The birds of Green Wattle Creek – monthly surveys 1996-2009

Mike Newman
7 Glenurie Close, Woodville, NSW 2321

The Green Wattle Creek woodland at Butterwick is an important natural resource located on the edge of the Paterson River flood plain. In view of its limited size (approximately 120ha) and its relative isolation from similar low-lying woodland habitat the 144 species identified since 1993 is impressive. Monthly surveys over a 13-year period have allowed changes in the reporting rates and abundance of individual species to be measured. Analysis of the results highlights a number of statistically significant changes in the woodland bird population. The number of declining species exceeds those which are increasing. Among the declining species a cohort of ground-foraging birds stand out, including the Speckled Warbler *Chthonicola sagittata*, Brown Treecreeper *Climacteris picumnus*, Buff-rumped Thornbill *Acanthiza reguloides* and the White-winged Chough *Corcorax melanorhamphos*. The reason for their decline is attributed to the cessation of light cattle grazing shortly after the surveys commenced resulting in a progressive increase in understorey and ground cover vegetation making the woodland less suitable for ground-foraging species. Of this group only the Speckled Warbler, a threatened species listed as vulnerable, retains resident status and it is increasingly restricted to habitat at the edge of the woodland. In contrast the Lewin's Honeyeater *Meliphaga lewinii* has benefited from the increased understorey growth. The reasons for the decline of other species like the Fuscous Honeyeater *Lichenostomus fuscus* are less clear and factors like variations in rainfall and the loss of connectivity to similar woodland habitat may be important. The diversity of its bird population, the presence of threatened species, the use of the area by migrants on passage and nomads seeking drought refuge all make the Green Wattle Creek woodland an area requiring a degree of protection and management which is sympathetic to its natural assets. The Speckled Warbler is a particularly important case. For instance an extensive fire could cause the local extinction of this species in view of the limited connectivity to similar habitat.

INTRODUCTION

This study was carried out in an area of woodland at the end of Green Wattle Creek Road, Butterwick 32º 40' S 151º 39' E in the Lower Hunter Valley near Paterson, comprising approximately 120ha (approximately 40 ha surveyed) of remnant woodland situated at the edge of the Butterwick floodplain. A similar study was made in parallel on an adjacent working cattle property (Newman 2007) allowing a comparison of the bird populations of the two sites. A third parallel study was conducted on a cattle property, Warakeila, in the upper Allyn River Valley (Newman & Lindsey 2008). Key features of this investigation are the cessation of light grazing shortly after the surveys commenced, the absence of any burning for at least twenty years and the isolation of the study area from similar habitat. Its bird population contains several species which are uncommon in the Butterwick area including a breeding population of the Speckled Warbler *Chthonicola sagittata* which is listed as vulnerable under the NSW Threatened Species Act.

All three 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. However this study was more intensive with surveys made at monthly intervals as opposed to three months in the parallel studies.

As with the previous papers the intention is to generate baseline data against which future bird population trends can be gauged. Discussion of changes in bird populations during this study and comparison with the other studies is limited to examples where trends and differences are obvious. A more detailed evaluation of these aspects will be the subject of subsequent papers as will differences in the sub-populations of different habitats sampled at the four 2ha sites.

METHODS

156 surveys were conducted monthly by the author over a 13-year period commencing April 1996. Observation typically commenced about one hour after sunrise and took about four hours to complete. A constant survey effort was adopted in which each survey followed the same route (**Figure 1**). Separate records were kept for the total survey and for the four 2ha sites at which 20-minute counts were made. The numbers of birds for each species was recorded based on birds both seen and heard.

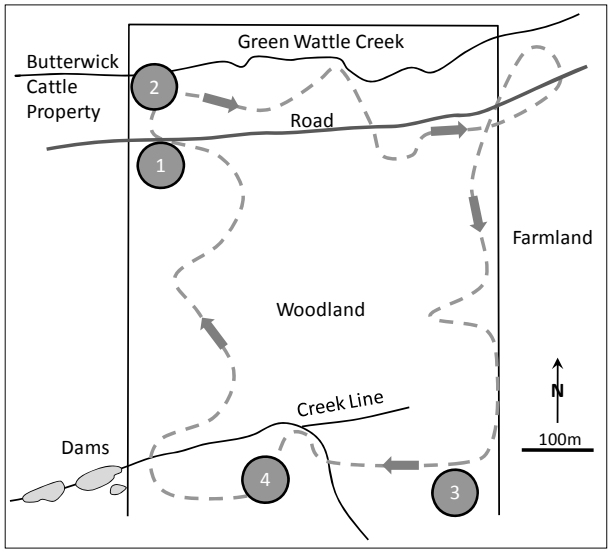

Figure 1. Survey route and 2ha survey sites at Green Wattle Creek woodland.

In the following sections some species have been classified as summer and winter visitors based on the relative frequency of their occurrence during October-January compared with April-July (i.e. the periods when birds were deemed most likely to be migrating through the area were not considered). Discussion of changes in the bird population during the study is based on a comparison of the results for 1997-2002 with 2003-2008. The exclusion of 12 surveys from this analysis creates two symmetrical sets of data each including 72 monthly surveys and allows the initial nine surveys made in 1996 when the survey technique was being fine tuned to be discarded. Differences in the reporting rates (RR; the percentage of surveys on which a species was recorded) and abundance (mean number of individual birds seen for each species considering only those surveys when a species was present) were compared for the two periods.

HABITAT OVERVIEW

A vegetation survey, with emphasis on the 2ha sites was made in April 2009. The following description relates to the habitat at the end of the study in 2009.

Cattle grazing ceased shortly after the bird surveys commenced resulting in a progressive increase in both ground cover and understorey vegetation. The woodland is approximately 120ha in area and rectangular in shape. Green Wattle Creek runs along the 0.5km long northern boundary and vegetation at its edges contains rainforest species. Although the area has been logged in the past the trees are about 30m in height and form a closed canopy in the northern half of the wood. At the southern end the habitat is temperate woodland with a more open canopy. The survey route primarily involves the closed canopy areas but the open woodland is sampled at 2ha site 4.

Four tree species dominate the canopy; Forest Red Gum *Eucalyptus tereticornis*, Spotted Gum *Corymbia maculata*, Grey Gum *Eucalyptus punctata* and Narrow-leaved Ironbark *Eucalyptus crebra*, with small numbers of White Mahogany *Eucalyptus acmenoides.* A combination of historical logging, removal of dead timber for firewood and the absence of recent fires means there are limited nest holes for birds. Recent illegal logging of live trees targeted mature ironbarks. Mistletoe *Dendrophthoe vitellina* is a feature of the woodland at and near 2ha site 1 and at 2ha site 3 with the Spotted Gum and Narrow-leaved Ironbark preferred hosts.

