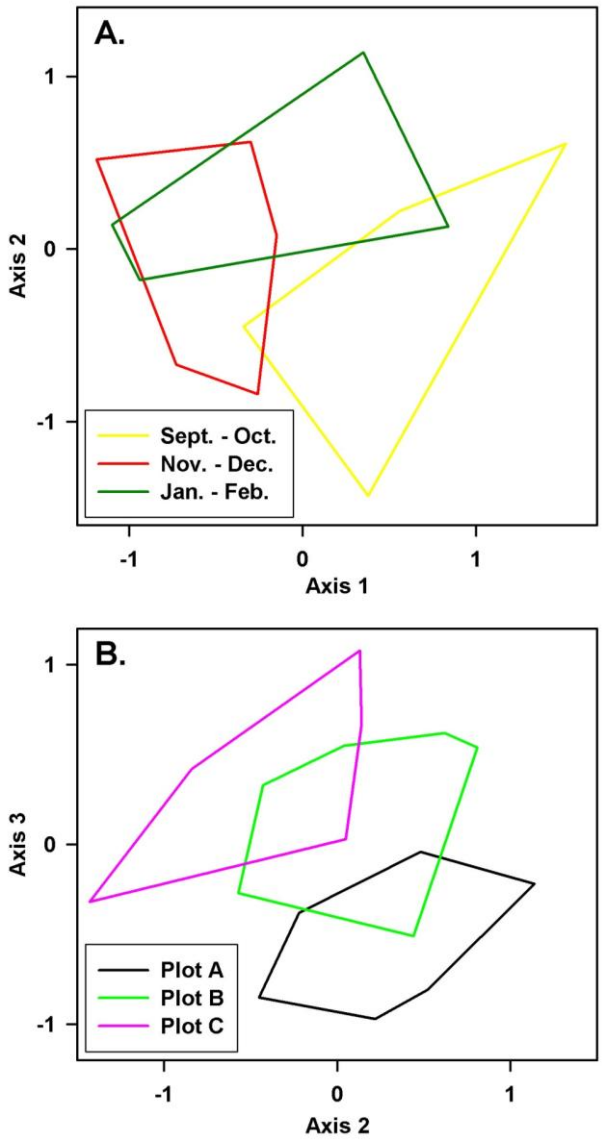

Figure 2. Convex polygons around each of three sets of nine replicate Plot-Day bird assemblages, presented for selected axes of a 3-dimensional ordination (stress = 0.16) and organised by two-month periods (A) and plots (B).
Orientation relative to axes is arbitrary and they are named only to indicate that we have selected two of three possible axes. The scaling is also retained to demonstrate relative similarity across axes and graphs.

Notwithstanding a scarcity of fruit resources and complete absence of closed canopy vegetation, vagrants and occasional visitors include a number of rainforest species, e.g. six species of rainforest pigeon, Tooth-billed Bowerbird observed once, Spectacled Monarch observed twice, and Large-billed Scrubwren observed once. Also of note among vagrants was a single, high-quality observation of Red Goshawk.

Discussion

In Australian tropical savannas (and doubtless elsewhere), adequate replication of counts across times of day and across days is essential to adequately represent the bird assemblage present (Perry *et al.* 2012). With 20-min 2-ha surveys conducted at three times of the day and over three sessions in each two-month period, our data were convincingly able to distinguish assemblages among plots and time periods (P both <0.0001), the former notwithstanding that the dominant tree species are the same in each. This suggests a satisfactory level of temporal replication that may suit other local, longer-term studies using Birdlife Australia standard 2-ha 20-min searches.

