

How remnant farm vegetation contributes to the resilience of bird populations: an example from near Paterson NSW.

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A small cattle farm near Paterson New South Wales, with approximately 15% remnant vegetation, was monitored quarterly from 1996 to 2013 using standard Birddata survey protocols. Linear regression analysis was used to differentiate between species with stable populations and those with indications of long-term change in status, either declining or increasing.

In total, 140 species were recorded of which 25 had 2 ha Reporting Rates of above 10%. Reporting Rate trends suggested that the populations of 19 species were relatively stable despite interannual variations that were attributed to factors such as annual rainfall. Trends in the numbers of birds (count data) provided support for the conclusions drawn from presence-based Reporting Rates.

Changes in the management practices at an extensive adjacent area of woodland at Green Wattle Creek, which included removing cattle, caused changes in the status of some species on the farm. For example, increased understorey vegetation at Green Wattle Creek resulted in an increase in the Lewin's Honeyeater *Meliphaga lewinii* population, which then led to increases in the farm population although the habitat there was unchanged. Similar habitat synergies were identified for other species.

Four species of woodland birds, listed as threatened under the *NSW Biodiversity Conservation Act 2016*, were recorded on numerous occasions - Little Lorikeet *Parvipsitta pusilla*, Grey-crowned Babbler *Pomatostomus temporalis*, Speckled Warbler *Pyrholaemus sagittatus* and Varied Sittella *Daphoenositta chrysoptera*. The Grey-crowned Babbler population had decreased by the end of the study.

The hybrid survey design that was used provided versatile analysis options enabling the detection of changes in a range of species with different habitat preferences.

INTRODUCTION

The need for base-line data and long-term studies using systematic methodology to provide early detection of the changes in the status of not (yet) threatened species was highlighted in a recent paper by Bennett *et al.* (2024). This paper addresses that call.

Several studies during the past two decades have demonstrated the high diversity of avifauna/birds of near-coastal areas in the Hunter Region of NSW (Kendall 2023; Newman 2007 & 2009; Powers & Date-Huxtable 2017). These long-term studies suggested that species diversity and abundance were relatively stable and that sustainably managed farms supported a number of threatened species. However, these studies were less informative about the trends of individual species.

This paper updates one of those studies (Newman 2007), adding seven years of data and analysing the entire 18-year data set (spanning 1996 to 2013). The previous study demonstrated the high species richness of the property (126 species recorded). This report focuses on the persistence of the bird populations in remnant vegetation where the survey sites were located, and on the effectiveness of the survey design. In particular, it seeks to determine whether quarterly monitoring is sufficiently frequent for identifying population changes. It also investigates the benefit of counting birds to provide information complementing insights gained from trends in reporting rates (the frequency at which birds are recorded in surveys). However, it is beyond the scope of this paper to seek detailed explanations of the factors underlying the observed changes.

METHODS

Study area

The study area was on a property located at Butterwick on the edge of the Paterson flood plain in the lower Hunter Valley of NSW (32° 39' S, 151° 38' E). The property had an estimated 15% remnant vegetation, including riparian vegetation and a number of small areas of woodland. The study area was adjacent to Green Wattle Creek Road. Four 2 ha sites were selected within the study area for specific surveys using BirdLife Australia's recommended survey protocol. Site 1 was in a roadside small copse about 200 m from Green Wattle Creek, and sites 2-4 were located in riparian vegetation adjacent to the creek. **Figure 1** shows the survey route and the four 2 ha sites.

All four 2 ha sites were well vegetated, with understorey and copses of tall trees. The reader is referred to Newman (2007) for additional details. There was minimal modification of the remnant vegetation during the 18 years of surveys and the cattle were grazed in a consistent manner.

Surveys were conducted quarterly by MN, usually in January, April, July and October. Surveys were conducted early in the morning to ensure maximum bird activity. Typical duration was three hours, of which 80 minutes was spent at the four 2 ha sites, and the remainder of the time was spent walking between the sites. The 2 ha sites were each surveyed for 20 minutes. The entire survey, of the birds recorded at the 2 ha sites plus those detected while walking between sites, was logged as one 500 m radius area survey.

Data analysis

Reporting Rates were calculated for all species, for each 2 ha site, for the four 2 ha sites combined, and for the 500 m surveys. The Reporting Rate is the number of times the species was recorded divided by the number of surveys conducted, expressed as a percentage. Species with annual Reporting Rates exceeding 10% for the combined 2 ha surveys were subject to more detailed evaluation involving:

1. Calculation of two measures of species abundance:
 - a. The mean number of individuals per survey (total number of individuals counted for all surveys divided by the total number of surveys conducted).
 - b. The mean number of individuals for surveys when the species was present (total number of individuals counted divided by the number of surveys in which a species was recorded). This measure provides a superior indication of group size.
2. Linear regression analysis of the annual data (i.e. combining the results from the four seasonal surveys), using Microsoft Office Excel, to determine:
 - a. The magnitude of the coefficient of determination, R^2 .
 - b. The slope of the linear trend line. From the slope, the decadal percentage rate of change was calculated.

