Bird population of Warakeila, a cattle property in the Allyn River Valley, NSW – a twelve year study

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Warakeila is a cattle property with about 15% remnant vegetation located in the Allyn Valley of the Hunter Region of NSW. Between 1996 and 2008 bird surveys were made at three-monthly intervals using the Birds Australia "Birds on Farms" methods. During these surveys 117 bird species were recorded.

Twenty five species were recorded on more than eighty percent of the surveys and are considered to be normally resident. An additional twelve species were regularly recorded as summer visitors. Other species recorded less frequently because of their elusive character may also be resident, notably the Red-backed Fairy-wren *Malurus melanocephalus* and Southern Emu-wren *Stipiturus malachurus*.

The second half of the study coincided with a prolonged period of drought which affected most of NSW. Preliminary analysis of the data suggests that a number of species declined during the drought period, examples being the Buff-rumped Thornbill *Acanthiza reguloides*, Dusky Woodswallow *Artamus cyanopterus*, Tree Martin *Petrochelidon nigricans*, Double-barred Finch *Taeniopygia bichenovii* and Red-browed Finch *Neochmia temporalis*. These species were seen less frequently and in smaller numbers during the second half of the study. As Warakeila is located in a landscape where vegetation is highly fragmented and lacking extensive tracts of woodland it is possible that some species may suffer local extinction. For instance, in the second half of the study the Double-barred Finch was not seen.

The survey results at Warakeila exemplify the importance of farms with remnant vegetation to local bird populations.

INTRODUCTION

This study ran in parallel with an identical investigation on a cattle property at Butterwick near Paterson in the NSW Hunter Valley (Newman 2007a). Both studies commenced as part of the "Birds on Farms" project run by Birds Australia. The studies were continued during the "New Atlas of Australian Birds" (Barrett *et al.* 2003) and the "Ongoing Atlas" projects which used compatible survey techniques. The lower boundary of Warakeila 32°15'S 151º31'E is the Allyn River at Eccleston. The property is run for cattle.

As with the previous paper the intention is to demonstrate the importance of farms with remnant vegetation to the conservation of bird populations. The study also provides baseline data against which future population trends can be gauged. Discussion of changes in bird population during this study and comparison with the Butterwick property is limited to examples where trends are obvious. A more detailed evaluation of these aspects will be the subject of a subsequent paper as will differences in the sub-populations of different habitats sampled at the 2ha sites.

METHODS

Surveys were at approximately three-monthly intervals, usually involving two observers. The timing of the surveys was close to the 15th day of January, April, July and October. Only two surveys were conducted outside 22 days of the target date. Surveys typically took between four and five hours to complete and commenced approximately two hours after sunrise. A constant survey-effort strategy was adopted in which each survey followed the same route (**Figure 1**). Separate records were kept for the four 2ha sites at which 20 minute counts were conducted as well as for the total survey.

The study involved 49 surveys at approximately three-monthly intervals between April 1996 and January 2008. The one exception to this routine was in 1999 when two surveys, one in September and the other in November, took place. The earlier of these surveys was

more than 22 days before the October target date and was excluded from the comparison of the two survey periods 1996 – 2001 and 2002 - 2007. The number of species recorded in November was 58 compared to 51 in September. This difference underscores the importance of the timing of the spring season count as a number of migrant species were absent in the earlier September survey.

In the following sections species have been classified according to the frequency and season in which they were recorded. The tabulated data includes a change ratio which is the ratio of the number of surveys a species was present in the first half (i.e. the first 24 surveys, 1996-2001) compared to the second half (i.e. the second 24 surveys, 2002-2007) of the study. Change ratio values greater than 1 suggest the possibility that a species may have decreased during the study. For instance, a change ratio of 1.2 indicates that a species was present on 20% more surveys in the first half of the study. Conversely, a change ratio of 0.8 indicates that a species increased, being present during 20% fewer surveys in the first half of the study.

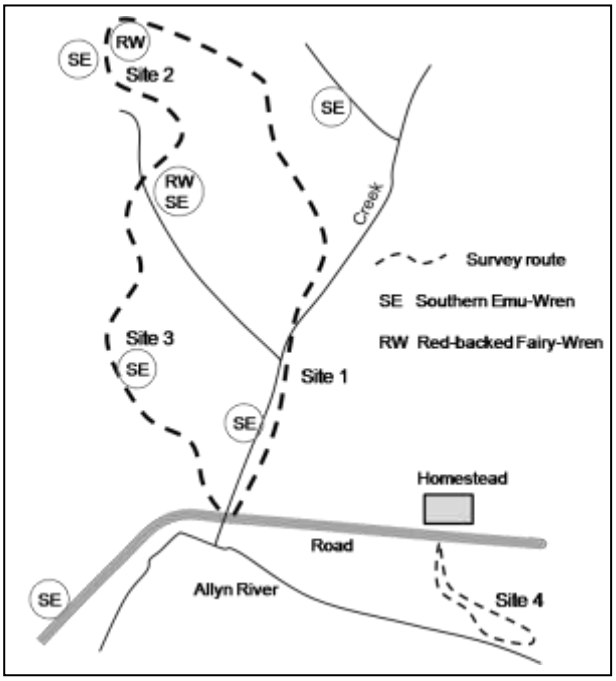

Figure 1. Warakeila – Survey route and location of key sightings.

