

# A FOUR-YEAR STUDY OF A BIRD COMMUNITY IN A WOODLAND REMNANT NEAR MOYSTON, WESTERN VICTORIA

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Bird species richness and abundance were estimated monthly between September 1989 and February 1994 at a woodland remnant near Moyston in western Victoria. The migratory status of each species was assessed. Changes in abundance seasonally and over a longer period are reported. The results indicate that this remnant is used by about thirty species of resident birds as well as supporting various migrants and partial migrants. The study site was occasionally visited by large numbers of several nectarivorous species.

Two resident species (Hooded Robin *Melanodryas cucullata* and Buff-rumped Thornbill *Acanthiza reguloides*) disappeared during the survey, and another (Speckled Warbler *Chthonicola sagittatus*) has since disappeared from the remnant. These species are all ground nesters and/or ground feeders. Such species are of conservation concern across the temperate woodlands of south-eastern Australia, as they also have declined elsewhere in these habitats in recent decades. The White-browed Scrubwren *Sericornis frontalis* was a resident by the survey's completion, having been recorded only sporadically earlier in the study.

The results give insight into the movements of birds at this site and presumably other woodland remnants in the area. The loss of resident species witnessed here is a tangible example of a loss of species occurring at a larger scale in temperate woodlands in Australia.

## INTRODUCTION

The bird communities of Australia's temperate woodlands have received considerable attention in recent years (Robinson and Traill 1996; Reid 1999). The region has been massively cleared and much of the remainder has been degraded. Robinson and Traill (1996) estimated that more than 80 per cent of the original vegetation is gone. The widespread degradation of this ecosystem has impacted significantly on many woodland birds. It has been recognized that a distinct suite of birds is in widespread decline in the temperate woodlands, progressively disappearing from individual remnants, districts and regions in response to habitat fragmentation, isolation and various forms of habitat degradation (Saunders 1989; Robinson 1993; Barrett *et al.* 1994; Paton *et al.* 1994; Robinson and Traill 1996; Bennett and Ford 1997).

Detailed information on woodland bird communities across the extent of the temperate woodlands of south-eastern Australia is much needed as a basis for future management. Assessing the changes taking place at the level of the individual remnant is essential for understanding changes taking place in the larger landscape and devising appropriate management (Saunders 1989).

This study investigated the role of a small woodland remnant for bird species. The site supports vegetation typical of habitat in central western Victoria and is one of a network of 'islands' of habitat in a landscape dominated by agriculture, primarily sheep production.

### *The importance of longer-term studies*

Longer-term study of bird populations is a research priority in Australian bird ecology (Ford 1986). Such studies are important as seasonal trends in bird populations

can be identified more accurately than would be possible in a twelve-month study, for example. The time-frame of this study allowed information to be gathered on the migratory status of a large number of species and enabled several important observations to be made. The climate in temperate Australia is to a degree unpredictable. Long dry periods and uncharacteristically wet years can occur. As a result, longer-term studies are useful as a wider range of climatic conditions and fluxes in food availability and their effect on avifauna can be observed.

A number of changes were observed in the bird fauna of this remnant and some further change has been noted since the study's completion. The species composition and migratory status of the remnant's avifauna are reported here. Changes in the composition of the resident population during and after the study are also discussed.

## METHODS

### *Study area*

The study site is a woodland remnant (14 ha) one kilometre west of Moyston, Victoria (37°18'S, 142°45'E), and approximately 215 kilometres west of Melbourne. Three distinct habitat types are present: woodland dominated by River Red Gum (*Eucalyptus camaldulensis*) is present on the watercourses; native grassland dominated by Kangaroo Grass (*Themeda triandra*) occurs on some of the lower slopes; and the remaining area supports a vegetation type classified as Heathy Woodland (Muir *et al.* 1995), which is dominated by Long-leaved Box (*E. goniocalyx*), Yellow Box (*E. melliodora*), and Scent-bark (*E. aromaphloia*), with an understorey of Hedge Wattle (*Acacia paradoxa*) and Golden Wattle (*A. pycnantha*). The surrounding landscape has been significantly modified by clearing for agriculture and is utilized predominantly for sheep grazing, although there is some cropping. There are a number of relatively intact woodland remnants of various sizes in the district, as well as patches of remnant trees on grazed paddocks and vegetated corridors along roads and watercourses.

The area has a temperate climate with average monthly maximum temperatures ranging from 27.7°C in January to 11.1°C in July, and average monthly minimum temperatures ranging from 12.6°C in February to 1.7°C in June and July (temperature data are for Ararat, 16 km to the east). Moyston receives an average of 573 millimetres of rain per year (LCC 1980), with most rain falling in winter and spring.

#### Censusing

A single, strip transect (approximately 1.5 km in length and 100 m in width) was used to estimate bird species richness and abundance. The transect route extensively sampled all habitats of the remnant, and was completed in approximately four hours. Censuses commenced at sunrise or soon after on overcast mornings.

Every bird sighted during the census was recorded and counted. Care was taken to avoid double counting. Birds heard calling from within the remnant were recorded when they were first heard, and if they were not ultimately sighted during the survey they were counted as 'one'. Birds using the aerial space over the study site for hunting (e.g. raptors) or feeding (e.g. martins or swallows) are included in the results. Data collected on other birds flying over the transect are not included in this paper. The census was made on the second or third weekend of each month between September 1989 and February 1994. There were five censuses in the spring and summer months and four in the autumn and winter months. Counts were averaged across the years.

#### Classification of migratory status

At the completion of data collection the seasonal variation in abundance of each species was assessed and each species was classed as a resident, migrant, partial migrant, or visitor. The definitions of migratory status have been adapted from Er and Tidemann (1996).

The species observed were grouped into resident birds, total migrants (where all individuals left the remnant on a seasonal basis, with allowance for occasional unseasonal records), partial migrants (when a proportion of the population remained in the remnant), irregular visitors (relatively frequent visitors with no seasonal pattern of abundance) and occasional visitors.

## RESULTS

#### Species richness and total relative abundance

A total of 88 species was recorded during the study. Of these, 34 were classed as residents, 9 as partial migrants, 14 as migrants, 5 as irregular visitors and 26 as occasional visitors.

Species richness was similar across all seasons, as was the cumulative total of species recorded in each season (Table 1). Total relative abundance was highest in autumn (Table 2). There was seasonal variation in the migratory status of the bird population. In spring and winter, more than 80 per cent of all individuals encountered were residents. The proportion of residents was lower in summer and autumn, when there was a greater abundance of partial migrants and irregular visitors. Relative abundance of total migrants was highest in summer and spring, and lowest in winter (Table 2).