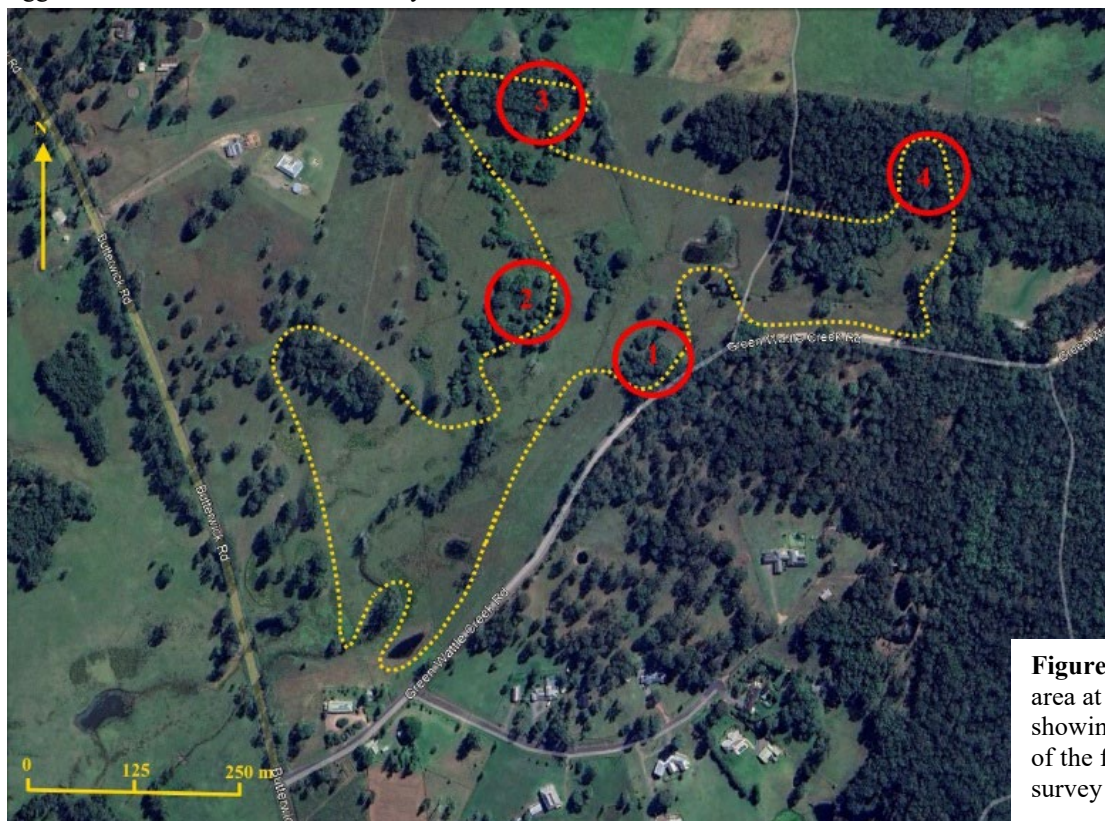


Figure 1. The study area at Butterwick, showing the locations of the four 2 ha survey sites.

The longevity of this 18-year study (Degrees of Freedom $DF = 16$) makes the linear correlation a powerful tool for use in screening trends for evidence of change. The variation of R^2 as a function of the degrees of freedom of the correlation is shown below (**Figure 2**) for probability values of 0.05 and 0.01 based on published tables (Rohlf & Sokal 1981, Table 25 pp.166–168).

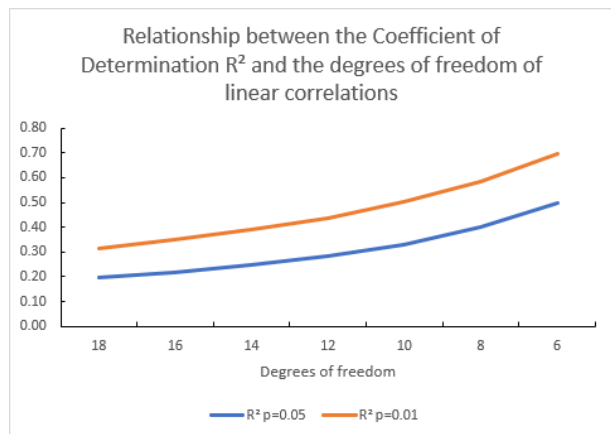


Figure 2. The relationship between R^2 and the degrees of freedom of linear correlations.

With 16 degrees of freedom, an R^2 value of 0.22 is statistically significant at 95% confidence level (i.e. p 0.05 or lower). As a screening method, we considered species with R^2 above 0.2 and decadal slopes above 25% as likely to have increasing or decreasing populations (dependent on the sign of the slope). Conversely, R^2 values below 0.1 and decadal slopes of <10% were deemed to involve stable populations. A similar approach was used to identify changes in the numbers of birds counted.

RESULTS

In 18 years of quarterly monitoring, 140 species were recorded; including 14 that were not observed during the initial eleven years of surveying. There were 106 species found in the 2 ha surveys; the other 34 species were only observed whilst moving between the 2 ha sites.

The survey results for 2 ha surveys are presented separately from the composite 500 m surveys because they provide different insights into the status of the birds inhabiting the area.