Lantana camara and Blackthorn *Bursaria spinosa* dominate the understorey layer, varying in relative proportions and density through the northern end of the woodland. Green Wattle *Acacia irrorata* and the smaller shrubs *Ozothamnus diosmifolius* and *Leucopogon juniperinus* are also present, the latter being the dominant ground cover species in places where taller shrubs, particularly the invasive Lantana are absent. Other ground cover species include Kidney Weed *Dichondra repens*, *Daviesia ulicifolia* which is a prickly shrub, Mulga Fern *Cheilanthes sieberi* and in areas of dense vegetation White Root *Pratia purpurascens.* Areas where the ground cover is predominantly leaf and bark litter without a shrub layer have decreased since grazing ceased. In the open woodland areas native grasses including Blady Grass *Imperata cylindrica*, Kangaroo Grass *Themeda australis* and Tufted Hedgehog Grass *Echinopogon caespitosus*, provide ground cover with a few invasive shrub species.

Site 1 vegetation is dominated by the four species of tall trees mentioned earlier which have minor mistletoe infestations. Lantana is the dominant understorey species providing approximately 50 percent ground coverage. The remainder of the

ground is more open with small shrubs, *Dianella sp.* and some native grass. Formerly there was a permanent pond which was drained when a small Equestrian Centre was established between sites 1 and 2 shortly after the surveys commenced. The ground in this area is relatively bare.

Site 2 is situated on Green Wattle Creek and includes the edge of the grassed Equestrian Centre oval. Consequently in addition to the species mentioned previously at site 1, which occur on the higher ground, the wetter areas contain species only found along the creek lines including *Melaleuca stypheloides*, Cheese Tree *Glochidion ferdinandi*, Muttonwood *Myrsine diosmifolius* and the native vine *Parsonsia straminea* which form a mid-storey layer (3 to 15m) below the taller canopy trees. About half the ground is covered by dense understorey dominated by Lantana. In the more open areas there are a few species like Native Olive *Notelaea spp.* and *Lomandra sp.*

At site 3, in addition to the dominant canopy trees mentioned at sites 1 and 2, there is an extensive dense understorey growth of Blackthorn to a height of 3m with minor amounts of Kurrajong *Brachychiton populneus*, wattle and the introduced species Lantana and Wild Olive *Olea europaea africana*. There are minor patches of the small shrub *Leucopogon juniperinus*.

Forest Red Gum is the dominant tree in the open woodland at site 4, with a few Narrow-leaved Peppermints. Wallaby grass provides dense ground cover with very few weeds and introduced grass species. There is one well established Wild Olive and a few Lantanas, but other than these exotic species there is no shrub layer. There is some fallen timber including several trees up-rooted during storms.

FACTORS IMPACTING ON SURVEY DATA

The primary purpose of the study was to determine the presence of species 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 minimises 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 mobile mixed species foraging groups.

Most of the area surveyed is woodland with a closed canopy involving trees of about 30m in height. This causes difficulties with the identification of small birds, a problem which is exacerbated when they are not vocal. Consequently small species tended to be under reported. In addition birds like raptors and the *Hirundinidae* soaring silently above the canopy are not visible and hence are also under reported. Where possible surveys commenced about one hour after sunrise when birds are active and adverse conditions involving wind and rain were avoided. During summer rising diurnal temperature is an issue, with the deafening noise of cicadas seriously affecting the detection of birds by their calls. In addition there was a tendency for the wind to increase about 2 hours into the survey. The combined impact of these issues is to make recording more difficult particularly at site 3 where there is both a closed canopy and dense understorey vegetation making visual identification of birds difficult.

Regular visits were made to the area for three years before the systematic surveys commenced. At that time and until 1998 the area was lightly grazed. Grazing subsequently ceased with a progressive increase in ground and understorey cover. During 1998 a small Equestrian Centre was established involving the clearing of vegetation between 2ha sites 1 and 2 and part of site 2. The Equestrian Centre is only used infrequently and has limited impact other than creating a grassy oval which provides foraging habitat for some species including flocks of finches which can be accurately counted. At the same time the Equestrian Centre was established trees and scrub were felled and left to decay along the perimeter of the wood on the section of the survey route approaching 2 ha site 3 (**Figure 1)**. The decay of fallen timber and the gradual regeneration of this perimeter strip attracted a number of small species from adjacent areas of the woodland where the understorey was becoming progressively dense in the absence of grazing. Small adjustments to the survey route were made to sample this area.

As indicated above, edge habitat is important to a number of species of woodland birds. The survey route samples the borders of the woodland at several places and at one point a 15-minute detour is made into a patch of grazed lightly timbered pasture. Elsewhere species more than 100m from the woodland boundary were ignored. During the

study residential development took place on two blocks of 2ha size adjacent to the western boundary of the wood, involving some clearing of vegetation and the creation of small dams.

Between 2002 and 2006 the area suffered a period of extended drought which impacted on both the woodland habitat and its use by birds.

Several factors impact on the assessment of population change during the study. Firstly observer experience with the birds, their calls and their use of the area increased over the duration of the study and hence survey effort may have been more effective during the second half of the study exaggerating the extent to which species appeared to increase. Conversely this bias would under-estimate the magnitude of the change for decreasing species. Secondly where species are identified by call, particularly flocks of small species like the pardalotes it is impossible to determine the number of birds accurately. Hence the count is inevitably an underestimate. The extent to which birds call varies through the year with peaks during the breeding season. This also impacts on both the detection of species (RR) and their abundance (number of individuals). A further complication is the influence of migrant birds (e.g. Yellow-faced Honeyeater *Lichenostomus chrysops*) during spring and autumn. The period of migration is quite short and may be missed in some years if the timing of the monthly survey does not correspond with the passage of birds through the woodland.

RESULTS

The results are summarized in **Table 1** which provides a comparison of the number of species and their abundance (i.e. number of individual birds) between seasons. A total of 135 species were positively identified. Four additional species were excluded from the analysis, three because identification was tentative and the other because it was considered to have escaped from a captive population. The greatest number of species 111 was recorded in spring (September to November) compared with 108 in summer (December to February) and 104 and 105 in autumn (March to May) and winter (June to August) respectively reflecting the absence of summer migrants during these months. The average number of species/survey was highest in spring during the peak of the breeding season and lowest in autumn and winter. However the lowest number of species recorded on a single survey was during summer, probably as a consequence of under reporting associated with the oppressive conditions in January and February when birds are both less active and less vocal.

The abundance of birds was greatest in spring. Numbers were relatively constant in the other seasons being lowest in summer probably associated with under reporting through missed detections as discussed above. The lowest number of birds counted coincided with the lowest number of species during a summer count.

On average 21 percent of the birds for the whole survey were recorded at the 2ha sites and this proportion showed little variation between seasons (range 20 to 22 percent).

Table 1. Summary of survey statistics.

	All Surveys	**Summer**	**Autumn**	**Winter**	**Spring**
Species Recorded	135	108	104	105	111
Average/survey	46.5	47.9	42.7	42.8	52.9
Maximum	62	60	49	51	62
Minimum	31	31	33	34	42
Number of Birds	47,989	10,478	11,096	12,372	14,043
Average/survey	307.6	268.6	284.5	317.2	360.1
Maximum	560	358	398	436	560
Minimum	144	144	201	175	266
Birds at 2ha sites **(%)**[1]	21.4	22.1	20.2	21.3	22.0

[1]Percentage of total birds seen on the surveys which were recorded at the 2ha sites.

Species Regularly Recorded Year Round

The 27 species listed in **Table 2** had a reporting rate of >80 percent and are generally very common in the study area. Even though only three species were recorded on every survey most of these species are thought to be residents.