#### Resident birds

There were 34 species of resident birds (Table 3a). Common residents included the Superb Fairy-wren *Malurus cyaneus*, Red-browed Finch *Neochmia temporalis*, White-plumed Honeyeater *Lichenostomus penicillatus*, Australian Magpie *Gymnorhina tibicen*, White-browed Babbler *Pomatostomus temporalis*, Brown Thornbill *Acanthiza pusilla* (Fig. 1a) and Yellow-rumped Thornbill *A. chrysorrhoa*. Species that occurred at low densities but were nevertheless recorded on most visits included the

Restless Flycatcher *Myiagra inquieta* (Fig. 1b), Jacky Winter *Microeca leucophaea* and Crested Shrike-tit *Falcunculus frontalis*.

#### Total migrants

There were 14 species of total migrants (Table 3b). Occasional records of some of these species were made at times of the year when they were usually absent. All but two of the species (Golden Whistler *Pachycephala pectoralis* and Silveryeye *Zosterops lateralis*) were visitors during the warmer months, although actual times of arrival and departure varied. The Golden Whistler was the only regular winter migrant (Fig. 1c), as the Silveryeye displayed two distinct increases in abundance, one in autumn and another in early spring (Table 3b). Other species known to arrive in the region in the cooler months (e.g. Swift Parrot *Lathamus discolor*, Flame Robin *Petroica phoenicea*, White-eared Honeyeater *Lichenostomus leucotis*, Pied Currawong *Strepera graculina*) only visited the remnant occasionally (Table 3e).

Spring-summer migrants (Table 3b) likely to have wintered in tropical or sub-tropical regions included the Pallid Cuckoo *Cuculus pallidus*, Fan-tailed Cuckoo *Cacomantis flabelliformis*, Horsfield's Bronze-cuckoo *Chrysococcyx basalis*, Golden Bronze-cuckoo *C. lucidus*, Rufous Whistler *Pachycephala rufiventris* (Fig. 1d),

TABLE 1

Seasonal variation in mean bird species richness at a woodland remnant in central western Victoria.

	Mean Species Richness <sup>1</sup> per census	Cumulative Species Richness <sup>2</sup> (number of censuses in parentheses)
Spring	40.5	71 (n = 15)
Summer	42.3	74 (n = 15)
Autumn	40.8	70 (n = 12)
Winter	39.7	72 (n = 12)

<sup>1</sup>Data averaged over all years.

<sup>2</sup>Data totalled for all years.

TABLE 2

Seasonal variation in relative abundance of birds in each migratory category at a woodland remnant in central western Victoria. Values are for mean birds/ha per census. Definition of migratory status adapted from Er and Tidemann (1996).

	Spring	Summer	Autumn	Winter
Resident	16.30 (79.5%)	18.43 (64.4%)	22.01 (68.9%)	22.16 (87.3%)
Migrant	1.49 (7.3%)	1.98 (6.9%)	1.14 (3.6%)	0.44 (1.7%)
Partial Migrant	2.12 (10.3%)	5.10 (17.8%)	7.56 (23.6%)	1.89 (7.4%)
Irregular visitor	0.30 (1.5%)	2.59 (9.1%)	0.98 (3.0%)	0.67 (1.7%)
Occasional	0.30 (1.5%)	0.52 (1.8%)	0.24 (0.8%)	0.22 (0.9%)
Total	20.50	28.62	31.94	25.38

Rainbow Bee-eater *Merops ornatus*, White-winged Triller *Lalage tricolor* and Dusky Woodswallow *Artamus cyanopterus*.

The Yellow-tailed Black-Cockatoo *Calyptorhynchus funereus* visited the area in spring and summer, apparently feeding exclusively on the cones of the introduced Radiata Pine *Pinus radiata* (pers. obs.). The Eastern Rosella *Platycercus eximius* (apart from a few records) was recorded only between December and May. The Brown Goshawk *Accipiter fasciatus* was recorded largely between September and January, with a pair occupying a territory each spring after being absent for several months. The occasional records over the February-August period (see Table 3b) were scattered across the study period; they were often made outside the area that the breeding pair occupied during September-January and may be records of other