2 ha surveys

The Reporting Rates for all species recorded at the 2 ha survey sites are presented in the **Appendix** (available at <https://www.hboc.org.au/the-whistler-volume-20/>). Twenty-five species (listed in **Table 1**) had an 18-year Reporting Rate of above 10%. They occurred at all four 2 ha sites, although less

frequently at site 1. The average Reporting Rates (i.e. across 18 years of surveys) at each site for the 25 species are presented in **Figure 3**.

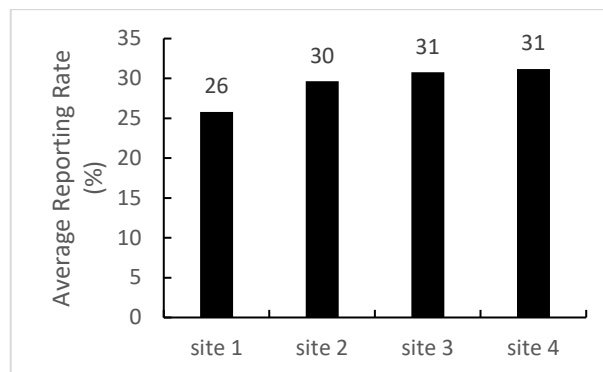


Figure 3. The average Reporting Rates of the 25 most frequently recorded species at the four 2 ha survey sites.

In **Table 1** we also report the Coefficient of Determination, R^2 , for each of the 25 species and the two measures for abundance (average number of birds per survey, average number of birds when present) and an assessment of the probable population trend. On this basis, 19 species appeared to have relatively stable populations over the 18 years. Three species appeared to have increasing populations – Lewin’s Honeyeater *Meliphaga lewinii* (R^2 0.44), Grey Shrikethrush *Colluricincla harmonica* (R^2 0.33), Australian Magpie *Gymnorhina tibicen* (R^2 0.26) – while the Yellow Thornbill *Acanthiza nana* (R^2 0.3) had a probably-decreasing population. There was inconclusive evidence that the populations of Eastern Spinebill *Acanthorhynchus tenuirostris* (R^2 0.18) and Scarlet Myzomela *Myzomela sanguinolenta* (R^2 0.12) were increasing.

Examples of the temporal trends in the annual Reporting Rates of species with increasing, stable and decreasing trends are shown in **Figure 4**. In each instance there was considerable interannual variation about the long-term linear trajectory.

Table 1. Summary statistics for the 25 species that were observed most frequently during quarterly surveys at four 2 ha sites (reported in order of descending Reporting Rate).

	Reporting Rate (%)	Coefficient of Determination R ²	Status ¹	Abundance	
				Birds/survey	Birds/observation
Superb Fairywren <i>Malurus cyaneus</i>	70.3	<0.001	Stable	3.0	4.3
Grey Fantail <i>Rhipidura albiscapa</i>	69.0	<0.001	Stable	1.2	1.7
Yellow-faced Honeyeater <i>Caligavis chrysops</i>	66.2	0.070	Stable (I)	2.2	3.3
Yellow Thornbill <i>Acanthiza nana</i>	57.6	0.300	Possibly Decreasing	2.6	4.5
Brown Thornbill <i>Acanthiza pusilla</i>	44.8	<0.001	Stable	0.7	1.6
Rufous Whistler ² <i>Pachycephala rufiventris</i>	35.5	0.015	Stable (I)	0.5	1.3
Spotted Pardalote <i>Pardalotus punctatus</i>	35.2	0.012	Stable (I)	0.5	1.4
Eastern Rosella <i>Platycercus eximius</i>	30.0	0.053	Stable (I)	0.7	2.3
Red-browed Finch <i>Neochmia temporalis</i>	30.0	0.041	Stable (D)	1.4	4.6
Scarlet Myzomela <i>Myzomela sanguinolenta</i>	25.5	0.12	Stable (I)	0.7	2.8
Australian Golden Whistler <i>Pachycephala pectoralis</i>	24.5	0.11	Stable (D)	0.3	1.3
Striated Thornbill <i>Acanthiza lineata</i>	24.5	0.094	Stable (I)	1.1	4.7
White-throated Gerygone ² <i>Gerygone olivacea</i>	24.1	0.006	Stable	0.3	1.1
Eastern Yellow Robin <i>Eopsaltria australis</i>	23.1	0.041	Stable (I)	0.3	1.4
White-browed Scrubwren <i>Sericornis frontalis</i>	21.7	0.002	Stable	0.3	1.3
Australian Magpie <i>Gymnorhina tibicen</i>	20.0	0.260	Possibly Increasing	0.3	1.7
Laughing Kookaburra <i>Dacelo novaeguineae</i>	20.0	0.023	Stable	0.3	1.3
Lewin's Honeyeater <i>Meliphaga lewinii</i>	17.9	0.422	Possibly Increasing	0.2	1.2
White-throated Treecreeper <i>Cormobates leucophaea</i>	16.6	0.060	Stable (I)	0.2	1.1
Sacred Kingfisher ² <i>Todiramphus sanctus</i>	14.8	0.002	Stable	0.2	1.1
Eastern Spinebill <i>Acanthorhynchus tenuirostris</i>	14.5	0.180	Possibly Increasing	0.2	1.5
Grey Shrikethrush <i>Colluricincla harmonica</i>	12.4	0.330	Possibly Increasing	0.1	1.1
Silveryeye <i>Zosterops lateralis</i>	12.4	0.008	Stable	0.6	4.9
Black-faced Cuckooshrike <i>Coracina novaehollandiae</i>	11.7	0.094	Stable (I)	0.2	1.3
Willie Wagtail <i>Rhipidura leucophrys</i>	11.4	0.005	Stable	0.1	1.2