Numbers of Yellow-faced Honeyeater, Grey Fantail *Rhipidura albiscapa* and Spotted Pardalote *Pardalotus punctatus*, three of the more numerous species, fluctuated throughout the year peaking during spring and autumn migration.

Most of the species were distributed throughout the woodland area. However Eastern Rosella *Platycercus eximius*, Superb Fairy-wren *Malurus cyaneus* , Australian Magpie *Cracticus tibicen* and Red-browed Finch *Neochmia temporalis* often foraged in the cleared areas at the woodland edge, particularly the Equestrian Centre oval, sometimes forming substantial flocks which could be accurately counted. The Noisy Miner *Manorina melanocephala* also favoured the edge of the woodland and was conspicuously absent from interior areas where the tree canopy was closed even when the shrub layer was sparse.

The Eastern Whipbird *Psophodes olivaceus* was well distributed along the wet habitat of Green Wattle Creek as well as in the drier woodland areas where introduced Lantana provided dense ground cover. The Variegated Fairy-wren *Malurus lamberti* favoured areas where the Lantana had colonised the drier woodland.

During summer the Golden Whistler *Pachycephala pectoralis* was primarily restricted to areas of wetter habitat, particularly along creek lines but during autumn moved into the drier woodland.

Table 2. Species recorded regularly in all seasons.

Common Name	Scientific Name	Reporting Rate (%)	Mean Number Present[1]	Maximum Number
Eastern Rosella	*Platycercus eximius*	94.9	8.6	32
Laughing Kookaburra	*Dacelo novaeguineae*	97.4	4.8	11
White-throated Treecreeper	*Cormobates leucophaea*	98.7	4.8	11
Superb Fairy-wren	*Malurus cyaneus*	100.0	26.6	51
Variegated Fairy-wren	*Malurus lamberti*	92.9	8.3	27
White-browed Scrubwren	*Sericornis frontalis*	94.9	5.0	15
Brown Gerygone	*Gerygone mouki*	91.7	4.7	33
Striated Thornbill	*Acanthiza lineata*	94.2	12.1	38
Yellow Thornbill	*Acanthiza nana*	89.1	7.0	28
Brown Thornbill	*Acanthiza pusilla*	92.3	3.4	10
Spotted Pardalote	*Pardalotus punctatus*	99.4	12.0	43
Eastern Spinebill	*Acanthorhynchus tenuirostris*	84.6	4.5	15
Lewin's Honeyeater	*Meliphaga lewinii*	99.4	7.9	17
Yellow-faced Honeyeater	*Lichenostomus chrysops*	97.4	28.1	60
Fuscous Honeyeater	*Lichenostomus fuscus*	93.6	8.7	22
Noisy Miner	*Manorina melanocephala*	89.1	7.3	35
Eastern Whipbird	*Psophodes olivaceus*	98.1	8.2	17
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	80.8	3.4	17
Golden Whistler	*Pachycephala pectoralis*	96.8	5.1	15
Grey Shrike-thrush	*Colluricincla harmonica*	93.6	3.5	12
Grey Butcherbird	*Cracticus torquatus*	92.9	3.3	8
Australian Magpie	*Cracticus tibicen*	98.7	6.9	16
Grey Fantail	*Rhipidura albiscapa*	100.0	18.8	46
Australian Raven	*Corvus coronoides*	96.8	4.3	11
Jacky Winter	*Microeca fascinans*	89.7	4.1	11
Eastern Yellow Robin	*Eopsaltria australis*	100.0	6.5	19
Red-browed Finch	*Neochmia temporalis*	95.5	22.5	101

[1] Mean number seen on surveys when the species was present.

The Brown Gerygone *Gerygone mouki* breeds along Green Wattle Creek and is regularly recorded in small numbers (4.7/survey). The exceptionally high peak number of 33, which included birds foraging in the drier woodland areas, indicates the occasional movement of non-breeding birds into the area.

Striated Thornbill *Acanthiza lineata* and Yellow Thornbill *Acanthiza nana* are small species which often forage high in the canopy sometimes in mixed flocks. Hence they are probably under-recorded compared to the less numerous Brown Thornbill *Acanthiza pusilla*, which tends to forage separately at lower height and with less tendency to flock.

Regular Seasonal Visitors

For the purpose of defining which species are seasonal visitors the summer and winter seasons were re-defined as the four-month periods October-January and May-August respectively to minimise the complication of birds passing through the area during the spring and autumn migration. Inclusion in **Table 3** as a summer visitor is based on being recorded during more than 30 percent of the summer surveys and at least five times more frequently in summer than winter. Twelve species met these criteria and one species the Rose Robin *Petroica rosea* matched the converse criteria for the winter season.

The Rufous Whistler *Pachycephala rufiventris* in addition to being the most numerous of the seasonal visitors was the only species recorded on every one of the 52 summer surveys. Occasionally an individual stays, as indicated by its presence on 10 percent of the winter surveys. Rufous Whistlers, which were highly vocal in spring, held territories throughout the drier woodland area.

The other common summer visitors were the Sacred Kingfisher *Todiramphus sanctus*, White-throated Gerygone *Gerygone albogularis*, and the Leaden Flycatcher *Myiagra rubecula*, none of which was recorded in winter.

The Dollarbird *Eurystomus orientalis* was primarily seen on the edges of the wood during the early part of the season but in late summer foraged with dependent young in the tree canopy.

The Eastern Koel *Eudynamis orientalis* and the Channel-billed Cuckoo *Scythrops novaehollandiae* are large highly vocal cuckoos which regularly pass through and over the study area in summer. These species have large territories extending beyond the woodland which is probably not core feeding and breeding habitat. The Brush Cuckoo *Cacomantis variolosus* frequents the denser woodland areas and based on the presence of dependent young breeds in the area. The Cicadabird *Coracina tenuirostris* also breeds at Green Wattle Creek and is recorded annually. The remaining two species the Rufous Fantail *Rhipidura rufifrons* and the Black-faced Monarch *Monarcha melanopsis* occur almost every summer.

In contrast to the summer visitors which are known to be north-south migrants, the Rose Robin is an altitudinal migrant moving down to the coastal lowlands in winter from the higher country along the Great Dividing Range where it breeds.

Table 3. Species which are seasonal.

Common Name	Scientific Name	Mean Number[1]	Maximum Number	Summer RR[2] (%)	Winter RR[2] (%)
Eastern Koel	*Eudynamis orientalis*	1.2	2	65.4	0.0
Channel-billed Cuckoo	*Scythrops novaehollandiae*	1.4	4	67.3	0.0
Pallid Cuckoo	*Cacomantis pallidus*	1.2	2	36.5	1.9
Brush Cuckoo	*Cacomantis variolosus*	1.2	2	30.8	0.0
Sacred Kingfisher	*Todiramphus sanctus*	5.0	11	98.1	0.0
Dollarbird	*Eurystomus orientalis*	2.1	6	61.5	0.0
White-throated Gerygone	*Gerygone albogularis*	5.1	14	96.1	1.9
Cicadabird	*Coracina tenuirostris*	1.6	4	48.1	0.0
Rufous Whistler	*Pachycephala rufiventris*	10.4	30	100.0	11.5
Rufous Fantail	*Rhipidura rufifrons*	1.7	6	40.4	0.0
Leaden Flycatcher	*Myiagra rubecula*	8.0	13	98.1	0.0
Black-faced Monarch	*Monarcha melanopsis*	2.0	6	56.9	0.0
Rose Robin	*Petroica rosea*	1.5	4	0.0	44.2

[1] Mean number seen on the surveys for which the species was present.
[2] Reporting Rate.