However, identification of species-level patterns was limited. We attempted further analysis but the data were clearly inadequate. This reflects two limitations: that there were only three plots (because the property is small), and that there were only three two-month periods. Nevertheless, our study illustrates a number of sources of variation in bird abundance over time. Migration (Leaden Flycatcher, Spangled Drongo) is perhaps the most obvious. Potentially it also includes seasonality of calling activity influencing observability (Little Shrike-thrush) and numbers varying with successful breeding (Bar-shouldered Dove, Peaceful Dove, White-throated Honeyeater, Spangled Drongo). In the case of breeding, abundance should peak at the end of the breeding season (peaks observed in Jan.-Feb. in this study). It should also be most obvious in species that are resident but not territorial such that young remain with adults for a prolonged period. Flocks of Spangled Drongo and White-throated Honeyeater in Jan.-Feb. included immatures.

Reflecting its woodland (borderline open forest) vegetation, the avifauna of the Koah property is essentially that of tropical eucalypt forests and woodlands, though its proximity to the rainforests of the Kuranda area doubtless contributed to the rainforest visitors. Kutt and Vanderduys (2017) studied the avifauna of Brooklyn Station 35 km north-west of Koah, though most sites were at higher elevation including those that were considerably drier; there is no direct floristic analogy and surprisingly weak avifaunal similarities. Of the 13 most abundant species at Koah (Table 1), seven were uncommon or absent

Table 1. Summed abundance across two-month periods and plots of thirteen bird species recorded on at least 10 of 27 Days.
Scientific names are provided in Supplementary Table 1. Species are listed in alphabetical order.

	Two-month periods			Plots		
Species	**Sept.–Oct.**	**Nov.–Dec.**	**Jan.–Feb.**	**A**	**B**	**C**
Bar-shouldered Dove	23	38	47	44	48	16
Eastern Yellow Robin	23	23	18	26	27	11
Fairy Gerygone	32	35	34	34	32	35
Grey Fantail	4	9	9	14	5	3
Leaden Flycatcher	0	33	7	12	16	12
Little Shrike-thrush	4	8	13	6	10	9
Mistletoebird	5	13	4	10	7	5
Peaceful Dove	8	11	17	26	10	0
Rainbow Bee-eater	10	15	14	16	18	5
Rufous Whistler	6	13	3	9	8	5
Spangled Drongo	0	13	29	9	23	10
White-browed Robin	2	7	13	18	0	4
White-throated Honeyeater	29	39	51	28	51	40

at Brooklyn: Fairy Gerygone, Leaden Flycatcher, Little Shrikethrush, Rainbow Bee-eater, Spangled Drongo, White-browed Robin and White-throated Honeyeater. Of those listed in their Table 2, three (Bar-shoulded Dove, Peaceful Dove, Rufous Whistler) were most abundant at lowest elevations comparable in that respect at least with Koah, whilst three species (Eastern Yellow Robin, Grey Fantail, Mistletoebird) were most abundant at higher elevation in tall open forest or rainforest in their study (though Grey Fantail and Mistletoebird were widespread).

Demonstrable processes shaping bird assemblages in eucalypt woodland in north-eastern Australia include elevation (Kutt & Vanderduys 2017), vegetation structure (positive effects of ground cover, presence of a mid-stratum and canopy height on abundance and species richness and the presence of Noisy Miners (*Manorina melanocephala*) as this species dominates space to the exclusion of smaller bird species (Kutt *et al.* 2012). Noisy Miners were not recorded in this study and were scarce or absent in the Brooklyn Station study of Kutt and Vanderduys (2017), and elevation does not provide a good analogy between their study and ours. It is unclear how vegetation structure affects species composition. Much remains to be learned about the the structure of bird assemblages in eucalypt vegetation in the region.

Of note also is the absence of non-native species from the Koah property notwithstanding the cleared area around the house. The nearest sightings of such species by SCM were of Common Myna (*Acridotheres tristis*) on two occasions 3 and 4 km away.

Supplementary file

A supplementary Excel file accompanies this paper on its web-page. It contains four worksheets:

- Table S1. List of all bird species observed on the 12.8 ha block at Koah, with scientific names and notes;
- Codes S1. Definitions of status and breeding in Table S1;
- Table S2. Summary of species counts; and
- Table S3. Two-ha 20-min search data.

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