HABITAT OVERVIEW

The following habitat description follows guidelines set out in Cooper (1999). The survey route initially ascended alongside a creek flowing into the Allyn River (**Figure 1**). Initially the vegetation was dominated by a narrow belt of River Oaks alongside the creek and the habitat was specified as 302 - River Oak (Cooper 1999, p. 42). At and beyond the 2ha site 1 there was an increasing influence of rainforest vegetation with vines and creepers. At site 1 were several isolated eucalypts one of which had extensive mistletoe growths. The mistletoe attracted a number of bird species when flowering. Away from the immediate creek bank clumps of blackberry provided ground cover and food for a variety of species. The adjacent hillsides had been extensively cleared, with little vegetation other than a few isolated trees. Occasional dams and boggy areas provided some habitat for water birds.

Above site 1 the survey route ascended more steeply through cleared pasture to a ridge line which was followed to the summit of the property above site 2. Gullies on either side of the ridge were heavily vegetated. On the right hand side of the ridge the northerly facing aspect of the gully favoured rainforest vegetation and has been tentatively assigned 404 - Warm Temperate Rainforest (Cooper 1999, p. 58). Vegetation on the other side of the ridge is predominantly 531 – Wet Sclerophyll (rough-barked) Forest (Cooper 1999, p.76) with a fairly sparse understorey. Site 2 is located at the top of this gully and while the vegetation predominantly contained wet sclerophyll species there was some rainforest type vegetation.

From site 2 the survey route descended through a cleared hillside with very little remnant vegetation. The view looking down from this point showed a mosaic of cleared hillside slopes segmented by numerous timbered creeks and gullies. Approximately 15 % of the land was vegetated.

Site 3 was situated on the route descending down the hillside and consisted of an isolated copse of rough-barked wet sclerophyll surrounding a dry creek. This site was chosen as an example of a small remnant of highly degraded woodland with no connectivity to other areas of remnant vegetation. There was some understorey including blackberry, which was periodically cleared.

The final section of the survey involved a descent from cattle sheds adjacent to the Warakeila homestead to site 4 on the banks of the Allyn River. At site 4 the vegetation was predominantly River Oak partially cleared for grazing. On the far bank of the Allyn River the narrow belt of vegetation has a rainforest influence, particularly at the southern end where a substantial cliff face provided shelter. At site 4 the understorey which contained a number of weeds was periodically

cleared. During the second half of the study a severe storm damaged a number of trees on the far bank of the river.

FACTORS IMPACTING ON THE SURVEY DATA

The primary purpose of the study was to determine the presence of species both at the four 2ha sites and for the total survey route. In addition, an estimate was made of the number of each species present. The four sites are separated by several hundred metres and there is typically an interval of at least 20 minutes between making each 2ha count. This minimizes the probability of the same birds being sampled at more than one of the 2ha sites, although it does not completely eliminate the possibility because outside the breeding season woodland birds often form a mobile mixed foraging group. However, at Warakeila the risk of double counting is thought to be negligible.

Conducting surveys at Warakeila involves considerable travel time to the site followed by a survey of approximately four hours duration. Consequently, despite aiming for an early start, most surveys were finished between noon and 1.00pm. Under hot conditions, particularly in summer, the surveys were completed when the birds were less active. However, as most of the areas containing dense vegetation where birds are difficult to detect were covered during the early stages of the survey, this problem was alleviated as the birds tended to still be active. Surveys were usually conducted under favourable weather conditions, in that extremely hot, windy and rainy days were avoided, because these conditions make the location and identification of birds by call difficult. During the study the observers' call identification skills improved as did their intuitive knowledge of where to expect individual species. Consequently surveys probably became more comprehensive as the study progressed. The regular detection of Southern Emu-wrens *Stipiturus malachurus* is an example of this effect and is discussed later. The presence of two observers was beneficial with respect to the identification of birds by call. In the case of larger species like waterbirds and birds frequenting open areas, the numbers counted provide an accurate measure of abundance. For the smaller woodland birds, particularly those of thornbill and pardalote size which forage in the crowns of tall trees, the numbers are only an indication and represent the minimum numbers present, particularly where records are based on call.

RESULTS

Summary Statistics

The results are summarized in **Table 1** which provides a comparison of species and individual bird numbers between seasons. A total of 117 species were positively identified and another two tentatively identified (excluded from the data analysis) during the surveys. An additional species was recorded during a night visit making a total species list of 120. The greatest number of species, 102, was recorded in spring compared with 92 in summer. Although the greatest number of species recorded during a survey, 67, occurred in summer, species diversity and abundance were higher in spring with 55.3 species/survey and 339.9 individual birds/survey. Diversity was appreciably lower in autumn and winter with 45.3 and 44.1 species/survey respectively. Bird abundance was greatest in autumn with an average of 360.8 but is biased by the inclusion of migrating birds (e.g. flocks of Yellow-faced Honeyeaters *Lichenostomus chrysops* accounted for 42.7% of the maximum autumn count of 597 birds).

Three of the four areas selected for the 20 minute 2ha counts were chosen because they were expected to be attractive bird habitat. Consequently it is surprising that only 25% of the total numbers of individual birds/survey were recorded at the 2ha sites for which the survey effort involved 33% of the survey time. This 25% value was extremely constant between seasons (**Table 1**).

Table 1. Summary of survey statistics.

	All Surveys	**Summer**	**Autumn**	**Winter**	**Spring**
Species Recorded	119	92	88	81	102
Average/survey	49.5	52.9	45.3	44.1	55.3
Maximum	67	67	54	51	64
Minimum	34	37	34	37	42
Number of Birds	16476	3723	4329	4005	4419
Average/survey	336.2	310.3	360.8	333.8	339.9
Maximum	597	409	597	391	448
Minimum	225	240	258	233	225
Birds counted 2ha surveys	4123 (25%)	900 (24%)	1120 (26%)	963 (24%)	1140 (26%)

Species Regularly Recorded Year Round

The 25 species falling in this category as listed in **Table 2** are best described as very common on the property and many are resident. Indeed, nine species were seen on every survey. Inclusion in this category is based on the species being seen on at least 40 surveys (i.e. more than 80% of the surveys).