Species Often Recorded

The 28 species in this category (**Table 4)** were recorded with a reporting rate in the range 20 to 80 percent. The broad range of species involved reflects both the woodland and the edge habitats of the study area.

The Silvereye *Zosterops lateralis*, and the White-naped Honeyeater *Melithreptus lunatus* are among the most frequently recorded woodland species. Two sub-species of Silvereye occur (*lateralis* in winter and *familiaris* in summer), sometimes in large flocks.

Six species, the Australian Wood Duck *Chenonetta jubata*, Pacific Black Duck *Anas superciliosa*, Masked Lapwing *Vanellus miles*, Galah *Eolophus roseicapillus*, Pied Butcherbird *Cracticus nigrogularis* and the Magpie-lark *Grallina cyanoleuca* are primarily species of the adjacent open country, although the two duck species may exploit the edges of the woodland for nest sites on occasions. The Willie Wagtail *Rhipidura leucophrys*, which favours the woodland edge, occurs in small numbers and is surprisingly scarce as it is common in the surrounding area.

The Striated Pardalote *Pardalotus striatus* and the Speckled Warbler are almost certainly resident in small numbers. The Striated Pardalote favours large trees on the edge of the woodland. The Speckled Warbler prefers woodland areas with limited understorey and appears to have declined during the study as will be discussed in a subsequent section. The Bar-shouldered Dove *Geopelia humeralis* increased during the study, breeding in the wet-adapted vegetation adjacent to Green Wattle Creek.

Table 4. Species often recorded.

Common Name	Scientific Name	Reporting Rate (%)	Average Number[1]	Maximum Number
Australian Wood Duck	*Chenonetta jubata*	54.5	5.1	14
Pacific Black Duck	*Anas superciliosa*	41.0	2.4	8
Bar-shouldered Dove	*Geopelia humeralis*	66.0	2.1	7
Masked Lapwing	*Vanellus miles*	21.2	1.6	3
Galah	*Eolophus roseicapillus*	44.2	2.7	9
Little Lorikeet	*Glossopsitta pusilla*	46.2	8.6	42
Australian King-Parrot	*Alisterus scapularis*	30.1	2.2	6
Shining Bronze-Cuckoo	*Chalcites lucidus*	34.0	1.6	6
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	46.8	2.2	6
Satin Bowerbird	*Ptilonorhynchus violaceus*	42.3	1.4	4
Speckled Warbler	*Chthonicola sagittata*	71.8	3.8	18
Striated Pardalote	*Pardalotus striatus*	75.6	3.7	10
Red Wattlebird	*Anthochaera carunculata*	49.4	1.8	8
Scarlet Honeyeater	*Myzomela sanguinolenta*	50.0	14.3	54
White-naped Honeyeater	*Melithreptus lunatus*	63.5	3.5	15
Noisy Friarbird	*Philemon corniculatus*	41.0	3.8	27
Varied Sittella	*Daphoenositta chrysoptera*	35.9	4.3	14
White-bellied Cuckoo-shrike	*Coracina papuensis*	22.4	1.2	4
Crested Shrike-tit	*Falcunculus frontatus*	44.2	1.7	4
Olive-backed Oriole	*Oriolus sagittatus*	50.0	3.8	10
Pied Butcherbird	*Cracticus nigrogularis*	54.5	1.7	5
Pied Currawong	*Strepera graculina*	63.5	1.4	10
Willie Wagtail	*Rhipidura leucophrys*	50.0	1.6	5
Magpie-lark	*Grallina cyanoleuca*	73.1	2.5	8
White-winged Chough	*Corcorax melanorhamphos*	34.6	8.9	30
Silvereye	*Zosterops lateralis*	70.5	8.3	83
Mistletoebird	*Dicaeum hirundinaceum*	30.1	1.6	5
Double-barred Finch	*Taeniopygia bichenovii*	30.1	4.8	20

[1] Average number seen on the surveys for which the species was present.

The Little Lorikeet *Glossopsitta pusilla* and Scarlet Honeyeater *Myzomela sanguinolenta* are periodically present, sometimes in large numbers and there is circumstantial evidence that both species may breed locally. There is an interesting correspondence in the timing of use of the area by the two species as discussed later.

The presence of flocks of White-winged Choughs *Corcorax melanorhamphos* was a feature of the surveys in the initial years of the study but they subsequently decreased markedly.

The Olive-backed Oriole *Oriolus sagittatus* primarily occurs in summer being recorded on 90 percent of the summer surveys. However it also occurred on 25 percent of the winter surveys, mostly in August.

The Crested Shrike-tit *Falcunculus frontatus,* and Varied Sittella *Daphoenositta chrysoptera* are present periodically with the former species faithful to a well defined territory for extended periods and then disappearing. The White-bellied Cuckoo-shrike *Coracina papuensis*, which has bred at Green Wattle Creek, is another example of a species which occurs relatively frequently (RR 35 percent) but is uncommon in the surrounding area. The Noisy Friarbird *Philemon corniculatus* also occurs intermittently when feeding conditions are favourable.

Species Recorded Occasionally

The 67 species listed in **Table 5** were recorded on less than 20 percent of the surveys with 24 species present on two or fewer surveys. In some instances these species are rare not only in the study area but also in the Lower Hunter Region. The record of the Oriental Cuckoo *Cuculus optatus* is an example. However in other instances the dearth or lack of records is a consequence of the survey technique or the limitations of the habitat (e.g. no *Banksia* species). For instance the night birds are under recorded with a single record of the White-throated Nightjar *Eurostopodus mystacalis*, which breeds in the area (Newman 2008), just two and three records of the Tawny Frogmouth *Podgarus strigoides* and the Southern Boobook *Ninox novaeseelandiae* respectively. The Australian Owlet-nightjar *Aegotheles cristatus* and the Powerful Owl *Ninox strenua* have been recorded by other observers (Grant Bosie and Brett Shields pers. comm.).

Most of the survey time was spent in woodland with a closed canopy which contributes to under reporting of species flying overhead such as the raptors. Similar observation difficulties occur with White-throated Needletail *Hirundapus caudacutus,* Welcome Swallow *Hirundo neoxena*, Fairy Martin *Petrochelidon ariel* and Tree Martin *Petrochelidon nigricans*. The two martin species are difficult to separate with certainty when seen briefly above the tree canopy. However, as both species have been positively identified they have been tentatively assigned to individual species when recorded. Fortunately other species passing through the area like the cockatoo, parrot and corvid species are usually very vocal which assists their detection and identification. All three species of lorikeet listed in **Table 5**, namely the Rainbow Lorikeet *Trichoglossus haematodus,* Scaly-breasted Lorikeet *Trichoglossus chlorolepidotus* and Musk Lorikeet *Glossopsitta concinna* have been positively identified, but difficulties exist with identifying birds flying rapidly through woodland and separation at the species level is tentative.