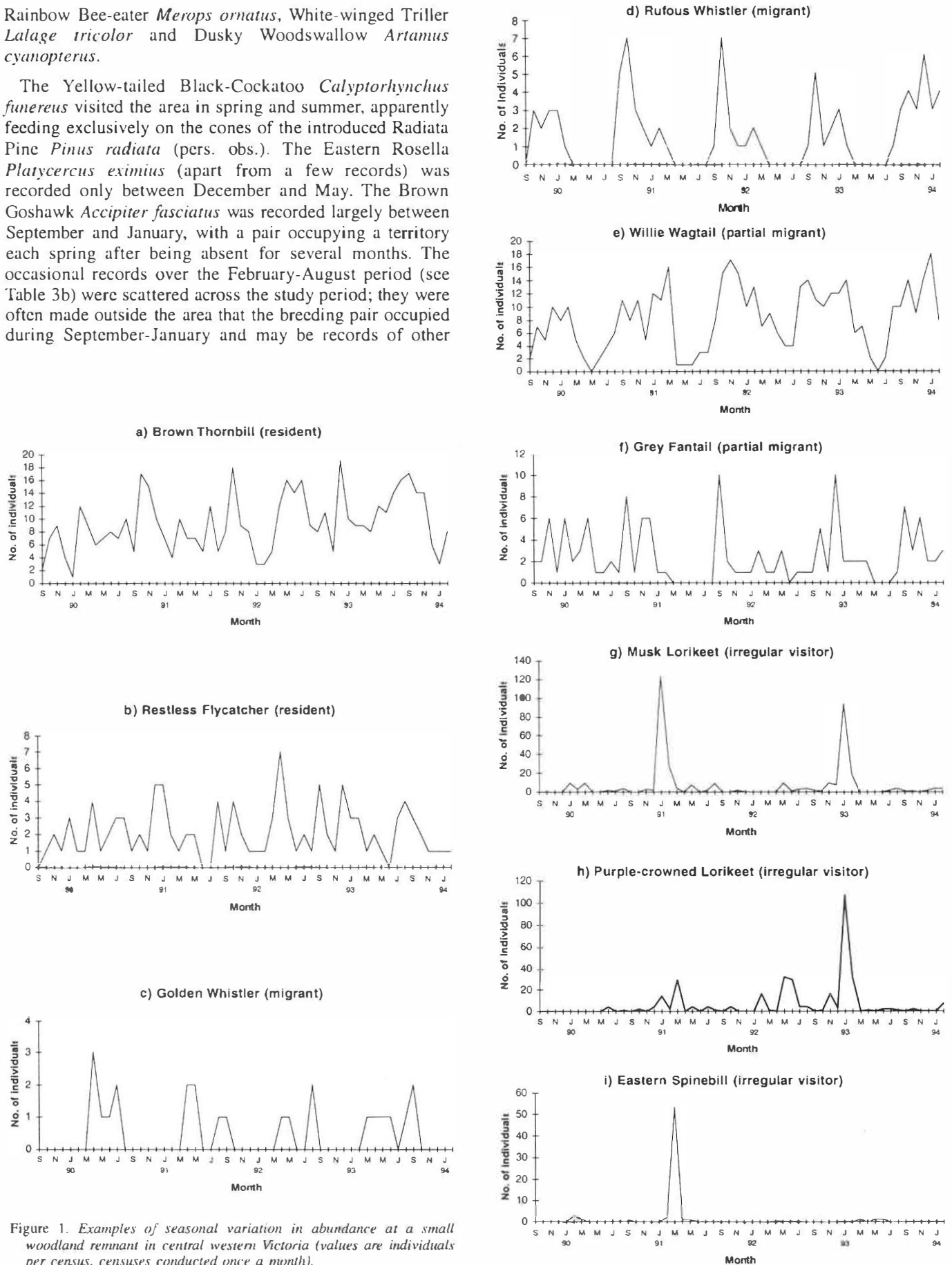


Figure 1. Examples of seasonal variation in abundance at a small woodland remnant in central western Victoria (values are individuals per census, censuses conducted once a month).

TABLE 3

Seasonal variation in abundance of bird species at a woodland remnant in central western Victoria. Mean density values indicate the average number of individuals per hectare. Frequency values indicate the number of censuses on which the species was recorded. Table 3a=residents, Table 3b=migrants, Table 3c=partial migrants, Table 3d=irregular visitors, Table 3e=occasional visitors.

**A) Residents (Remained throughout year with no distinct seasonal change in abundance)**

		Jan (n=5)	Feb (n=5)	Mar (n=4)	Apr (n=4)	May (n=4)	Jun (n=4)	Jul (n=4)	Aug (n=4)	Sep (n=5)	Oct (n=5)	Nov (n=5)	Dec (n=5)	Total (n=54)
Little Eagle	Density	0.04	0.04	0.05	0	0	0.03	0.11	0.02	0.01	0.03	0.01	0.01	0.03
<i>Hieraetus morphnoides</i>	Frequency	1	3	3	0	0	2	4	1	1	1	1	1	18
Brown Falcon	Mean density	0.13	0.16	0.13	0.14	0.09	0.16	0.07	0.14	0.10	0.06	0.07	0.16	0.12
<i>Falco berigora</i>	Frequency	5	5	3	4	3	4	3	4	4	3	4	5	46
Crimson Rosella	Mean density	1.10	0.56	0.59	0.52	0.93	0.39	0.41	0.79	0.26	0.23	0.31	0.57	0.55
<i>Platycercus elegans</i>	Frequency	5	5	4	4	4	4	4	4	5	4	4	5	52
Laughing Kookaburra	Mean density	0.06	0.01	0.07	0.07	0.09	0.05	0.13	0.07	0.07	0.14	0.07	0.10	0.08
<i>Dacelo gigas</i>	Frequency	4	1	3	3	4	3	4	4	3	5	5	4	43
White-throated Treecreeper	Mean density	0.19	0.11	0.16	0.20	0.16	0.09	0.21	0.27	0.21	0.14	0.19	0.19	0.18
<i>Cormobates leucophaea</i>	Frequency	5	5	4	4	4	4	4	4	4	4	5	5	52
Superb Fairy-wren	Mean density	5.10	5.46	4.98	6.34	7.29	7.93	8.14	7.00	4.56	5.91	5.14	5.71	6.04
<i>Malurus cyaneus</i>	Frequency	5	5	4	4	4	4	4	4	5	5	5	5	54
White-browed Scrubwren	Mean density	0.09	0.04	0.14	0.04	0.09	0.05	0.14	0.07	0.09	0.14	0.10	0.09	0.09
<i>Sericornis frontalis</i>	Frequency	3	2	3	1	2	1	2	2	1	2	2	2	23
Speckled Warbler	Mean density	0.07	0.07	0.14	0.05	0.09	0.25	0.11	0.21	0.10	0.10	0.07	0.09	0.11
<i>Chthonicola sagittatus</i>	Frequency	4	3	3	2	3	3	3	4	3	3	3	4	38
Brown Thornbill	Mean density	0.34	0.51	0.59	0.59	0.75	0.68	0.88	0.71	0.57	0.96	0.74	0.67	0.66
<i>Acanthiza pusilla</i>	Frequency	5	5	4	4	4	4	4	4	5	5	5	5	54
Buff-rumped Thornbill	Mean density	0	0.20	0.05	0.04	0.09	0.07	0.20	0.18	0.06	0	0	0.17	0.09
<i>A. reguloides</i>	Frequency	0	1	1	1	1	1	2	1	1	0	0	1	10
Yellow-rumped Thornbill	Mean density	0.47	0.60	0.64	1.25	0.70	0.50	1.05	0.73	0.93	0.76	1.10	0.59	0.77
<i>A. chrysorrhoea</i>	Frequency	3	3	3	4	3	3	4	4	5	5	5	3	45
Striated Thornbill	Mean density	0.27	0.24	0.43	0.70	0.64	0.82	0.50	0.66	0.44	0.33	0.36	0.37	0.46
<i>A. lineata</i>	Frequency	5	4	3	4	4	4	3	4	4	5	4	5	49
Southern Whiteface	Mean density	0	0.03	0	0.05	0.07	0.02	0.02	0	0.03	0.03	0.06	0.01	0.03
<i>Aphelocephala leucopsis</i>	Frequency	0	1	0	2	2	1	1	0	1	1	2	1	12
Red Wattlebird	Mean density	0.07	0.19	0.09	0.13	0.21	0.05	0.05	0.09	0.03	0.10	0.24	0.16	0.12
<i>Anthochaera carunculata</i>	Frequency	5	5	4	4	4	3	3	4	2	5	5	4	48
White-plumed Honeyeater	Mean density	1.69	1.86	2.36	2.36	2.07	1.41	1.61	2.36	0.99	1.66	1.79	1.64	1.79
<i>Lichenostomus penicillatus</i>	Frequency	5	5	4	4	4	4	4	4	5	5	5	5	54
Black-chinned Honeyeater	Mean density	0.17	0.11	0.09	0.25	0.07	0.04	0.16	0.13	0.04	0.11	0.20	0.14	0.13
<i>Melithreptus gularis</i>	Frequency	4	4	4	3	3	2	3	4	2	4	4	3	40
Brown-headed Honeyeater	Mean density	0.07	0.34	0.05	0.38	0.16	0	0	0.11	0.04	0.07	0.04	0.17	0.12
<i>M. brevirostris</i>	Frequency	1	4	3	3	2	0	0	2	1	2	3	4	27
New Holland Honeyeater	Mean density	0.44	0.93	0.95	0.57	0.34	0.18	0.16	0.70	0.10	0.29	0.13	0.36	0.42
<i>Phylidonyris novaehollandiae</i>	Frequency	5	5	4	4	2	1	4	3	4	3	3	5	43
Jacky Winter	Mean density	0.11	0.24	0.23	0.16	0.23	0.04	0.20	0.29	0.17	0.20	0.11	0.14	0.18
<i>Microeca leucophaea</i>	Frequency	5	5	3	4	4	2	4	4	4	4	4	5	48
Eastern Yellow Robin	Mean density	0.29	0.54	0.39	0.70	0.43	0.77	0.57	0.55	0.20	0.40	0.33	0.47	0.46
<i>Eopsaltria australis</i>	Frequency	4	4	4	4	4	4	4	4	5	5	5	5	52
Hooded Robin	Mean density	0.04	0	0.09	0.07	0.02	0.07	0.04	0.04	0	0	0.04	0.03	0.03
<i>Melanodryas cucullata</i>	Frequency	2	0	1	2	1	2	1	1	0	0	1	2	13
White-browed Babbler	Mean density	0.97	0.63	1.13	1.84	1.16	1.09	0.93	1.05	0.91	1.00	0.63	0.84	0.99
<i>Pomatostomus temporalis</i>	Frequency	5	5	4	4	4	4	4	4	5	5	5	5	54