Table 2. Species recorded regularly in all seasons (present on at least 40 i.e. >80% of surveys).

Common Name	**Scientific Name**	**Average Number Present**[1]	**Maximum Number Present**	**Number of Surveys Present**	**Change Ratio**[2]
Australian Wood Duck	*Chenonetta jubata*	12.1	33	41	0.74
Crimson Rosella	*Platycercus elegans*	9.5	32	46	0.96
Laughing Kookaburra	*Dacelo novaeguineae*	5.5	12	48	0.96
White-throated Treecreeper	*Cormobates leucophaea*	3.4	9	47	0.92
Superb Fairy-wren	*Malurus cyaneus*	39.6	70	49	1.00
White-browed Scrubwren	*Sericornis frontalis*	6.9	16	49	1.00
Brown Gerygone	*Gerygone mouki*	6.8	20	44	1.15
Striated Thornbill	*Acanthiza lineata*	10.2	30	40	1.11
Yellow Thornbill	*Acanthiza nana*	7.1	19	48	1.04
Brown Thornbill	*Acanthiza pusilla*	8.6	14	49	1.00
Spotted Pardalote	*Pardalotus punctatus*	6.7	16	47	0.92
Lewin's Honeyeater	*Meliphaga lewinii*	10.8	16	49	1.00
Yellow-faced Honeyeater	*Lichenostomus chrysops*	24.1	255	49	1.00
Bell Miner	*Manorina melanophrys*	23.5	30	49	1.00
White-naped Honeyeater	*Melithreptus lunatus*	5.0	21	42	0.95
Golden Whistler	*Pachycephala pectoralis*	4.0	8	43	1.00
Grey Shrike-thrush	*Colluricincla harmonica*	6.5	15	49	1.00
Australian Magpie	*Cracticus tibicen*	8.4	16	49	1.00
Pied Currawong	*Strepera graculina*	3.0	9	42	1.05
Grey Fantail	*Rhipidura albiscapa*	12.4	25	49	1.00
Willie Wagtail	*Rhipidura leucophrys*	2.5	5	43	1.00
Australian Raven	*Corvus coronoides*	4.9	13	48	1.04
Jacky Winter	*Microeca fascinans*	4.2	12	47	1.09
Eastern Yellow Robin	*Eopsaltria australis*	4.6	11	48	1.04
Red-browed Finch	*Neochmia temporalis*	25.0	90	46	1.05

[1] Average number seen on surveys when present.

[2] Ratio of numbers of surveys in which species were present during first half of the study (1996-2001) compared to the second half (2002-2007).

Species favouring woodland and creek margin vegetation dominate the list in **Table 2**. The composition of the list also reflects the absence of wetland habitat on Warakeila and surrounding properties other than the Allyn River habitat at and adjacent to the 2ha site 4. Only the Superb Fairy-wren, Bell Miner, Yellow-faced Honeyeater and Red-browed Finch were consistently seen in appreciable numbers (e.g. average number of the species >20/survey). The Crimson Rosella, Brown Gerygone, three species of thornbill, Lewin's Honeyeater and the Grey Fantail at around 10/survey were consistently recorded in modest numbers.

During the 1996-2001 surveys the Bell Miner was always present as a single large colony, estimated to contain 30 birds, located in a dense wet sclerophyll vegetated gully near the top of the property immediately adjacent to the survey route. During the 2002-2007 surveys Bell Miners were heard from two new locations each about 1km distant from the main colony. Towards the end of the study the original colony was completely abandoned. As the new colonies, which are assumed to have derived from a split of the original colony, were not directly on the survey route it was not possible to make reliable estimates of their size but the impression was that we were hearing fewer birds.

As mentioned previously, Yellow-faced Honey-eater numbers were biased by the results of one autumn survey when a large number of migrating birds estimated at 255 passed through Warakeila. This resulted in a maximum autumn survey count of 597 birds. If this value is discounted by the 230 Yellow-faced Honeyeaters in excess of the average count/survey, the adjusted number of 367 birds is close to the average autumn bird total of 361/survey.

The Australian Wood Duck, Australian Magpie, Australian Raven and Pied Currawong were typically recorded in the cleared, but lightly-timbered areas. The low value of the change ratio for the Australian Wood Duck suggests that this species increased during the second half of the study. Initially, this is a surprising result as drought conditions prevailed during the 2002-2006 period and a decline in this species was found in the Butterwick study (Newman 2007). The increase at Warakeila may be a consequence of the establishment of a number of new dams during the study period which provide the best drought refuge for the local area. Population trends and the change ratio based on presence, which is of limited value for frequently observed species, are discussed in more detail in a later section of this paper.

Species Regularly Recorded in Summer

Twelve species fall in the regular summer visitor category based on presence during at least four (33%) of the summer surveys and being recorded at least five times more frequently in summer than during winter surveys (**Table 3)**. The threshold for inclusion was deliberately set low at 33% because summer survey conditions are difficult with some species relatively inactive and non vocal because temperatures are high and most species have completed breeding. This point is emphasized by the data in **Table 3** which show that for most of the summer visitors less than half the records were during summer surveys (i.e. summer visitors are usually present and more active during spring surveys). Two species which met the criteria were excluded for reasons discussed in the next section. No species were classified as winter visitors by meeting the converse criteria to that defining a summer visitor.