The Grey Goshawk *Accipter novaehollandiae*, which has successfully bred in the area and has a secretive disposition, was recorded on 10 percent of the surveys.

The Common Starling *Sturnus vulgaris* and the Common Myna *Sturnus tristis* were recorded once and thrice respectively. Both these species are common around residential homes within 1km of the study site.

In discussing the remaining species emphasis is placed on the woodland birds for which Green Wattle Creek provides a scarce, perhaps unique habitat niche in the Butterwick area.

At the start of the study the Painted Button-quail *Turnix varius* was regularly present but it was rarely seen during the second half of the study. A similar decline was noted for a cohort of woodland birds which favour habitat with a sparse understorey including the Brown Treecreeper *Climacteris picumnus,* a winter visitor and the Buff-rumped Thornbill *Acanthiza reguloides*.

The Brown-headed Honeyeater *Melithreptus brevirostris* and the Dusky Woodswallow *Artamus cyanopterus*, which has bred in the wood, also decreased.

The Stubble Quail *Coturnix pectoralis,* Black-chinned Honeyeater *Melithreptus gularis* and the White-cheeked Honeyeater *Phylidonyris niger* were only tentatively identified and have been excluded from **Table 5**, as has the record of a

female Turquoise Parrot *Neophema pulchella*, which is thought to have escaped from captivity.

Six other species were seen during my visits before the surveys started; Black-eared Cuckoo *Chalites osculans*, Masked Woodswallow *Artamus personatus*,White-browed Woodswallow *Artamus superciliosus*, Satin Flycatcher *Myiagra cyanoleuca*, Scarlet Robin *Petroica boodang* and Rufous Songlark *Cincloramphus mathewsi*.

The Nankeen Night-Heron *Nycticorax caledonicus* was seen in an additional survey in August 2009. Two other species, the Australian Owlet-nightjar and the Powerful Owl, have been recorded by other observers as discussed earlier. A large mixed flock of the nomadic Masked and White-browed wood-swallows used the wood as a drought refuge, roosting near site 4 (**Figure 1)** for several weeks in the spring of 1994 (Stuart 1995).

Table 5. Species seen occasionally.

Common Name	Scientific Name	Reporting Rate (%)	Mean Number[1]	Maximum Number
Black Swan	*Cygnus atratus*	1.3	2.0	2
Grey Teal	*Anas gracilis*	5.1	2.3	4
Chestnut Teal	*Anas castanea*	4.5	2.4	6
Hardhead	*Aythya australis*	0.6	1.0	1
Australasian Grebe	*Tachybaptus novaehollandiae*	0.6	1.0	1
Crested Pigeon	*Ocyphaps lophotes*	16.7	1.9	7
Peaceful Dove	*Geopelia striata*	1.3	1.5	2
Wonga Pigeon	*Leucosarcia picata*	19.9	1.4	4
Topknot Pigeon	*Lopholaimus antarcticus*	0.6	2.0	2
Tawny Frogmouth	*Podargus strigoides*	1.3	1.5	2
White-throated Nightjar	*Eurostopodus mystacalis*	0.6	1.0	1
White-throated Needletail	*Hirundapus caudacutus*	3.2	3.0	5
Little Pied Cormorant	*Microcarbo melanoleucos*	12.8	1.2	2
Great Cormorant	*Phalacrocorax carbo*	0.6	5.0	5
Little Black Cormorant	*Phalacrocorax sulcirostris*	3.2	1.0	1
White-necked Heron	*Ardea pacifica*	1.3	1.0	1
Eastern Great Egret	*Ardea modesta*	3.2	1.0	1
Cattle Egret	*Ardea ibis*	14.1	2.4	5
White-faced Heron	*Egretta novaehollandiae*	14.7	1.0	2
Straw-necked Ibis	*Threskiornis spinicollis*	12.2	4.8	27
Royal Spoonbill	*Platalea regia*	2.6	1.3	2
Pacific Baza	*Aviceda subcristata*	1.3	1.0	1
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	1.9	1.0	1
Whistling Kite	*Haliastur sphenurus*	7.1	1.0	1
Brown Goshawk	*Accipter fasciatus*	4.5	1.0	1
Collared Sparrowhawk	*Accipter cirrocephalus*	1.9	1.0	1
Grey Goshawk	*Accipter novaehollandiae*	10.3	1.4	3
Wedge-tailed Eagle	*Aquila audax*	11.5	1.4	2
Nankeen Kestrel	*Falco cenchroides*	1.3	1.0	1
Brown Falcon	*Falco berigora*	15.4	1.0	1
Australian Hobby	*Falco longipennis*	0.6	2.0	2
Purple Swamphen	*Porphyrio porphyrio*	2.6	2.0	4
Dusky Moorhen	*Gallinula tenebrosa*	3.2	2.6	7
Painted Button-quail	*Turnix varius*	14.1	3.1	14
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	1.9	1.3	2
Long-billed Corella	*Cacatua tenuirostris*	3.2	2.0	5
Sulphur-crested Cockatoo	*Cacatua galerita*	15.4	1.4	3
Rainbow Lorikeet	*Trichoglossus haematodus*	16.0	4.6	14
Scaly-breasted Lorikeet	*Trichoglossus chlorolepidotus*	1.9	1.3	2

[1] Mean number seen on surveys when present.

Table 5. Species seen occasionally (cont.)

Common Name	Scientific Name	Reporting Rate (%)	Mean Number[1]	Maximum Number
Musk Lorikeet	*Glossopsitta concinna*	3.8	6.2	12
Crimson Rosella	*Platycercus elegans*	0.6	1.0	1
Red-rumped Parrot	*Psephotus haematonotus*	1.9	3.0	4
Pheasant Coucal	*Centropus phasianinus*	8.3	1.1	2
Horsfield's Bronze-Cuckoo	*Chalcites basalis*	1.9	1.3	2
Oriental Cuckoo	*Cuculus optatus*	0.6	1.0	1
Southern Boobook	*Ninox novaeseelandiae*	1.9	1.3	2
Rainbow Bee-eater	*Merops ornatus*	0.6	2.0	2
Brown Treecreeper	*Climacteris picumnus*	1.9	1.0	1
Regent Bowerbird	*Sericulus chrysocephalus*	2.6	1.0	1
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	9.0	3.8	11
Buff-rumped Thornbill	*Acanthiza reguloides*	17.9	3.4	7
Yellow-tufted Honeyeater	*Lichenostomus melanops*	0.6	1.0	1
New Holland Honeyeater	*Phylidonyris novaehollandiae*	0.6	1.0	1
Brown-headed Honeyeater	*Melithreptus brevirostris*	13.5	5.0	18
Blue-faced Honeyeater	*Entomyzon cyanotis*	0.6	1.0	1
Striped Honeyeater	*Plectorhyncha lanceolata*	1.9	1.0	1
Grey-crowned Babbler	*Pomatostomus temporalis*	18.6	3.2	8
White-winged Triller	*Lalage sueurii*	1.9	1.0	1
White-breasted Woodswallow	*Artamus leucorhynchus*	0.6	2.0	2
Dusky Woodswallow	*Artamus cyanopterus*	18.6	2.0	5
Spangled Drongo	*Dicrurus bracteatus*	3.2	1.0	1
Torresian Crow	*Corvus orru*	6.4	3.3	8
Welcome Swallow	*Hirundo neoxena*	12.2	1.6	4
Fairy Martin	*Petrochelidon ariel*	2.6	14.0	40
Tree Martin	*Petrochelidon nigricans*	6.4	15.2	50
Common Starling	*Sturnus vulgaris*	0.6	1.0	1
Common Myna	*Sturnus tristis*	1.9	1.3	2

[1] Mean number seen on surveys when present.