<i>Crested Shrike-tit</i>	Mean density	0.14	0.11	0.16	0.18	0.20	0.18	0.13	0.07	0.13	0.09	0.11	0.14
<i>Falcunculus frontatus</i>	Frequency	5	5	4	4	4	4	4	5	5	4	4	52
Grey Shrike-thrush	Mean density	0.30	0.17	0.14	0.38	0.18	0.11	0.30	0.55	0.33	0.40	0.17	0.27
<i>Colluricincla harmonica</i>	Frequency	5	5	4	4	4	4	4	5	5	5	5	54
Restless Flycatcher	Mean density	0.19	0.11	0.11	0.27	0.13	0.05	0.14	0.21	0.14	0.16	0.10	0.19
<i>Myiagra inquieta</i>	Frequency	5	5	4	4	4	2	3	4	4	5	5	50
Black-faced Cuckoo-shrike	Mean density	0.03	0	0	0.02	0.05	0.02	0.04	0.04	0.31	0.01	0.10	0.09
<i>Coracina novaehollandiae</i>	Frequency	1	0	0	1	1	1	2	2	4	1	4	3
White-bellied Cuckoo-shrike	Mean density	0.06	0.06	0.02	0.07	0	0.04	0.04	0.13	0.01	0.07	0.10	0.14
<i>C. papuensis</i>	Frequency	4	3	1	4	0	1	2	4	1	3	4	2
Australian Magpie	Mean density	1.83	2.24	3.11	2.98	2.41	2.63	2.64	2.55	2.00	2.09	1.69	2.11
<i>Gymnorhina tibicen</i>	Frequency	5	5	4	4	4	4	4	5	5	5	5	54
Red-browed Finch	Mean density	2.11	2.57	2.45	2.55	2.48	3.41	1.93	1.70	0.87	1.06	1.54	1.83
<i>Neochmia temporalis</i>	Frequency	5	5	4	4	4	4	4	4	4	5	5	53
European Goldfinch	Mean density	0.41	0.46	0.43	0.14	0.59	0.23	0.25	0.32	0.06	0.66	0.49	0.49
<i>Carduelis carduelis</i>	Frequency	5	3	2	3	3	3	2	3	2	5	4	5
House Sparrow	Mean density	0.11	0.03	0.09	0.11	0.21	0.20	0.30	0.27	0.11	0.11	0.14	0.13
<i>Passer domesticus</i>	Frequency	4	2	3	4	2	3	4	4	4	4	4	43
Mistletoebird	Mean density	0.17	0.07	0.04	0.05	0.05	0.04	0.04	0.04	0.07	0.11	0.07	0.19
<i>Dicaeum hirundinaceum</i>	Frequency	5	4	2	3	3	2	2	2	5	4	4	5
Welcome Swallow	Mean density	0.50	0.13	0.30	0.16	0.25	0.09	0.34	0.43	0.26	0.37	0.23	0.26
<i>Hirundo neoxena</i>	Frequency	4	3	3	3	4	2	4	4	5	5	5	5
Common Blackbird	Mean density	0.06	0.06	0.07	0.07	0.21	0.16	0.14	0.09	0.13	0.14	0.17	0.14
<i>Turdus merula</i>	Frequency	4	4	3	4	4	4	4	4	5	5	5	5