None of the summer visitors were abundant with average numbers typically in the range 2 to 3 birds/survey and maximum numbers of 6 to 8. The Black-faced Monarch was the only species recorded on every summer survey.

The Rainbow Bee-eater is classed as a summer migrant to the Hunter Region (Stuart 2007). Although it was recorded during only 4 (33%) of the summer surveys (**Table 3**) it was recorded on 9 (75%) of the spring surveys indicating that it is a more frequent visitor than indicated by the summer survey data. The high change ratio value of 2.00 indicates a decline during the second half of the study (2002-2007). During the initial phase of the study a pair was present every spring, apparently nesting in a creek bank near the start of the survey route. This pair was not seen during the second half of the study but, after a number of years with no records, small flocks were observed in the summers of 2005/06 and 2006/07 near 2ha site 4. These data indicate the ease with which a species for which the local population depends on isolated pairs could become locally extinct.

Table 3. Frequently observed summer visitors
(species recorded on at least 4 summer surveys and at least 5 times more frequently in summer than winter).

Common Name	Scientific Name	Average No. Present[1]	Maximum No. Present	No. Surveys Present	No. Summer Records	No. Winter Records	Change Ratio[2]
Sacred Kingfisher	*Todiramphus sanctus*	2.2	3	13	5	0	0.63
Rainbow Bee-eater	*Merops ornatus*	2.7	6	13	4	0	2.00
Dollarbird	*Eurystomus orientalis*	2.6	6	19	11	0	1.11
White-throated Gerygone	*Gerygone albogularis*	2.6	7	22	8	0	1.00
Scarlet Honeyeater	*Myzomela sanguinolenta*	3.6	9	9	5	0	0.50
Noisy Friarbird	*Philemon corniculatus*	3.5	6	19	8	0	1.71
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	3.1	10	32	11	2	1.07
Rufous Whistler	*Pachycephala rufiventris*	3.2	12	24	10	0	1.56
Olive-backed Oriole	*Oriolus sagittatus*	1.5	4	16	6	1	1.00
Rufous Fantail	*Rhipidura rufifrons*	3.1	10	14	10	0	1.80
Leaden Flycatcher	*Myiagra rubecula*	3.0	7	16	7	0	1.29
Black-faced Monarch	*Monarcha melanopsis*	3.4	8	24	12	0	1.09

[1]Average number seen on surveys when the species was recorded.
[2]Ratio of numbers of surveys in which species were present during first half of study (1996-2001) compared with second half (2002-2007).

In contrast the Sacred Kingfisher and Scarlet Honeyeater are examples of species with very low change ratios, 0.63 and 0.50 respectively, indicating that these species were recorded more frequently in the second half (2002-2007) of the study.

The Black-faced Cuckoo-shrike and the Olive-backed Oriole are included as summer visitors in **Table 3** on the basis that they are at least 5 times more frequently observed in summer than in winter. Both species are classed as resident in the Hunter Region (Stuart 2007). The results of this study suggest that there are local movements outside the breeding season, possibly indicating changes in habitat preference after the breeding season. For instance the authors have noted congregations of Olive-backed Orioles attracted to white cedar trees during winter.

Species Often Recorded

The 37 species in this category (**Table 4**) were recorded during 20% to 80% of the surveys. A broad range of species are involved, many of which are vocal and conspicuous (e.g. Galah present on 61% of surveys) suggesting that they are only intermittently present in the study area. Skulking species like the Eastern Whipbird (recorded on 67% of surveys) were primarily detected by call. Seasonal variations in vocal activity would impact adversely on the detection of this species which is assumed to be resident in small numbers at Warakeila.

The Pheasant Coucal was recorded on 16 (33%) surveys, and 6 times more frequently in summer than winter. Strictly speaking this species meets the criteria for inclusion in **Table 3** as a summer visitor. However, the Pheasant Coucal is considered to be a resident which exhibits seasonal variations in conspicuousness, particularly vocal, as claimed in explanation of other investigations where variations in seasonal reporting rates were found (Higgins 1999, p. 796).

The Warakeila study unexpectedly established the presence of a population of the Southern Emu-wren (**Figure 1**) which was recorded on 13 (27%) of the surveys (Newman 2007). Most of the records were in the second half of the study (2002-2007). Although the very low change ratio 0.20 suggests a population increase or even colonisation of the Warakeila property during the study it is probable that the observers were sensitized to the presence of this elusive species subsequent to its initial discovery in 1999. Although there are no winter records, the Southern Emu-wren is considered to be a widespread breeding resident at Warakeila, with immature birds noted in a family foraging group during autumn.

Other species with low change ratios indicating a possible population increase include the

Mistletoebird *Dicaeum hirundinaceum* 0.22 and the Torresian Crow *Corvus orru* 0.42. In the case of the Mistletoebird the number of records was low. However, if the result is meaningful a possible explanation is that the vigorous flowering of mistletoe provided an important food source for this species during the drought-dominated period (2002-2007). The apparent increase in the Torresian Crow may be a consequence of the authors' lack of familiarity with the calls of this species at the start of the study. This species appears to have expanded its range in the Lower Hunter recently (Stuart 2007).

In contrast, high change ratio values for the Buff-rumped Thornbill *Acanthiza reguloides*, 1.71, and the Double-barred Finch *Taeniopygia bichenovii*, which was not recorded during 2002-2007, suggest that these ground-feeding species have undergone a population decline. The conspicuous Tree Martin *Petrochelidon nigricans*, with a change ratio of 1.83, is another species which appears to have declined. The evidence for these claims will be discussed in more detail in a later section.