DISCUSSION

The total number of species recorded during this study of the Green Wattle Creek woodland and its immediate surrounds is currently 144. Three additional species the Stubble Quail, Black-chinned Honeyeater and the White-cheeked Honeyeater were tentatively identified and a fourth species, the Turquoise Parrot, was not included as it was thought to have escaped from a captive population.

The floristic characteristics of the area determine its intermittent use by some species. For instance the flowering of ironbarks and other gum species attract honeyeaters, for which mistletoe is also an important resource at times. The rarity of the New Holland *Phylidonyris novaehollandiae* and White-cheeked honeyeaters is attributed to the absence of *Banksia s*pecies.

Comparison with other Studies

During similar surveys at three-monthly intervals on the adjacent cattle property at Butterwick (Newman 2007) 126 species were recorded compared with 135 in the surveys of the present study. The larger number of species in this study reflects the greater diversity of the woodland habitat in the Green Wattle Creek study area and the extra survey effort associated with monthly as opposed to quarterly surveys over a longer period (13 vs. 11 years). However, the average number of species/survey was very similar at 46.5 (this investigation) and 45.3. In contrast the average number of individual birds recorded/survey was much higher in the present investigation at 307.6 compared with 249.1. This difference is attributed to the low proportion (15 percent) of vegetated habitat on the cattle property as compared with c.90% in the study area. As the four 2ha sites in the

former study selectively sampled areas of remnant vegetation along and adjacent to the creek it is not surprising that a higher proportion of the birds (64 percent) were recorded at the 2ha sites compared with 21 percent in this study, only one of which was adjacent to a creek and all of which had vegetation continuous with the larger study area.

At Warakeila (Newman & Lindsey 2008) another cattle property situated in the upper Allyn Valley, with about 15 percent remnant vegetation, the species list for surveys made over a 12-year period at a three-monthly interval was lower at 119. However the average number of species recorded/survey 49.5 was higher than in the other studies, probably a consequence of having a second observer at Warakeila and a longer survey route. The average number of birds/survey 336.2 at Warakeila was the highest of all the studies and more birds were recorded away from the 2ha sites (75 percent) than at the Butterwick property.

The species richness as indicated by the total number of species at the Butterwick property and in this study was higher than at Warakeila and is associated with their location on the edge of the Paterson River flood plain; dams and marshy areas along the creek attract more waterfowl, particularly on the Butterwick cattle property.

Variation in Regularly Recorded Species

The 27 species listed in **Table 2** were recorded on at least 80 percent of the surveys and are considered to be mainly resident. Only three species, a surprisingly small number, were recorded on all 156 surveys. However, because the species listed in **Table 2** are nearly always recorded the reporting rate is of limited use as a measure of population change. For these species variation in their abundance is more useful and has been used to calculate the percentage change by comparing the mean numbers seen during 1997-2002 with 2003-2008. From **Table 6** it is apparent that the 27 most commonly recorded species are almost equally split between those that appear to have increased and decreased. Of the 18 species with a variation of greater than 20 percent in abundance eight have increased and ten have decreased to an extent which is with one exception statistically significant. In **Table 6** where changes are statistically significant they are classed as either "significant" or "highly significant". The **Appendix** provides an explanation of these terms and the methods used to make the tests. The magnitude of the change in the remaining nine species is too small for any firm conclusion to be drawn.

Table 6. Changes in the abundance and reporting rate of species seen on 80 percent of surveys.

Increasing Species	**Change in Abund-ance[3] (%)**	**Change in Reporting Rate (%)**	**Decreasing Species**	**Change in Abund-ance (%)**	**Change in Reporting Rate (%)**
Lewin's Honeyeater [1]	48	1	Eastern Rosella [1]	-42	-8
Striated Thornbill [1]	36	12	Noisy Miner [2]	-42	-16
Spotted Pardalote [1]	32	1	Grey Shrike-thrush [2]	-40	-2
Red-browed Finch	28	-1	Black-faced Cuckoo-shrike [2]	-40	-12
Eastern Whipbird [1]	26	0	Brown Gerygone [1]	-30	3
Brown Thornbill [1]	25	-2	Golden Whistler [1]	-30	-7
White-browed Scrub-wren [1]	22	11	Australian Magpie [1]	-29	-3
Yellow-faced Honeyeater [1]	21	6	Jacky Winter [1]	-26	-3
Variegated Fairy-wren	16	9	Eastern Yellow Robin [1]	-24	0
Australian Raven	10	-3	Fuscous Honeyeater [1]	-22	-6
Eastern Spinebill	8	24	Yellow Thornbill	-18	3
Superb Fairy-wren	2	0	Laughing Kookaburra	-11	-3
Grey Butcherbird	2	-2	Grey Fantail	-1	0
			White-throated Treecreeper	-1	-3

[1] Highly significant change in abundance between 1997-2002 and 2003-2008 ($P<0.01$).

[2] Significant change in abundance between 1997-2002 and 2003-2008 ($P<0.05$).

[3] See **Appendix** for calculation method.

The approach taken in screening the results for change by comparing the two six-year periods is very simplistic. For instance many woodland species sometimes have non-linear trends including turning points in which a trend is reversed (Bounds *et al.* 2008).

Of the ten species which have declined in abundance to a statistically significant extent the Eastern Rosella, Noisy Miner, Black-faced Cuckoo-shrike, Australian Magpie and Jacky Winter *Microeca fascinans* are species which favour more open woodland. The increase in ground cover and understorey vegetation since grazing ceased is suggested as a potential cause of their decline. However, they remain common in the area particularly at the woodland edges. Although the Eastern Yellow Robin *Eopsaltria australis* is found in wet-adapted habitat it too favours ground-foraging opportunities at the forest edge. The reasons for the apparent decline in species like the Grey Shrike-thrush *Colluricincla harmonica*, Brown Gerygone, Golden Whistler, Fuscous Honeyeater and Yellow Thornbill are less obvious, particularly the first three species which favour dense vegetation. The result for Brown Gerygone is biased by a single abnormally large flock foraging in open woodland during the first half of the study and should probably be treated with caution. The decline of the Fuscous Honeyeater is of some concern as this species has a discontinuous distribution in the Lower Hunter with Green Wattle Creek appearing to be an isolated resident colony. The decline in abundance coincided with the disappearance of Fuscous Honeyeaters at the southern end of the survey area between sites 3 and 4 (**Figure 1)** which was formerly the stronghold of the species.