¹ I (Increasing) and D (Decreasing) denote the directions of weak trends in trajectory. ² Summer visitor

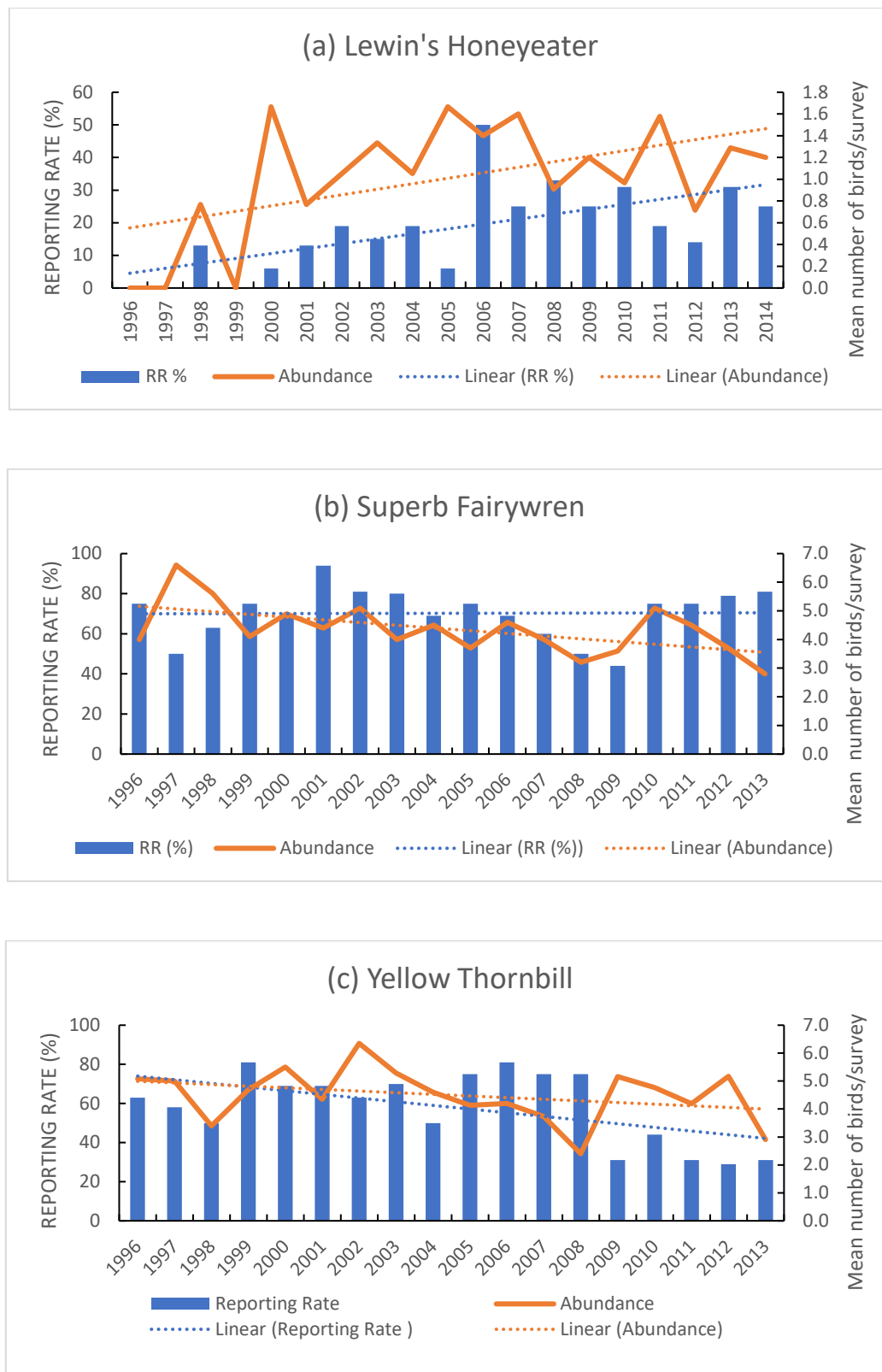


Figure 4. Examples of (a) increasing (Lewin's Honeyeater), (b) stable (Superb Fairywren) and (c) decreasing (Yellow Thornbill) temporal trends in annual Reporting Rates and the corresponding trend in abundance (mean number of individuals observed) for four 2 ha survey sites monitored quarterly.

The decadal changes in Reporting Rate based on the slope of the linear regressions are compared with the linear Coefficient of Determination R^2 (Table 2) for 13 species selected to demonstrate a range of trajectories. In most instances an R^2 of >0.2 corresponded with a high decadal change in Reporting Rate, either increasing (e.g. Lewin's

Honeyeater and Grey Shrikethrush), or decreasing (e.g. Yellow Thornbill).

There was a modest increase (12% per decade) in the mean number of species recorded during the 2 ha surveys (Figure 5).

Table 2. Comparison of population trends based on changes in Reporting Rate (RR) and abundance as indicated by the number of individuals present when birds were recorded during 2 ha surveys.