Table 4. Species often observed and present in all seasons (recorded on 10 (20%) to 39 (80%) of the 49 surveys).

Common Name	Scientific Name	Average Number Present[1]	Maximum Number Present	Number Surveys Present	Change Ratio[2]
Pacific Black Duck	*Anas superciliosa*	3.5	13	39	0.95
Brown Cuckoo-Dove	*Macropygia amboinensis*	1.8	6	13	1.17
Crested Pigeon	*Ocyphaps lophotes*	2.7	10	10	0.43
Bar-shouldered Dove	*Geopelia humeralis*	2.9	13	28	0.56
Wonga Pigeon	*Leucosarcia picata*	1.4	3	30	0.67
Little Pied Cormorant	*Microcarbo melanoleucos*	1.2	2	17	1.00
White-faced Heron	*Egretta novaehollandiae*	1.6	6	22	1.33
Wedge-tailed Eagle	*Aquila audax*	1.5	3	19	1.11
Dusky Moorhen	*Gallinula tenebrosa*	2.6	8	12	1.75
Masked Lapwing	*Vanellus miles*	2.4	5	14	0.27
Galah	*Eolophus roseicapillus*	3.6	13	30	0.80
Australian King-Parrot	*Alisterus scapularis*	2.5	9	15	1.80
Eastern Rosella	*Platycercus eximius*	5.0	18	35	0.55
Pheasant Coucal	*Centropus phasianinus*	1.6	3	16	0.88
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	2.5	10	27	1.00
Satin Bowerbird	*Ptilonorhynchus violaceus*	3.2	12	32	1.07
Variegated Fairy-wren	*Malurus lamberti*	5.3	11	37	1.12
Southern Emu-wren	*Stipiturus malachurus*	3.4	8	13	0.20
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	6.3	21	25	1.00
Buff-rumped Thornbill	*Acanthiza reguloides*	4.8	10	20	1.71
Striated Pardalote	*Pardalotus striatus*	2.4	7	31	1.50
Eastern Spinebill	*Acanthorhynchus tenuirostris*	3.1	9	34	0.79
Noisy Miner	*Manorina melanocephala*	4.1	11	15	0.88
Red Wattlebird	*Anthochaera carunculata*	2.9	6	36	0.57
Noisy Friarbird	*Philemon corniculatus*	3.5	6	19	1.71
Eastern Whipbird	*Psophodes olivaceus*	2.5	6	33	0.57
Varied Sittella	*Daphoenositta chrysoptera*	7.9	23	10	0.80
Grey Butcherbird	*Cracticus torquatus*	1.8	4	31	0.48
Pied Butcherbird	*Cracticus nigrogularis*	2.8	6	39	0.73
Torresian Crow	*Corvus orru*	2.8	7	27	0.42
Magpie-lark	*Grallina cyanoleuca*	2.6	8	38	1.00
White-winged Chough	*Corcorax melanorhamphos*	9.3	20	28	1.00

Table 4. Species often observed and present in all seasons (recorded on 10 (20%) to 39 (80%) of the 49 surveys) (cont.).

Common Name	*Scientific Name*	Average Number Present[1]	Maximum Number Present	Number Surveys Present	Change Ratio[2]
Silvereye	*Zosterops lateralis*	9.4	24	34	1.38
Tree Martin	*Petrochelidon nigricans*	6.4	28	18	1.83
Common Myna	*Sturnus tristis*	2.7	9	12	0.71
Mistletoebird	*Dicaeum hirundinaceum*	1.2	2	11	0.22
Double-barred Finch	*Taeniopygia bichenovii*	10.0	25	10	(NR2)

[1] Average number seen on surveys when species recorded.
[2] Ratio of number of surveys in which species was recorded during first half of study (1996-2001) compared with second half (2002-2007).
(NR2) Species not recorded during 2002-2007 surveys.

Species Recorded Occasionally

The 44 species recorded occasionally (**Table 5)** occurred in less than 20% of the surveys. The change ratios in **Table 5** should be interpreted with caution because of the small number of sightings. However, as will be discussed below, a number of species denoted NR2 in **Table 5** were recorded only in the first half of the study which, in some instances, may be indicative of a change in distribution, at least at the local scale.

Of the 10 raptor species recorded at Warakeila nine are in the **Table 5** category, the Wedge-tailed Eagle being the only species recorded regularly (19 surveys). The Brown Goshawk and Collared Sparrowhawk which were present on 5 surveys were the most regularly recorded of the remaining raptor species.

Of the seven species of cuckoo found at Warakeila, only two were recorded on ten or more surveys. Surprisingly there were no records of the Pallid Cuckoo, a vocal and conspicuous species, which is considered to be a moderately common breeding summer visitor to the Hunter Region (Stuart 2007).

Table 5. Species seen infrequently and classed as either uncommon or rare (recorded on less than 10 surveys).