The decrease in the Noisy Miner abundance was dramatic towards the end of the study with the two colonies in the study area deserting their territories. Very interestingly, pairs of Grey Butcherbirds C*racticus torquatus*, which nested near the Noisy Miner colonies, also disappeared, suggesting a possible symbiotic relationship between these species.

In contrast to the Fuscous Honeyeater, numbers of the Yellow-faced Honeyeater have increased, indicating that for this species the woodland remains attractive habitat. Of the other increasing species the Lewin's Honeyeater, Eastern Whipbird, Brown Thornbill, White-browed Scrub-wren *Sericornis frontalis* and Variegated Fairy-wren are all species which are favoured by the increase in understorey vegetation.

The change in reporting rate has been included in **Table 6** primarily to demonstrate its limited usefulness and any differences in the direction of population change between the abundance and reporting rate data should be ignored. However for the three species with slightly lower reporting rate in the range 80 to 90 percent, namely the Eastern Spinebill, Noisy Miner and Black-faced Cuckoo-shrike, a meaningful change might be anticipated. For these species the variations in reporting rate were greater than ten percent and in each case the direction of the change coincided with that indicated by the abundance data. However none of these changes was statistically significant.

Variation in Less Frequently Recorded Species

For less frequently recorded species, particularly those which are recorded in small numbers, comparison of reporting rate becomes a useful indicator of population change as shown in **Table 7.** This table was compiled from the species listed in **Tables 3, 4** and **5** by selecting woodland species which had been reported on at least 13 percent of the surveys with a variation in reporting rate of greater than 20 percent between the two six-year periods. Variations in abundance similar to those shown in **Table 6** are included for comparison.

Most of the species in **Table 7** appeared to have declined, the decrease in reporting rate being highly significant in the case of the Painted Button-quail, Grey-crowned Babbler *Pomatostomus temporalis*, Crested Pigeon *Ocyphaps lophotes* and White-winged Chough (see the **Appendix** for further discussion). This is in contrast to the conclusion reached for the commoner species, which are predominantly resident and show a near equal tendency between increase and decline. In **Table 7** there are a number of instances where species which had been reported less frequently showed a modest increase in abundance. In most cases, for example the Brown-headed Honeyeater, Dusky Woodswallow and Varied Sittella, this is because the species occurs as a single flock and while flocks were encountered on fewer surveys towards the end of the study there was little variation in flock size throughout the surveys.

Four species, the Painted Button-quail, White-winged Chough, Buff-rumped Thornbill and Speckled Warbler all forage on the ground where there is sparse ground cover. Consequently the increase in ground cover following the cessation of grazing is a potential cause of decline. However Painted Button-quail, the species showing the most

Table 7. Variations in reporting rate and abundance for less frequently recorded species. Species ranked in decreasing order of change in reporting rate.

Species	Reporting Rate (%)	Change in Reporting Rate[1] (%)	Change in Abundance[1] (%)
Painted Button-quail [3]	14.1	-84	-71
Grey-crowned Babbler [3]	18.6	-82	-7
Crested Pigeon [3]	16.7	-75	-18
Brown-headed Honeyeater [2]	13.5	-64	9
White-winged Chough [3]	34.6	-62	11
Dusky Woodswallow	16.0	-53	12
Buff-rumped Thornbill	17.9	-38	-25
Rose Robin	22.4	-37	0
Magpie-lark	73.1	-23	-35
Fan-tailed Cuckoo	46.8	-30	-22
Speckled Warbler	71.8	-26	-64
Galah	44.2	-25	-31
Varied Sittella	35.9	-25	2
Australian King-Parrot	30.1	-20	-11
Scarlet Honeyeater	50.0	34	15
Little Lorikeet [2]	46.2	69	-28
Wonga Pigeon [2]	19.9	144	35

[1] Comparing 1997-2002 with 2003-2008. See Appendix for calculation method.
[2] Change in Reporting Rate Significant ($P<0.05$).
[3] Change in Reporting Rate Highly Significant ($P<0.01$).

marked decline, returned to the wood in 2008 after an absence of several years. This period of absence corresponded to drought conditions extending from 2002 to 2006 which was followed by high rainfall in 2007 and 2008. The timing of the reappearance of the Painted Button-quail suggests rainfall may be an important factor for this species, for instance influencing the generation of grass seed. While White-winged Choughs which formerly bred in the wood are no longer regularly seen, large flocks still frequent adjacent farmland and gardens and occasionally pass through the study area. The Buff-rumped Thornbill, another former breeding species, progressively moved to the edges of the area and has only been seen once recently. Speckled Warblers are still resident but have also become scarce with a marked decline in abundance. Like the Buff-rumped Thornbill they have become a bird of the edges because the interior of the wood is less suitable habitat now. While the decline in reporting rate for both these species is not statistically significant the magnitude of the change is sufficiently high to warrant concern.

Woodland birds which have declined include the Brown-headed Honeyeater (statistically significant), Dusky Woodswallow, Varied Sittella, Fan-tailed Cuckoo *Cacomantis flabelliformis*, and Rose Robin, the latter being a winter visitor. The first three species were noted to have declined during the New Atlas of Australian Birds (Barrett *et al.* 2003) and in other studies. Their decline may be associated with external factors affecting the species exacerbated by the poor connectivity of the Green Wattle Creek woodland to similar habitat. Numerous woodland species have declined in the past decade (Olsen 2008).

The decline of the Australian King-Parrot *Alisterus scapularis* may be a consequence of a substantial increase in residential development in the surrounding area where gardens and bird feeding provide superior foraging options outside the woodland habitat.

Grey-crowned Babblers, Crested Pigeons (both have highly significant declines), Magpie-lark and Galah are primarily species of the adjacent habitat and woodland edges rather than the woodland itself. The babbler and pigeon appear to have been particularly affected by the clearing of adjacent open bush habitat for low density housing.

Only three of the species in **Table 7** increased during the study, the most dramatic being the Wonga Pigeon *Leucosarcia picata* which increased by 144 percent. Presumably this species has benefited from the increased understorey vegetation since grazing ceased. It is often flushed

from Lantana thickets where it forages on the ground. The other two species which have increased, the Little Lorikeet and Scarlet Honeyeater show a remarkable correspondence in the timing of their episodic presence in the area (**Figure 2)**.

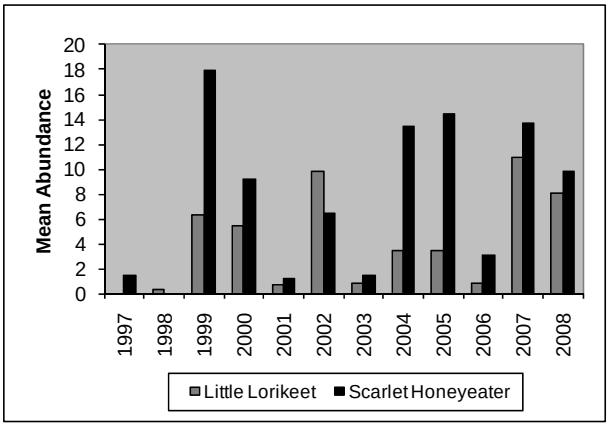

Figure 2. Variation in mean annual abundance of Little Lorikeet and Scarlet Honeyeater at Green Wattle Creek.