Species	Reporting Rate		Abundance (No. of birds when present)	
	Decadal change (%)	R^2	Decadal change (%)	R^2
Superb Fairywren	0	0	-17	0.32
Red-browed Finch	-13.3	0.04	-15	0.02
Yellow-faced Honeyeater	15.2	0.07	34	0.14
Brown Thornbill	15.2	0.07	35	0.14
Grey Fantail	0	0	-6	0.01
Lewin's Honeyeater	500	0.42**	100	0.28*
Grey Shrikethrush	350	0.32*	10	0.01
Yellow Thornbill	-25	0.30*	-12	0.11
Silvereye	12	0.32*	-3	0
Rufous Whistler	6	0.01	5	0.02
Golden Whistler	-24	0.11	-8	0.02
Australian Magpie	109	0.28*	14	0.02
Striated Thornbill	32	0.09	7	0.01

*Statistically significant $p < 0.05$ **Statistically highly significant $p < 0.01$

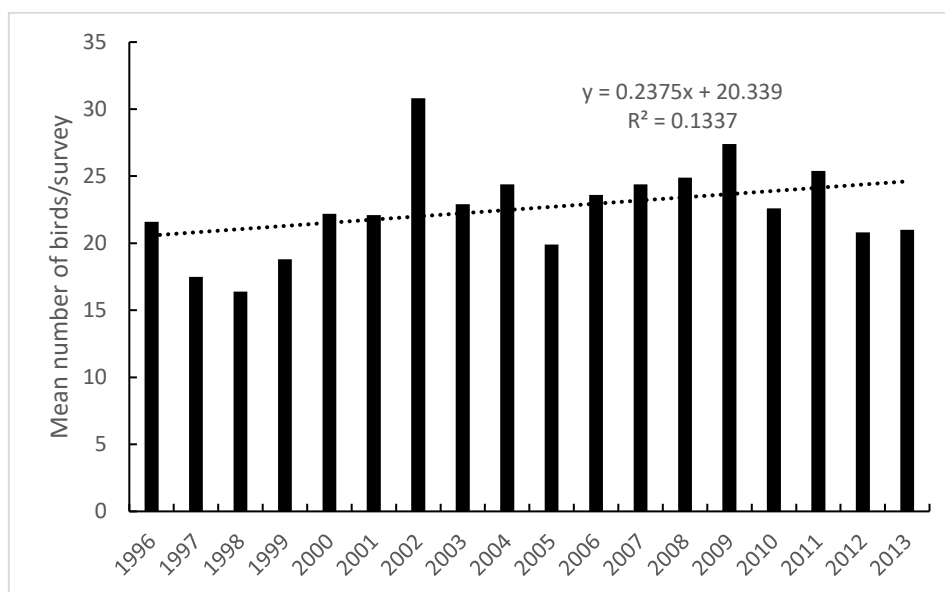


Figure 5. Annual variation of the mean number of birds (all species) per survey recorded during 2 ha surveys between 1996 and 2013 (R^2 0.13).

Abundance

The most numerous birds recorded at the 2 ha sites were Superb Fairywren, Yellow Thornbill and Yellow-faced Honeyeater *Caligavis chrysops* with 3.0, 2.6 and 2.2 birds per survey (Table 1). However, when these values are adjusted for differences in Reporting Rate, Silvereye *Zosterops lateralis*, Striated Thornbill *Acanthiza lineata* and Red-browed Finch *Neochmia temporalis* were recorded in the largest numbers at 4.9, 4.7 and 4.6 birds per observation respectively compared with the Superb Fairywren at 4.2 birds per observation (Table 1). In other words, species like Silvereyes were recorded less frequently, but in larger groups than Superb Fairywrens.

The direction of the temporal trends based on abundance generally corresponded well (Table 2 and Figures 4 a, b, c), but there were exceptions, exemplified by the modest decrease in abundance compared with the long-term stability of the Reporting Rate trend of the Superb Fairywren.

Composite 500 m surveys

Five of the regularly recorded species in the 2 ha surveys were recorded on every composite survey and 21 others were recorded on more than 80% of composite surveys. In contrast, 70 of the species were recorded on less than half of the composite surveys.

Generally, annual variations in the Reporting Rates of these composite surveys were uninformative concerning changes in the status of common species (i.e., there was little interannual difference in Reporting Rate). The 2 ha surveys were superior for this purpose as demonstrated in Figure 4. However, variations in the number of individual birds seen per survey may be useful (Figure 6a) where both correlations indicated population stability (R^2 0.01) and there was a correspondence of the interannual variations in the 2 ha Reporting Rate and the interannual abundance (birds per survey) from the 500 m area surveys.