Common Name	Scientific Name	Average Number Present[1]	Maximum Number Present	No. of Surveys Present	Change Ratio[2]
Stubble Quail	*Coturnix pectoralis*	1.0	1	1	(NR1)
Brown Quail	*Coturnix ypsilophora*	1.3	2	3	2.00
Grey Teal	*Anas gracilis*	2.0	2	1	(NR1)
Chestnut Teal	*Anas castanea*	1.0	1	1	(NR1)
Australasian Grebe	*Tachybaptus novaehollandiae*	1.0	1	1	(NR2)
Great Cormorant	*Phalacrocorax carbo*	1.0	1	2	(NR2)
Little Black Cormorant	*Phalacrocorax sulcirostris*	1.0	1	1	(NR2)
White-necked Heron	*Ardea pacifica*	1.0	1	4	1.00
Cattle Egret	*Ardea ibis*	3.0	3	1	(NR1)
Straw-necked Ibis	*Threskiornis spinicollis*	6.7	21	6	0.50
Black-shouldered Kite	*Elanus axillaris*	1.0	1	2	(NR2)
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	1.0	1	1	(NR1)
Brown Goshawk	*Accipter fasciatus*	1.4	2	5	1.50
Collared Sparrowhawk	*Accipter cirrocephalus*	1.2	2	5	3.00
Grey Goshawk	*Accipter novaehollandiae*	1.0	1	3	2.00
Nankeen Kestrel	*Falco cenchroides*	2.0	2	4	0.50
Brown Falcon	*Falco berigora*	1.0	1	4	(NR2)

Table 5. Species seen infrequently and classed as either uncommon or rare (recorded on less than 10 surveys) (cont.).

Common Name	***Scientific Name***	**Average Number Present**[1]	**Maximum Number Present**	**No. of Surveys Present**	**Change Ratio**[2]
Australian Hobby	*Falco longipennis*	1.3	2	3	2.00
Peregrine Falcon	*Falco peregrinus*	1.0	1	4	1.00
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	1.8	2	4	0.33
Sulphur-crested Cockatoo	*Cacatua galerita*	2.0	2	1	0.00
Eastern Koel	*Eudynamis orientalis*	1.8	2	8	1.00
Channel-billed Cuckoo	*Scythrops novaehollandiae*	1.0	1	3	2.00
Horsfield's Bronze-Cuckoo	*Chalcites basalis*	1.5	2	2	(NR2)
Shining Bronze-Cuckoo	*Chalcites lucidus*	1.4	3	9	1.00
Brush Cuckoo	*Cacomantis variolosus*	1.5	2	2	(NR2)
Southern Boobook	*Ninox novaeseelandiae*	1.0	1	2	(NR1)
Azure Kingfisher	*Ceyx azureus*	1.2	2	5	1.50
Green Catbird	*Ailuroedus crassirostris*	1.7	2	6	1.00
Regent Bowerbird	*Sericulus chrysocephalus*	1.0	1	1	(NR2)
Red-backed Fairy-wren	*Malurus melanocephalus*	3.0	5	7	0.75
Large-billed Scrubwren	*Sericornis magnirostra*	1.0	1	3	0.50
Speckled Warbler	*Chthonicola sagittata*	1.0	1	1	(NR2)
Scarlet Honeyeater	*Myzomela sanguinolenta*	3.6	9	9	0.50
White-winged Triller	*Lalage sueurii*	1.0	1	1	(NR2)
Crested Shrike-tit	*Falcunculus frontatus*	1.3	2	3	0.50
Dusky Woodswallow	*Artamus cyanopterus*	2.0	4	4	(NR2)
Restless Flycatcher	*Myiagra inquieta*	1.4	3	5	1.00
Spectacled Monarch	*Symposiarchus trivirgatus*	1.0	1	1	(NR2)
Rose Robin	*Petroica rosea*	1.5	2	4	0.33
Australian Reed-Warbler	*Acrocephalus australis*	2.0	2	1	(NR1)
Bassian Thrush	*Zoothera lunulata*	1.4	2	5	1.5
Common Starling	*Sturnus vulgaris*	4.5	12	4	3.00
Australasian Pipit	*Anthus novaeseelandiae*	1.5	2	4	3.00

[1]Average number seen on surveys when species recorded.

[2]Ratio of number of surveys in which species was present during first half of study (1996-2001), compared with second half (2002-2007).

(NR1) Species not recorded during 1996-2001 surveys.

(NR2) Species not recorded during 2002-2007 surveys.

The Red-backed Fairy-Wren was recorded on 7 surveys and appears to be a scarce resident with, as indicated by **Figure 1,** a limited distribution on the property (Newman 2007b). The Warakeila population is a slight southern extension to the previously known range of the Red-backed Fairy-wren.

The four records of the White-necked Heron were all in summer, but because the number of observations was small and this species is considered a resident in the Hunter Region (Stuart 2007) it was not included as a summer visitor in **Table 4**.

Given the absence of suitable reed habitat the occurrence of two Australian Reed-Warblers along the edge of the Allyn River was an unexpected record during one survey.

Five records of the Bassian Thrush were made including two in a patch of creek-side rainforest immediately above site 1. Two birds were present on the second occasion which was eleven years after the first record. This cryptically coloured and elusive species is probably an under-recorded sparse resident.

The three records of the Large-billed Scrubwren were all made at the upper end of the 2ha site 2 which suggests that the species may be resident in the gully below this point which contains rainforest type vegetation. This species is common in the rainforest of the Upper Allyn Valley as are the Rose Robin and the Spectacled Monarch, both of which were only recorded on 4 and 1 surveys respectively. It is suggested that these species only occur on passage, in the case of the Rose Robin during an altitudinal movement to the coastal region where it winters (Newman 2007a).

Seven (16%) of the 44 species in **Table 5** were not recorded in the first six years (NR1) of the study. In contrast nearly twice as many 12 (27%) of the **Table 5** species were not recorded in the last six years (NR2). This may indicate that conditions were more favourable to bird populations in the first six years of the investigation and will be discussed further in the next section.

Two species, the Painted Button-quail *Turnix varius* and the Musk Lorikeet *Glossopsitta concinna* were tentatively identified during the surveys but have been excluded from the analysis because of a slight doubt concerning their identification. A further species, the Masked Owl *Tyto novaehollandiae*, was recorded while driving at night along the public road which passes through the property near the start of the survey route.