### B) Total Migrants (All individuals departed remnant on seasonal basis, allowing for occasional unseasonal records)

		Jan (n=5)	Feb (n=5)	Mar (n=4)	Apr (n=4)	May (n=4)	Jun (n=4)	Jul (n=4)	Aug (n=4)	Sep (n=5)	Oct (n=5)	Nov (n=5)	Dec (n=5)	Total (n=54)
Brown Goshawk	Mean density	0.06	0.01	0.02	0.02	0.02	0	0.02	0.02	0.13	0.06	0.07	0.07	0.04
<i>Accipiter fasciatus</i>	Frequency	3	1	1	1	1	0	1	1	5	3	4	3	24
Yellow-tailed Black-cockatoo	Mean density	0.11	0.14	0.04	0.13	0	0	0	0	0	0	0	0.03	0.04
<i>Calyptorhynchus funereus</i>	Frequency	2	3	2	3	0	0	0	0	0	0	0	1	11
Eastern Rosella	Mean density	0.64	0.91	0.52	0.25	0.43	1.07	0.54	0	0.10	0	0	0.20	0.27
<i>Platycercus eximius</i>	Frequency	4	4	3	4	3	2	1	0	1	0	0	3	25
Pallid Cuckoo	Mean density	0	0	0	0	0	0	0	0	0.03	0.04	0	0	0.01
<i>Cuculus pallidus</i>	Frequency	0	0	0	0	0	0	0	0	2	3	0	0	5
Fan-tailed Cuckoo	Mean density	0	0	0	0.02	0	0	0.02	0.04	0.03	0.01	0	0	0.01
<i>Cacomantis flabelliformis</i>	Frequency	0	0	0	1	0	0	1	2	2	1	0	0	7
Horsfields Bronze-Cuckoo	Mean density	0	0.01	0	0	0	0	0.02	0.07	0.06	0.04	0.09	0.01	0.03
<i>Chrysococcyx basalis</i>	Frequency	0	1	0	0	0	0	1	4	3	3	4	1	17
Golden Bronze-cuckoo	Mean density	0	0	0	0	0	0	0	0	0	0.06	0.01	0.03	0.01
<i>C. lucidus</i>	Frequency	0	0	0	0	0	0	0	0	0	4	1	2	7
Rainbow Bee-eater	Mean density	1.04	1.36	0	0	0	0	0	0	0	0.61	0.14	0.06	0.30
<i>Merops ornatus</i>	Frequency	5	4	0	0	0	0	0	0	0	3	2	3	17
Varied Sittella	Mean density	0.04	0.09	0.09	0	0	0	0.11	0.11	0.27	0.30	0.26	0.09	0.12
<i>Daphoenositta chrysoptera</i>	Frequency	1	2	2	0	0	0	1	2	5	4	3	1	21
Golden Whistler	Mean density	0	0	0.02	0.13	0.09	0.04	0.04	0.07	0.04	0	0	0	0.03
<i>Pachycephala pectoralis</i>	Frequency	0	0	1	4	4	2	1	3	2	0	0	0	17
Rufous Whistler	Mean density	0.16	0.14	0.04	0	0	0	0	0.02	0.14	0.37	0.16	0.20	0.11
<i>P. rufiventris</i>	Frequency	5	5	3	0	0	0	0	1	4	5	5	5	33
White-winged Triller	Mean density	0.03	0	0	0	0	0	0	0	0	0.06	0.06	0.04	0.02
<i>Lalage tricolor</i>	Frequency	2	0	0	0	0	0	0	0	0	1	3	2	8

Table 3 — *continued*

**B) Total Migrants (All individuals departed remnant on seasonal basis, allowing for occasional unseasonal records)**

		Jan (n=5)	Feb (n=5)	Mar (n=4)	Apr (n=4)	May (n=4)	Jun (n=4)	Jul (n=4)	Aug (n=4)	Sep (n=5)	Oct (n=5)	Nov (n=5)	Dec (n=5)	Total (n=54)
Dusky Woodswallow	Mean density	0.17	0.07	0.09	0.29	0.05	0	0	0.32	0.11	0.27	0.29	0.21	0.16
<i>Artamus cyanopterus</i>	<b>Frequency</b>	<b>4</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>3</b>	<b>4</b>	<b>32</b>
Silvereye	Mean density	0	0	0.09	0.64	0.43	0.18	0.02	0.09	0.63	0.03	0	0	0.17
<i>Zosterops lateralis</i>	<b>Frequency</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>4</b>	<b>4</b>	<b>3</b>	<b>1</b>	<b>2</b>	<b>4</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>21</b>

**C) Partial Migrants (Seasonal variation in abundance, but proportion of the population remained in remnant)**

		Jan (n=5)	Feb (n=5)	Mar (n=4)	Apr (n=4)	May (n=4)	Jun (n=4)	Jul (n=4)	Aug (n=4)	Sep (n=5)	Oct (n=5)	Nov (n=5)	Dec (n=5)	Total (n=54)
Common Bronzewing	Mean density	0.03	0.13	0.05	0.17	0.27	0.25	0.13	0.09	0.01	0	0.01	0.04	0.09
<i>Phaps chalcoptera</i>	<b>Frequency</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>3</b>	<b>24</b>
Red-rumped Parrot	Mean density	1.87	0.99	2.04	1.20	1.23	0.63	0.79	0.16	0.09	0.23	0.41	1.66	0.93
<i>Psephotus haematonotus</i>	<b>Frequency</b>	<b>5</b>	<b>4</b>	<b>2</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>1</b>	<b>4</b>	<b>4</b>	<b>5</b>	<b>45</b>
Spotted Pardalote	Mean density	0.01	0.03	0.09	0.25	0.14	0.13	0.09	0.18	0.06	0.03	0.07	0.07	0.09
<i>Pardalotus punctatus</i>	<b>Frequency</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>4</b>	<b>2</b>	<b>4</b>	<b>3</b>	<b>34</b>
Striated Pardalote	Mean density	0.11	0.20	1.20	2.20	0.41	0.41	0.05	0.02	0.06	0.06	0.04	0.04	0.36
<i>P. striatus</i>	<b>Frequency</b>	<b>5</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>37</b>
Yellow-faced Honeyeater	Mean density	0.83	0.60	1.30	0.68	0.09	0.05	0.05	0.34	0.36	0.43	0.47	0.76	0.51
<i>Lichenostomus chrysops</i>	<b>Frequency</b>	<b>5</b>	<b>5</b>	<b>4</b>	<b>4</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>4</b>	<b>3</b>	<b>4</b>	<b>4</b>	<b>5</b>	<b>42</b>
Fuscous Honeyeater	Mean density	0.49	0.37	1.11	0.21	0.02	0.07	0.07	0.59	0.17	0.27	0.31	0.39	0.34
<i>L. fuscus</i>	<b>Frequency</b>	<b>4</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>3</b>	<b>1</b>	<b>4</b>	<b>3</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>36</b>
Willie Wagtail	Mean density	0.86	0.80	0.61	0.34	0.16	0.13	0.23	0.57	0.64	0.79	0.74	0.80	0.58
<i>Rhipidura leucophrys</i>	<b>Frequency</b>	<b>5</b>	<b>5</b>	<b>4</b>	<b>4</b>	<b>3</b>	<b>3</b>	<b>4</b>	<b>4</b>	<b>5</b>	<b>5</b>	<b>5</b>	<b>5</b>	<b>52</b>
Grey Fantail	Mean density	0.17	0.16	0.11	0.16	0.07	0.02	0.05	0.05	0.40	0.19	0.29	0.29	0.17
<i>R. fuliginosa</i>	<b>Frequency</b>	<b>5</b>	<b>5</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>5</b>	<b>5</b>	<b>5</b>	<b>5</b>	<b>44</b>
Tree Martin	Mean density	0.89	2.54	3.79	4.29	0.50	0	0.11	0.41	0.04	0.01	0.09	0.19	1.02
<i>Hirundo nigricans</i>	<b>Frequency</b>	<b>4</b>	<b>5</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>0</b>	<b>1</b>	<b>4</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>28</b>