At times when the ironbarks are flowering they are among the most abundant species and breeding is suspected for both species based on nest hollow inspection and nest building respectively. Their increased use of Green Wattle Creek during 2003-2008 may reflect the decrease in food resources elsewhere during drought conditions between 2002 and 2006. The increased reporting rate of the Little Lorikeet in the second half of the study coincided with a decrease in the size of the flocks. It appears that the use of the area by Little Lorikeets has changed from the occasional presence of a single large flock to multiple smaller mobile flocks which appear to be more continuously present in the wood and surrounding areas.

Threatened Species

The Speckled Warbler and Little Lorikeet (recently listed) are the only species listed under the NSW Threatened Species Act which are recorded regularly at Green Wattle Creek. Both are classified as vulnerable. As discussed previously, although several pairs of Speckled Warbler appear to remain resident, its reporting rate and abundance declined during the study. This decline is attributed to an increase in ground cover and understorey vegetation since cattle grazing ceased. As the Green Wattle Creek woodland has limited connectivity to other woodland with Speckled Warbler populations appropriate fire management of the area is essential to ensure the viability of this population, which is located at the eastern extremity of its range in the Hunter Region. However it is probable that carefully controlled burns of small patches of the wood would benefit the species by creating areas with reduced ground cover which are favoured by the species. In 1993 a number of pairs of Speckled Warblers were fostering juvenile Black-eared Cuckoos for which the Speckled Warbler is a preferred host species. This is the only year the Black-eared Cuckoo, which is locally rare, has been recorded breeding in the east of the Hunter Region (Stuart 1995).

The Little Lorikeet, which is listed as vulnerable, appears to have increased in the study area and has also become quite numerous in the surrounding district.

The Brown Treecreeper is another woodland species which is classed as vulnerable. Although this species was only recorded during one survey it was seen regularly during winter between 1993 and 1995 (Stuart 1995) before the surveys started. It also favours woodland habitat with bare ground and fallen timber and superficially its habitat requirements are similar to those of the Speckled Warbler. However unlike the Speckled Warbler it does not appear to have been a breeding resident. Its former consistent appearance in winter, probably involving only one or two birds, is unusual as the literature does not suggest that this species is a migrant and no breeding populations in the vicinity of Green Wattle Creek are known. Its past occurrence in the area may have been anomalous and the study area is probably marginal habitat.

The Grey-crowned Babbler is another vulnerable species which has declined during the study. However ,as indicated previously, woodland is not the core habitat of this species. It is thriving in the adjacent Butterwick and Woodville areas where suburban gardens provide more suitable habitat, involving a park-like environment with a combination of trees for nesting and shrub beds and short grassland for foraging.

There is one tentative record of the Black-chinned Honeyeater which is also classified as vulnerable.

CONCLUSIONS

The Green Wattle Creek woodland at Butterwick is an important natural resource located on the edge of the Paterson River flood plain. In view of its limited size (approximately 120ha) and its relative isolation from similar low-lying woodland habitat the 144 species identified since 1993 is impressive.

Monthly surveys over a 13-year period have allowed changes in the reporting rate and abundance of individual species to be measured. For the 27 commoner species, which are mostly resident, there have been changes in the abundance of 18, which are statistically significant. Ten of these species have decreased and the other eight have increased, typically by more than 20 percent.

Most of the remaining species frequent the study area intermittently. Analysis of the reporting rate of the more regular of these visitors again indicates that some species have decreased and others increased, some at a statistically significant level. Species in the decreasing category dominate this group.

Among the declining species a cohort of ground-foraging species including the Speckled Warbler, Brown Treecreeper, Buff-rumped Thornbill and White-winged Chough stand out. The reason for their decline is attributed to the cessation of light cattle grazing shortly after the surveys commenced resulting in a progressive increase in understorey and ground cover vegetation making the wood less suitable for ground-foraging species. Of this group only the Speckled Warbler remains as a resident species and it is increasingly restricted to habitat at the edge of the woodland. In contrast the Lewin's Honeyeater has benefited from the increased understorey growth. The reasons for the decline of other species like the Fuscous Honeyeater are not clear and factors like variations in rainfall, illegal felling of mature ironbarks and the loss of connectivity to similar woodland habitat may be important.

The diversity of its bird population, the presence of threatened species, the use of the study area by migrants during migration and as a seasonal residence and nomads seeking drought refuge all make Green Wattle Creek an area requiring protection and management in a manner which is sympathetic to its natural assets. The Speckled Warbler, a declining resident species is a particularly important case. For instance an extensive fire could cause the local extinction of the species in view of the limited connectivity to similar woodland habitat.

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APPENDIX: Statistical Testing of Changes in Bird Population

Statistical tests were used to gauge the strength of the conclusions drawn from comparisons of the results for the periods 1997-2002 and 2003-2008. The methods used followed advice provided in "Statistics for Ornithologists" (Fowler & Cohen).

For the changes in the abundance of the 27 common species (see **Table 2** of the paper) the mean number of birds/survey over the two six-year periods was compared. The first step was to screen the data for each species using the F test to determine whether the variances of the two six-year samples belonged to the same population. Four species failed this test (Red-browed Finch, Noisy Miner, Grey Shrike-thrush and Black-faced Cuckoo-shrike). As the samples for each six-year period were large (>20) the z test was used to assess the differences in the means of the two samples for the remaining 23 species. The differences in the mean abundance for fourteen of these species were found to be highly significant with $P<0.01$ (i.e. a less than 1 in 100 probability of

the result occurring by chance). For the sample sizes used in this study it appears that any difference in abundance greater than 20 percent will be statistically significant provided the F test condition is passed.

The results for the four species which failed the F test were examined using the Mann-Whitney U-Test which involves comparing the medians of the annual mean abundances for each of the six-year periods. The Noisy Miner, Grey Shrike-thrush and Black-faced Cuckoo-shrike all passed this test with $P<0.05$ (i.e. a less than 1 in 20 probability of the result occurring by chance). The failure of the Red-browed Finch to pass the test despite the large (28 percent) increase is thought to be a consequence of the intermittent occurrence of very large flocks on the Equestrian Centre oval resulting in an unusually large variance of the count numbers.

For the less common species differences in the Reporting Rates between the two six-year periods were used as a measure of population change. The chi square test was used to assess the difference between the Reporting Rates for the two periods using Yates' correction because there was only one degree of freedom.

Based on the test procedures described above a number of population changes were found to be statistically significant. Where the test passes at the $P<0.05$ level (1 in 20 probability of occurring by chance) the outcome is described as significant in the text of the paper. If the more stringent condition of $P<0.01$ is passed the change is described as highly significant. For the sample sizes in this study only a change in reporting rate of greater than 50 percent was significant.

In **Tables 6** and **7** the changes in the abundance and reporting rates between the two periods 1997-2002 and 2003-2008 were calculated by comparing the difference between the second and first period with the magnitude of the first period. For example where the abundance or reporting rate increased in the second period 2003-2008 to double the magnitude for the first period the change in reporting rate is 100 percent.

Correspondingly where the abundance or reporting rate in the second period decreased to half the value in the first period the change in reporting rate is -50 percent.