Examples of Population Change

In the previous tables and discussion the change ratio involved a comparison of the number of surveys a species was present in the first 24 surveys (1996-2001) with the second 24 surveys (2002-2007). This ratio based on presence was used as an indication of population change and a number of examples of change were highlighted in previous sections. However, this measure has limitations particularly for species which are either infrequently recorded (small sample size) or resident (always present giving a ratio of 1.0 which indicates no change). In the case of resident species, comparison of the average number of birds (i.e. abundance) seen on a survey when a species is present provides a more helpful indicator of population change. In **Table 6** the change ratios based on presence and abundance are compared for a few species which were suggested in the previous sections to warrant further evaluation.

Table 6. Comparison of change ratios based on presence and abundance.

Common Name	**Scientific Name**	**Surveys Present First Half**[1]	**Surveys Present Second Half**	**Change Ratio**[3] **Presence**	**Average Number First Half**[5]	**Average Number Second Half**	**Change Ratio**[4] **Average Number**
Australian Wood Duck	*Chenonetta jubata*	17	23	0.74	9.2	14.4	0.64
Australian King-Parrot	*Alisterus scapularis*	9	5	1.80	2.9	1.8	1.61
Superb Fairy-wren	*Malurus cyaneus*	24	24	1.00	43.1	35.9	1.20
Variegated Fairy-wren	*Malurus lamberti*	19	17	1.12	5.5	5.1	1.08
Buff-rumped Thornbill	*Acanthiza reguloides*	12	7	1.71	5.5	3.4	1.59
Scarlet Honeyeater	*Myzomela sanguinolenta*	3	6	0.50	2.3	4.2	0.56
Dusky Woodswallow	*Artamus cyanopterus*	3	0	NR[2]	2.0	0	NR[2]
Rufous Fantail	*Rhipidura rufifrons*	9	5	1.80	3.4	2.6	1.32
Grey Fantail	*Rhipidura albiscapa*	24	24	1.00	13.4	11.3	1.19
Jacky Winter	*Microeca fascinans*	24	22	1.09	4.8	3.5	1.34
Tree Martin	*Petrochelidon nigricans*	11	6	1.83	8.3	2.7	3.09
Mistletoebird	*Dicaeum hirundinaceum*	2	9	0.22	1.0	1.2	0.82
Double-barred Finch	*Taeniopygia bichenovii*	10	0	NR[2]	10.0	0	NR[2]
Red-browed Finch	*Neochmia temporalis*	23	22	1.05	32.3	17.0	1.90

[1] Based on 24 seasonal surveys in each half.

[2] Not recorded in second half surveys.

[3] Ratios greater than 1 indicate that a species was less frequently present during second half surveys.

[4] Ratios greater than 1 indicate that a species was less abundant during second half surveys.

[5] Average numbers reported for surveys when species present.

The two finch species provide an excellent example of the use of the change ratios. The Double-barred Finch was seen on 10 surveys (42%) during the period 1996-2001 and averaged 10.0 birds/survey. It was not recorded during the second half of the study 2002-2007 indicating probable local extinction of the species. In contrast the Red-browed Finch was recorded on 45 out of 48 surveys and the change ratio of 1.05 indicates a 5% variation in frequency of presence which is too small to draw any conclusion. Examination of the abundance ratio 1.90 suggests that although this species remains numerous it has undergone a substantial population decline the average number/survey having fallen from 32.3 to 17.0 as shown in **Figure 2**.

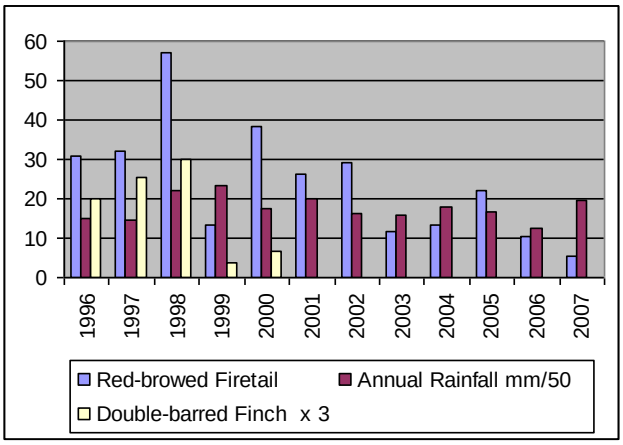

Figure 2. Variation of finch numbers at Warakeila and annual rainfall measured at Tocal.

Other species for which the evidence for decline appears strong as indicated by change ratios greater than 1.4 include Australian King-Parrot, Buff-rumped Thornbill and Tree Martin. In each case the change ratios indicate that not only were these species seen less frequently in the second period but they were present in lower numbers during the latter half of the study. Similarly the Dusky Woodswallow, which is occasionally but widely recorded in the Hunter Region (Stuart 2007), is scarce at Warakeila and was not recorded during 2002-2007. The Rufous Fantail, a summer migrant, also exhibits strong evidence of decline but, in this case, the evidence based on abundance is less compelling than for presence. It is interesting to note that in every case in which the change ratio for presence exceeded 1 suggesting a possible decline this conclusion was supported by a correspondingly high value of ratio based on abundance. In **Figure 3,** which is based on **Table 6,** the two ratios are presented as a scatter diagram. A feature of the correlation between the two change ratios is the grouping of the three increasing species in the lower left hand quadrant with the eight decreasing exclusively occupying the upper right hand quadrant. At face value this suggests the ratios are a useful tool for detecting changes in local bird populations which warrants evaluation for an extended species set.