**D) Irregular visitors (Relatively frequent visitors with no seasonal pattern of abundance)**

		Jan (n=5)	Feb (n=5)	Mar (n=4)	Apr (n=4)	May (n=4)	Jun (n=4)	Jul (n=4)	Aug (n=4)	Sep (n=5)	Oct (n=5)	Nov (n=5)	Dec (n=5)	Total (n=54)
Musk Lorikeet	Mean density	3.30	0.76	0.25	0	0.32	0.05	0.14	0.38	0.04	0.03	0.21	0.17	0.50
<i>Glossopsitta concinna</i>	<b>Frequency</b>	<b>4</b>	<b>4</b>	<b>2</b>	<b>0</b>	<b>2</b>	<b>2</b>	<b>4</b>	<b>4</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>32</b>
Purple-crowned Lorikeet	Mean density	1.73	0.80	0.54	0.02	0.64	0.63	0.18	0.13	0	0.13	0.23	0.10	0.43
<i>G. porphyrocephala</i>	<b>Frequency</b>	<b>2</b>	<b>4</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>4</b>	<b>0</b>	<b>4</b>	<b>1</b>	<b>2</b>	<b>28</b>
Little Lorikeet	Mean density	0.11	0.14	0	0	0.04	0.07	0.04	0.09	0	0.07	0	0.07	0.05
<i>G. pusilla</i>	<b>Frequency</b>	<b>1</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>0</b>	<b>2</b>	<b>0</b>	<b>2</b>	<b>12</b>
White-naped Honeyeater	Mean density	0.23	0.03	0	0.02	0.09	0.11	0.04	0.16	0.07	0.03	0.09	0.26	0.10
<i>Melithreptus lunatus</i>	<b>Frequency</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>17</b>
Eastern Spinebill	Mean density	0	0.07	0.98	0.02	0.04	0.02	0	0	0	0	0	0	0.08
<i>Acanthorhynchus tenuirostris</i>	<b>Frequency</b>	<b>0</b>	<b>2</b>	<b>3</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>9</b>

**E) Occasional visitors (infrequently recorded, with no seasonal pattern of abundance)**

	Months recorded and abundance	Total (n=54)
Whistling Kite	Jan 91 (1), Sep 91 (1), Oct 91 (1), Mar 92 (1), May 92 (4), Sep 92 (3), Oct 92 (2), Jun 93 (1), Dec 93 (1)	9
<i>Milvus sphenurus</i>		

Collared Sparrowhawk	Dec 92 (1)	1
<i>Accipiter cirrhocephalus</i>		
Wedge-tailed Eagle	Feb 90 (2), Feb 92 (1), May 93 (1), Feb 93 (1)	4
<i>Aquila audax</i>		
Masked Lapwing	Jun 92 (4), Jul 92 (1), Oct 92 (2), Nov 92 (2), Jan 93 (2), Feb 93 (3), Aug 93 (2), Sep 93 (2)	8
<i>Vanellus miles</i>		
Rainbow Lorikeet	Feb 93 (9)	1
<i>Trichoglossus haemotodus</i>		
Swift Parrot	Jun 90 (4), Jul 93 (2)	2
<i>Lathamus discolor</i>		
Elegant Parrot	Aug 93 (2), Oct 93 (1)	2
<i>Neophema elegans</i>		
Barking Owl	Aug 90 (1)	1
<i>Ninox connivens</i>		
Weebill	Feb 90 (2), Jul 90 (2), Dec 92 (1), Jan 93 (1)	4
<i>Smicrornis brevirostris</i>		
White-eared Honeyeater	Jun 90 (2), Apr 91 (1), May 91 (1)	3
<i>Lichenostomus leucotis</i>		
Yellow-tufted Honeyeater	Dec 90 (1), Jan 91 (2), Mar 91 (12), Apr 91 (1), Dec 93 (1)	5
<i>L. melanops</i>		
Painted Honeyeater	Nov 91 (2), Jan 92 (1)	2
<i>Grantiella picta</i>		
White-fronted Chat	Nov 90 (1), Aug 91 (1), Jul 92 (2)	3
<i>Ephthianura albigrons</i>		
Flame Robin	Mar 91 (3), Jun 92 (1)	2
<i>Petroica phoenicea</i>		
Scarlet Robin	May 90 (2), Apr 92 (1), Jul 92 (1)	3
<i>P. multicolor</i>		
Leaden Flycatcher	Dec 92 (1)	1
<i>Myiagra rubecula</i>		
White-browed Woodswallow	Mar 90 (1), Jan 92 (1), Feb 92 (5), Oct 92 (5), Dec 92 (3)	5
<i>Artamus superciliosus</i>		
Magpie-lark	May 92 (1), Aug 92 (2), Dec 93 (1)	3
<i>Grallina cyanoleuca</i>		
Richard's Pipit	Oct 90 (1), Jul 91 (1), Oct 91 (3), Apr 92 (3), Aug 92 (3), May 93 (3), Dec 93 (1)	7
<i>Anthus novaeseelandiae</i>		
Diamond Firetail	Nov 91 (1), Jan 92 (1), May 92 (2)	3
<i>Stagonopleura guttata</i>		
Fairy Martin	Sep 89 (22), Jan 90 (17), Feb 90 (23), Nov 90 (1), Feb 91 (3), Jun 92 (2), Jan 94 (20)	7
<i>Hirundo ariel</i>		
Rufous Songlark	Nov 91 (1), Nov 92 (1)	2
<i>Cinclorhampus mathewsi</i>		
Pied Currawong	Apr 92 (1)	1
<i>Strepera graculina</i>		
Grey Currawong	Sep 89 (3), Aug 91 (1), Sep 91 (4), Nov 91 (5), Dec 91 (1), Mar 92 (1)	6
<i>S. versicolor</i>		
Singing Bushlark	May 90 (1)	1
<i>Mirafra javanica</i>		
Common Starling	Aug 90 (3), Jul 93 (1)	2
<i>Sturnus vulgaris</i>		

individuals. The Varied Sittella *Daphoenositta chrysoptera* was not recorded in April, May or June.

#### Partial migrants

There were nine species classified as partial migrants (Table 3c). Four species, including the Willie Wagtail *Rhipidura leucophrys* (Fig. 2e), Grey Fantail *R. fuliginosa* (Fig. 2f), Yellow-faced Honeyeater *Lichenostomus chrysops* and Fuscous Honeyeater *L. fuscus* were least abundant during the winter months. Mean density values of the Tree Martin *Hirundo nigricans* and the Striated Pardalote *Pardalotus striatus* increased dramatically in late summer and autumn (Table 3c). The Common Bronzewing *Phaps chalcoptera* and Spotted Pardalote *P. punctatus* were more numerous in winter. The Red-rumped Parrot *Psephotus haematonotus* was less abundant in spring than in other months.