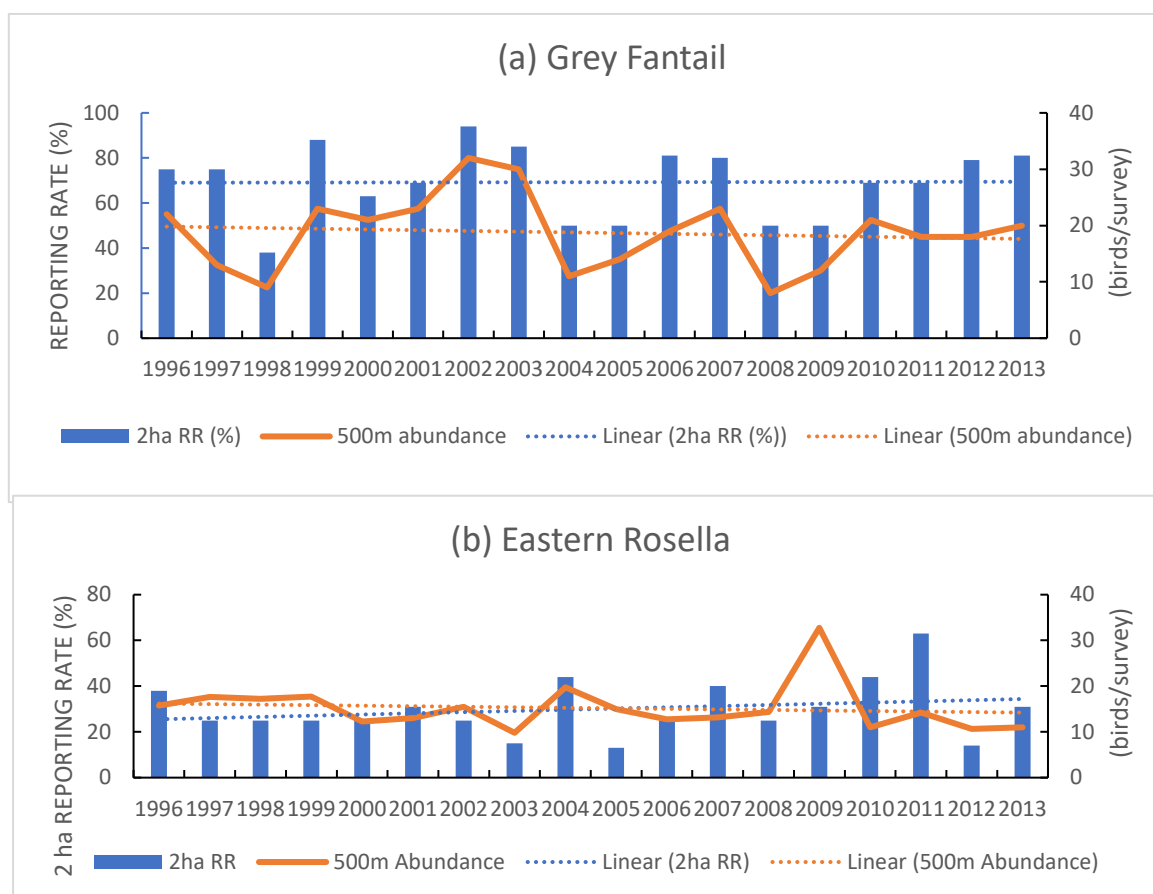


Figure 6. Comparison of the temporal variation of 2 ha Reporting Rate and 500 m survey abundance (birds /survey) for Grey Fantail and Eastern Rosella.

Eastern Rosellas were recorded on every 500 m survey, but were poorly represented at the 2 ha sites where the mean Reporting Rate was 30% and only 19% of the birds counted in the composite 500 m surveys occurred at the 2 ha sites. Both linear trends in **Figure 6(b)** indicated the species was relatively stable (R^2 values of 0.05 and 0.01 for the 2 ha Reporting Rate and 500 m radius area survey abundance data respectively).

Species of conservation concern

Six species of conservation concern were recorded, as listed in **Table 3**. Five species listed as Vulnerable under the NSW *Biodiversity Conservation Act 2016* were recorded on numerous occasions. Two species, listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) as Vulnerable, were recorded occasionally.

The four woodland species were recorded regularly. Grey-crowned Babblers *Pomatostomus temporalis* primarily occurred in relatively open habitat, with only 11% of the birds counted coming from the 2 ha survey sites. The frequency of occurrence of the species and the group size progressively decreased

until January 2011, after which it was not recorded (**Figure 7**). Little Lorikeets *Parvipsitta pusilla* occurred intermittently in numbers of up to 20 except in the first two years. Only 30% of the birds counted were associated with observations at the 2 ha sites. Speckled Warblers *Pyrrholaemus sagittatus*, between 1 and 5 birds, occurred in 10 (56%) years, but there were no records between 2007 and 2012. Some 60% of the records came from two 2 ha sites; site 4 (seven records) and site 1 (two records). Varied Sittellas *Daphoenositta chrysoptera* were recorded intermittently throughout the study, occurring in 13 (72%) years. Small flocks favoured 2 ha sites 1, 2 and 4 which had more trees than site 2. It was recorded annually between 2001 and 2009, appearing again in 2012 and 2013.

Latham's Snipe *Gallinago hardwickii*, a summer visitor, was recorded in nine years (50%), but not after spring 2008. From one to three birds were seen foraging in flooded pasture near the creek when water meadow conditions formed. White-throated Needletails *Hirundapus caudacutus* are an aerial species and variations in their occurrence were not related to habitat conditions of the study area.