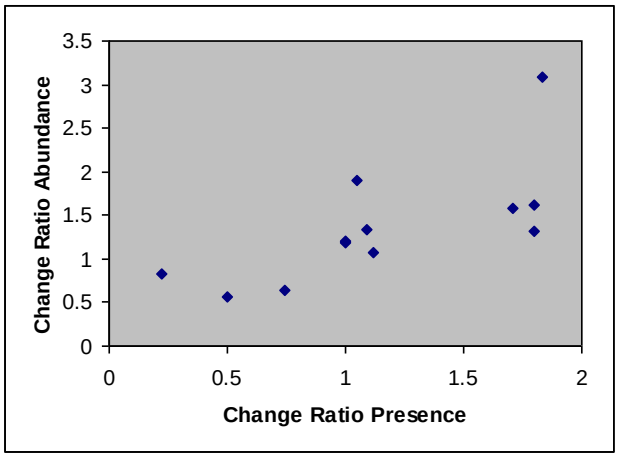

Figure 3. Correlation between change ratios based on presence and abundance.

The Speckled Warbler which was recorded on only one survey was also seen at site 3 on a visit to Warakeila several years before the study commenced. This is another of a cohort of small ground-feeding species for which there is evidence of widespread decline.

The Superb Fairy-wren is a resident species recorded on every survey and in greater numbers, 39.6/survey, than any other species. However, even this species appears to have declined during the study with average numbers falling from 43.1 to 35.9/survey. Similar conclusions hold for the Grey Fantail although this species is less numerous and subject to fluctuations caused by passage birds on migration. The Jacky Winter which is even less numerous demonstrates a similar trend with the small drop in abundance being a more compelling indicator of possible decline than the change in presence.

Variations in rainfall are an obvious factor influencing changes in bird populations by impacting on the availability of food. Low food availability can adversely impact on the breeding success of resident species as well as making an area less attractive to nomadic and migratory species which may be experiencing broad scale decline under extensive drought conditions. Comprehensive rainfall data is available for Tocal near Paterson (Gillespie 2007) which is about 50 km from Warakeila. This data indicates that for the

second half of the study until mid 2007 conditions were 19.7% dryer than in the first half (**Figure 2**). In June 2007 the rainfall increased dramatically ending one of the most prolonged and widespread droughts experienced throughout much of NSW in recent years. It is, however, too early to assess the impact of a return to higher than average rainfall conditions on the recovery of the bird population at Warakeila. The ongoing degradation of remnant vegetation by clearing is another factor expected to cause a decline in bird numbers and diversity. In 2003 track upgrades resulted in limited habitat loss at site 1 and more substantial habitat alteration at site 2 including the felling of a number of trees. By the end of 2003 the copse at site 3 was half its original size and the understorey had been removed. At site 4 a storm caused substantial damage taking out the tops of much of the thin belt of trees on the far bank of the river.

As indicated previously the Australian Wood Duck is a species which appears to have increased, being recorded both more frequently and in greater numbers during 2002-2007. Two other species which appear to have increased are the Scarlet Honeyeater and the Mistletoebird but in these cases the sample sizes are small. For the Mistletoebird the change ratio of 0.22 based on presence is more convincing than the abundance ratio of 0.82.

CONCLUSIONS

One hundred and seventeen species were positively identified on the surveys with one additional species identified outside the surveys. A further 2 species were recorded on the surveys, but only tentatively identified, giving a probable species list of 120 for Warakeila. These numbers are comparable but slightly fewer than those found at the Butterwick property where 126 species were recorded on the surveys. Both these studies demonstrate the important contribution which working cattle properties with remnant vegetation make to sustaining bird diversity. At both properties the composition of the species list is consistent with the status of birds listed in the Annual Bird Reports for the Hunter Region of New South Wales (Stuart 2007). Differences between the bird populations on the two properties include the occurrence of more waterbird species (e.g. Baillon's Crake *Porzana pusilla* and Latham's Snipe *Gallinago hardwickii*) at Butterwick which has marshy habitat at times and is adjacent to a floodplain. In contrast Warakeila provides hillside habitat for the Southern Emu-wren and the Red-backed Fairy-wren as well as a niche for the Azure Kingfisher along the Allyn River. In both studies the limited extent of continuous woodland and the lack of cereal crops explain the absence of the Common Bronzewing *Phaps chalcoptera* (Barrett *et al.* 2002).

As in the Butterwick study, counting the numbers of birds proved beneficial in assessing change and complemented an analysis based on the presence of species. For a sub-set of species a correlation between the change ratios based on presence and abundance was established which provides intuitive support to the efficacy of these empirical factors as indicators of population change. As in the previous study January is not the optimal month for assessing the summer population. For instance summer migrants were recorded more frequently during the October than in the January surveys because the peak of breeding season is past and survey conditions are sub-optimal.

Intensive survey methods where it is important to adhere to a constant effort routine are not conducive to obtaining comprehensive information on breeding. While dependent young were seen for some species very few nests were found.

There are clear indications of the local decline of a number of species, the most dramatic being the Double-barred Finch which was not recorded in the second half of the study. The more numerous Red-browed Finch was present throughout the study but declined in abundance.

The apparent decline of woodland species like the Buff-rumped Thornbill, Tree Martin and Dusky Woodswallow is consistent with the conclusions of other studies.

Drought and ongoing clearing of trees and understorey probably contributed to the population decline. The re-establishment of species like the Double-barred Finch on Warakeila may be difficult in view of the highly fragmented nature of the remnant vegetation.

The increase in the Australian Wood Duck was unexpected given the drought conditions prevalent during the latter half of the investigation. Dams on Warakeila may provide a local drought refuge for this species.

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