#### Irregular visitors

Five species were identified as irregular visitors (Table 3d). The Musk Lorikeet *Glossopsitta concinna* was present in large numbers in January 1991 and January 1993 when River Red Gums flowered more abundantly than in other years (Fig. 1g). The Purple-crowned Lorikeet *G. porphyrocephala* also appeared in response to abundant flowering of River Red Gums, particularly in January 1993 (Fig. 1h). The Little Lorikeet *G. pusilla* was never present in large numbers and was often observed feeding on the flowers of mistletoe *Amyma miquelii*.

The Eastern Spinebill *Acanthorhynchus tenuirostris* was recorded in large numbers in March 1991, in response to flowering Scent-barks (Fig. 1i). The Yellow-faced Honeyeater (generally a partial migrant) also appeared in great numbers at this time. The Scent-barks also flowered abundantly in March 1992, but on this occasion the White-plumed Honeyeater *L. penicillatus* and Fuscous Honeyeater were present in greater numbers than usual, with the resident populations of these two species boosted by individuals from other areas.

The White-naped Honeyeater *Melithreptus lunatus* was generally present between May 1992 and November 1993 but was otherwise rarely sighted, with the two occurrences outside the aforementioned period being single birds among flocks of other honeyeater species.

#### Occasional visitors

There were 26 species classified as occasional visitors (Table 3e). Several species in this list are common species in the area that visited the remnant sporadically (such as the Grey Currawong *Strepera versicolor*, Richard's Pipit *Anthus novaeseelandiae*, Australian Magpie-lark *Grallina cyanoleuca* and the Masked Lapwing *Vanellus miles*). Other species in this classification were uncommon in the area.

#### Longer-term changes in abundance during the study

Two species recorded throughout the year early in the survey (Hooded Robin *Melanodryas cucullata* and Buff-rumped Thornbill *Acanthiza reguloides*) were no longer

present by the survey's completion (Fig. 2a,b). One species (White-browed Scrubwren *Sericornis frontalis*) recorded only occasionally earlier in the survey was regularly recorded towards the survey's completion (Fig. 2c). The White-browed Scrubwren appeared rather suddenly as a regular species at the site in early 1992. The species was recorded on four of the first thirty-four censuses, and nineteen of the last twenty censuses. Table 4 shows details for five species whose status is of concern.

## DISCUSSION

This site is similar to other woodland remnants in central western Victoria in that it supports a high number of bird species (Table 1). Avifauna typical of drier habitats inland of the Great Dividing Range (Hooded Robin, Southern Whiteface *Aphelocephala leucopsis*) and species more typical of wetter habitats (Eastern Yellow Robin, White-throated Treecreeper *Cormobates leucophaea*) were supported here. Eucalypt flowering events attract nectarivorous species in large numbers (Fig. 1g,h,i). A number of spring/summer migrants, and winter migrants (Golden Whistler) that breed in wetter habitats, also visit the area.

The remnant continues to support a high number of species and individuals in winter, a result also found in other woodland remnant studies (Er and Tidemann 1996). This contrasts with the overall reduction in bird density and species richness during winter in many forest habitats in south-eastern Australia (Loyn 1985; Recher and Holmes 1985; Osborne and Green 1992).

#### Use of the remnant by migrants

Woodlands in south-eastern Australia provide important habitat for a significant number of migratory birds that spend part of the year in other habitat types (Nix 1976; Robinson and Traill 1996). Most of the migrants to this site were breeding visitors, such as the cuckoos, Rainbow Bee-eater *Merops ornatus*, White-winged Triller *Lalage tricolor*, Rufous Whistler and Dusky Woodswallow *Artamus cyanopterus*. These species are all widely recognized as breeding visitors to Victorian forests and woodlands (Blakers *et al.* 1984; Emison *et al.* 1987).

The Golden Whistler, present in the remnant from March to September, visits many drier districts in Australia during this period. This species leaves some wetter forests at higher altitudes on the mainland during autumn (Loyn 1985; Emison *et al.* 1987) and Griffioen (2001) identified strong evidence of a north-south movement, including movement out of Tasmania. The Golden Whistler can be found during summer in stringybark-dominated open forests in the Grampians National Park only 10 kilometres to the west of the study site (pers. obs.).

#### Use of the remnant by partial migrants

The Tree Martin *Hirundo nigricans* is generally present in greater numbers in summer than in winter in southern Australia (Blakers *et al.* 1984; Griffioen 2001), a trend that was evident in this study. However, the largest numbers of Tree Martins were encountered in February-April, when large flocks settled in dead trees, occasionally dispersing



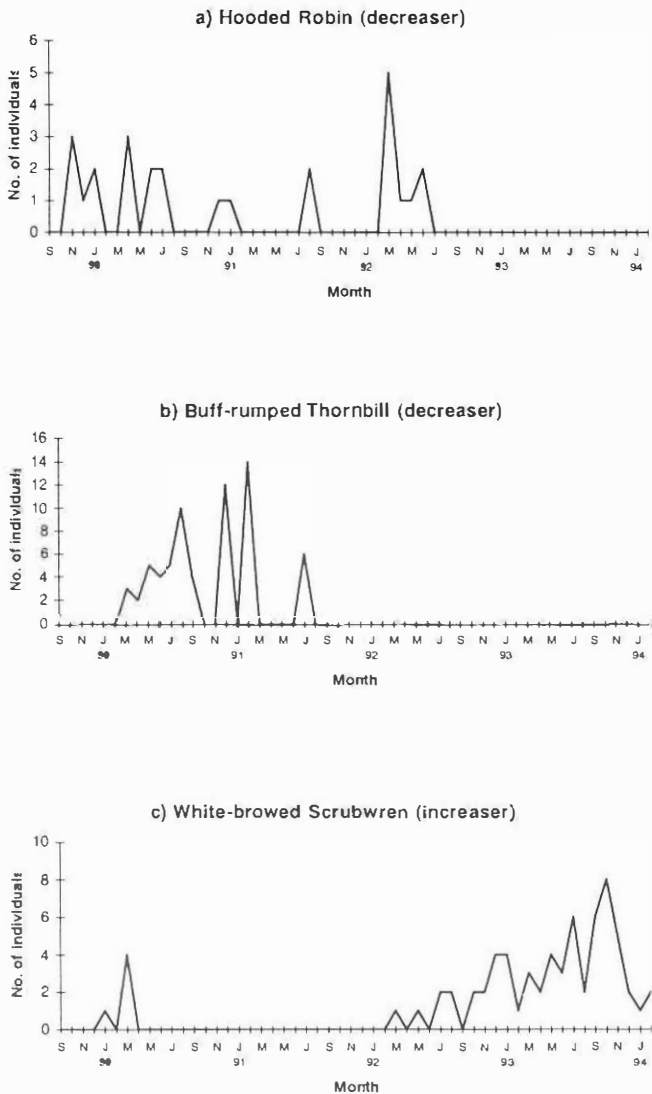


Figure 2. Examples of changes in abundance across the study period at a small woodland remnant in central western Victoria (values are individuals per census, censuses conducted once a month).