Table 3. Summary statistics for Threatened Species

	500 m survey	2 ha survey	2 ha sites recorded	Years recorded	Proportion of records at 2 ha sites	500 m Abundance ¹
	RR (%)	RR (%)	Number	(%)	(%)	Birds per observation
Grey-crowned Babbler ²	47.9	1.4	2	89	11	4.8
Latham's Snipe ³	16.9	0	0	50	0	1.6
Little Lorikeet ²	28.2	2.1	4	83	23	6.3
Speckled Warbler ²	21.1	3.1	2	56	37	1.8
Varied Sittella ²	28.2	5.9	4	72	46	7.1
White-throated Needletail ^{2&3}	2.8	0.3	1	2	33	26.0

¹ The average number of birds in surveys in which the species was recorded.

² Listed under the 2016 BC (NSW) Act. ³ Listed under the 1999 EPBC Act.

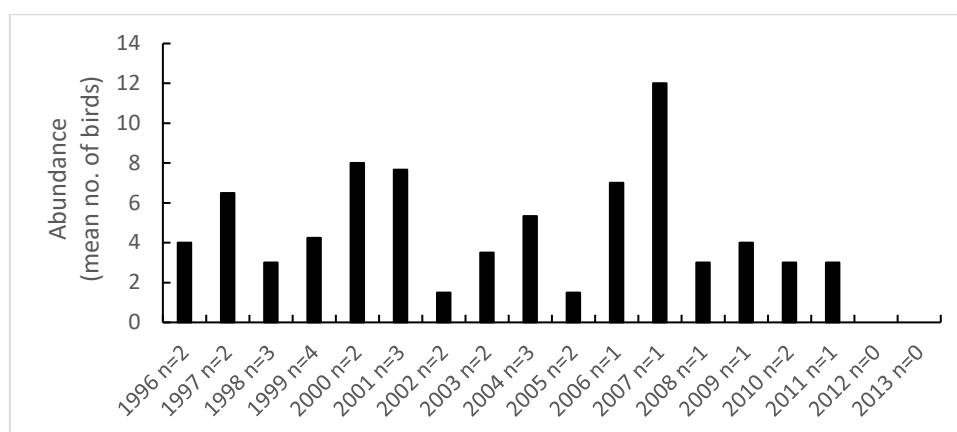


Figure 7. Numbers of Grey-crowned Babblers recorded in 500 m surveys when present (n = the number of surveys in which Grey-crowned Babblers were recorded).

DISCUSSION

The 18-year period of the study exceeds the three generation times that are required to assess population stability for most woodland species (Bird *et al.* 2020; Newton 2013). In assessing population trends based on annual data, a low Coefficient of Determination R^2 (e.g. <0.1) indicates that there is minimal long-term variation in annual Reporting Rate despite short-term fluctuations caused by factors such as rainfall patterns. While there may be some suggestion of long-term change (i.e., non-zero slopes) these indications are not statistically meaningful and can be a consequence of factors such as data deficiency. Higher levels of R^2 indicate the possibility that long-term changes in status, either increasing or decreasing, may be occurring, and the magnitude of the coefficient is a measure of the extent that the population is deviating from long-term stability. In addition, it is important to appreciate that while trends may fail to satisfy the $p < 0.05$ threshold this does not negate the possibility that they are real.

There are a number of caveats associated with the above approach:

1. A linear model may not be appropriate and is merely used to identify species requiring more sophisticated evaluation (e.g., multiple regression analysis to determine the impact of factors like variations in annual rainfall).
2. Reporting Rate and the average numbers of surveys are subject to numerous sources of bias/error that are species-specific. Some examples follow:
 - (a) Detectability, especially of cryptic species.
 - (b) The difficulty of identifying and counting small non-vocal birds in the canopy.
 - (c) The difficulty of accurately counting small flocks moving through vegetation, especially when multiple species are involved.
3. This study involved one observer thus ensuring surveys were conducted in a consistent manner and eliminating variability inherent in citizen science data involving multiple observers with different experience levels.

Biodiversity and abundance

The study reaffirms the role of small sustainably managed properties in supporting healthy regional

bird communities. At the four well-vegetated 2 ha sites, there were 106 species recorded including 25 species with overall Reporting Rates above 10%. The number of species seen cumulatively and annually confirmed the stability of the bird diversity while the observed increase of 11% per decade in the number of birds counted demonstrated that species populations were at least stable and probably were increasing.

Population stability (long-term trends)

Both of the survey techniques – the 20 minute/2 ha surveys and 500 m radius area surveys – enabled findings about population trends to be derived, although the 2 ha surveys were overall more useful.

2 ha surveys: 80% of the 25 species with sufficient records for assessment (Reporting Rate $>10\%$) appeared stable over the 18-year period of this study (**Table 1**) based on the Reporting Rate trends. The trends showed considerable inter-annual variation, which is a normal response to factors such as differences in annual and seasonal rainfall (Newman & Woehler 2024). Three species appeared to increase in status and only one species, Yellow Thornbill, appeared to be decreasing. The substantial increase in Lewin's Honeyeater population has an apparent explanation. Grazing ceased on the adjacent woodland at Green Wattle Creek about the time that these surveys commenced. The consequent development of understorey vegetation at the latter location resulted in increased occurrence of Lewin's Honeyeater and Eastern Whipbird (Newman & Cunningham 2018). While Lewin's Honeyeater expanded its range onto the farm, the habitat requirements of Eastern Whipbird were more specialised and the farms' 2 ha sites were unsuitable. Reasons for the increases in Grey Shrike-thrush, Australian Magpie and Eastern Spinebill and the decrease in the Yellow Thornbill are not obvious, though the latter's trajectory is in line with findings from a preliminary analysis of population trends on the eastern seaboard showing long-term declines for Yellow Thornbill between 1999 and 2019 (BirdLife Australia, unpublished). The correspondence between annual variations in Reporting Rate and the mean number of birds recorded per survey (**Figure 3** and **Table 2**) confirms the stability of the commonly recorded species and supports the use of presence data (Reporting Rate) as a surrogate measure of species abundance.

500 m radius area surveys: For this survey type, whole-of-count data was more informative than the Reporting Rates of commonly occurring species

which were insensitive to interannual variation. Whole-of-count provided unique insights for species that were not particularly suited to the 20 minute/2 ha survey technique (e.g. Eastern Rosella, mainly detected flying across the property). However, a limitation is that the annual sample sizes were small (four surveys per year) compared with sixteen 2 ha surveys per year. Nevertheless, the results demonstrate the benefits from not relying solely upon one survey technique.

Threatened species

The regular occurrence of five threatened woodland species suggests that the farm afforded them important habitat. In the case of the Grey-crowned Babbler, which bred locally, there may have been breeding territories on the property. Their decreased occurrence towards the end of the study was consistent with the author's experience (MN unpublished) elsewhere in the area for reasons that are unclear. Preliminary analysis of population trends on the eastern seaboard (southern Queensland to southern NSW) shows long-term declines for Grey-crowned Babbler between 1999 and 2019 (BirdLife Australia, unpublished).

The occurrence of Varied Sittellas and Speckled Warblers appears linked to habitat changes in the adjacent woodland at Green Wattle Creek (Newman & Cunningham 2018) where both species became increasingly sparse following the development of understorey vegetation. The demise of the Speckled Warbler was attributed to the loss of ground-foraging opportunities. Habitat rehabilitation projects, including weed removal and burning in 2010, partially restored the habitat in favour of species like the Speckled Warbler which returned to the site (Newman 2016), but such improvements may be temporary without ongoing maintenance. The farm appeared to provide supplementary habitat for species inhabiting the contiguous woodland at Green Wattle Creek.

Records of the Little Lorikeet primarily involved birds in transit between areas of mature forest, although the farm provided some foraging opportunities. Latham's Snipe opportunistically exploited ephemeral water meadow conditions.

Effectiveness of survey design

The hybrid survey design involving the collection of count data at an array of 2 ha sites, and as a whole of survey area search involving a fixed route, provided the flexibility to assess the status of both common and uncommon species using four

different approaches to assessing changes in the status of species.

Reporting Rates, 20 min/2 ha surveys: By sampling small areas for short periods, common species are recorded less frequently which makes interannual variations in occurrence more likely to be detected (e.g., **Figure 4b**, the Superb Fairywren). The results from the present study involved an annual sample of 16 surveys (four sites monitored quarterly) and they provided informative trends for 25 species with Reporting Rates above 10%. The other 115 species, some of which were not even sampled at the 2 ha sites, could not be trended because of insufficient data.

Reporting Rates, 500 m radius area surveys: This survey type did not provide useful information on common species (e.g. Superb Fairywren) because they were nearly always recorded and there was minimal interannual variation. However, these surveys were informative concerning the presence of unusual or particularly scarce species that may be missed at the 2 ha sites. Information on Threatened Species often fell into this category (e.g. the Latham's Snipe records). On larger properties with an opportunity to include several 500 m radius sites into the study this survey protocol may have advantages.

Count data, 20 min/2 ha surveys: Variations in the abundance of species provides an added dimension to Reporting Rate information because flock/group sizes may decrease earlier than Reporting Rates in terms of population trends. It is encouraging that there was a degree of correspondence between interannual variations in abundance measures (birds/survey) and Reporting Rate (e.g., **Figure 4b**, Superb Fairywren).

Count data, 500 m radius area surveys: This survey approach provided information on common species that were seldom recorded at the 2 ha survey sites (e.g., **Figure 5b**, Eastern Rosella and **Figure 6**, Grey-Crowned Babbler). It also provided an option for assessing the abundance of all individuals present, not just those at the 2 ha sites, resulting in a better definition of interannual variations in abundance (**Figure 5a**, Grey Fantail).

CONCLUSIONS

The hybrid survey design, involving quarterly surveys at an array of four 2 ha sites embedded in a whole survey area search proved extremely flexible. The analysis of count data complemented presence-

based Reporting Rates. Central to the success of this project was the consistent application of standard survey methodology by one observer.

Most of the 25 most-frequently recorded species appeared to have stable populations over a period of almost two decades, based both on their frequency of occurrence (Reporting Rate), and their abundance (birds/survey). However, both of these measures involved short-term fluctuations, and further evaluation is required to determine the extent to which these can be explained by factors like annual and seasonal rainfall.

Consistent with other studies in the Hunter Region, avian diversity was high with 140 species recorded over the 18-year period. Four threatened woodland species occurred regularly, with the farm property providing bird corridors, foraging habitat and breeding territories (for the Grey-crowned Babbler).

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