TABLE 4

Status of species of concern in woodland remnants in the vicinity of the study site. (P — Present, N — Never recorded) \* — Diamond Firetail status uncertain, two recent records of single birds.

	Jallukar State Forest (1 291 ha)	The Nook Flora Reserve (281 ha)	Study site (14 ha)
Hooded Robin	P	N	Last record 1993
Speckled Warbler	P	P	Last record 1995
Diamond Firetail	P	N	P*
Buff-rumped Thornbill	P	P	Last record 1991
Southern Whiteface	P	P	?

to feed overhead. The flocks abruptly disappeared before the onset of winter. Large numbers of Tree Martins appear to leave Tasmania in February and March (Blakers *et al.* 1984; Griffioen 2001) and it is possible that these large flocks of Tree Martins were part of the population moving out of Tasmania.

As with other sites in Australia (Blakers *et al.* 1984), there appears to be a resident population of Striated Pardalotes in the remnant, as well as non-breeding visitors at certain times of the year. The Tasmanian race of this species (*Pardalotus striatus* ssp. *striatus*) migrates to the Australian mainland in autumn and there is a winter influx of these birds into the Murray-Darling Region (Blakers *et al.* 1984). Striated Pardalotes moving out of Tasmania possibly caused the pronounced increase in numbers during autumn in the study site. The autumn visitors were noticeably paler than the resident birds and unlike the resident population these visitors formed flocks of up to 20 birds (pers. obs.).

Spotted Pardalotes become less common at higher altitudes in Victoria during winter (Emison *et al.* 1987) and the winter increase of this species is likely to be a result of an influx of non-breeding birds from higher altitudes and possibly Tasmania, although Griffioen (2001) did not find evidence of significant movement of this species out of Tasmania.

The lower abundance of Willie Wagtail in May-July (Table 3c) may be explained by the use of more open environments for foraging at these times. Blakers *et al.* (1984) and Emison *et al.* (1987) reported no large-scale seasonal movements of this species. However, Griffioen (2001) identified evidence of local movements and that Willie Wagtails were generally more common in summer than winter in Victorian censuses for the Australian Bird Count.

Grey Fantails were generally scarce and sometimes absent altogether during winter. Part of the population moves northward in autumn (Blakers *et al.* 1984; Griffioen 2001). There were no winter records of Grey Fantails at the study site in 1991 and only small winter numbers in other years.

The Yellow-faced Honeyeater is a spring-summer migrant to many Victorian open forests (Emison *et al.* 1987). Large numbers migrate each autumn to the central, east coast of Australia, but this movement appears to be sourced from birds moving out of eastern Victoria and patterns in western Victoria are less clear (Griffioen 2001). The temporal pattern of abundance of Yellow-faced Honeyeaters was very similar to the Fuscous Honeyeater and it is conceivable that both species moved locally. The lower winter numbers of Yellow-faced and Fuscous Honeyeaters (Table 3c) could be a result of the absence of winter-flowering eucalypts in the remnant (stands of winter-flowering Yellow Gum *Eucalyptus leucoxylon* occur in nearby remnants). Both species are common in winter in nearby box-ironbark forests in central-west Victoria (including Jallukar State Forest, only 7 km away), when flowering eucalypts attract many non-breeding visitors (Mac Nally and McGoldrick 1997).

*Use of the remnant by irregular visitors*

Birds such as the Eastern Spinebill, Musk Lorikeet and Purple-crowned Lorikeet visited the site in large numbers at times when nectar was abundant, with each 'flowering event' attracting a different group of nectar feeders. The lack of a seasonal pattern in the abundance of these birds is attributable to the sporadic flowering of the eucalypts, especially the Long-leaved Box and Scent-bark (pers. obs.).

This patch was probably one of many used by these birds during the study period as resources became available across the landscape (see Lambeck and Saunders 1993). These irregular visitors were clearly capable of moving freely between this and other remnants as food availability fluctuated.

The Musk, Purple-crowned and Little Lorikeets are all considered nomadic, appearing when eucalypts flower and showing no apparent seasonality (Blakers *et al.* 1984). Emison *et al.* (1987) reported that Eastern Spinebills were recorded more often in winter at lowland sites in Victoria. In the Moyston area they are most often sighted in autumn and winter (pers. obs.), but the great numbers seen in March 1991 (Fig. 2i) in response to flowering Scent-barks both in this remnant and others in the area was conspicuously different to other years. Another major influx of Eastern Spinebills (also in response to Scent-bark flowering) occurred at the study site in the autumn of 1997 (pers. obs.).

The lack of a seasonal pattern for the White-naped Honeyeater *Melithreptus lunatus* (Table 3d) is difficult to explain as the species is considered a latitudinal and altitudinal migrant in eastern Australia (Emison *et al.* 1987). Unlike the other irregular visitors, this species did not appear to respond to flowering events (pers. obs.).

#### *The resident population*

The resident population was typical of a woodland avifauna, with a significant component of small insectivores and several species of honeyeaters. The high species richness of the resident bird population can be attributed to the diversity of habitats (heathy woodland, riparian woodland and native grassland) and the geographical location of the site. The resident population included habitat generalists (Australian Magpie, Black-faced Cuckoo-shrike), species with ranges that extend into wetter habitats (Crimson Rosella, White-throated Treecreeper) and birds of woodlands and drier habitats (Black-chinned Honeyeater, White-bellied Cuckoo-shrike).

The presence of thickets of Hedge Wattle, a dense and prickly shrub, explains the high densities for species such as the Superb Fairy-wren, Red-browed Finch, Eastern Yellow Robin and White-browed Babbler (Table 3a). All four species are ground feeders but utilized Hedge Wattles for shelter and nesting (pers. obs.).

#### *Changes in the resident population*

##### ARRIVALS

The White-browed Scrubwren was an established resident by the survey's completion and is still regularly recorded at the site (pers. obs.). This species is found in the dense cover of Hedge Wattle thickets.

##### DISAPPEARANCES

The author has visited the study site frequently since the completion of the survey. The Hooded Robin and Buff-rumped Thornbill, two species that disappeared during the survey, have not returned. One species that was a resident during the survey, the Speckled Warbler, has since disappeared. The Southern Whiteface, classified as a

resident during the survey, has not been recorded since 1997 and may have also disappeared, although the species often foraged in semi-wooded farmland to the south of the remnant and may still be present in the area.

#### *Woodland bird decline*

The disappearance of these birds represents a relatively small loss in the overall species richness of the resident population but a significant loss in the diversity of species that are characteristic of woodlands and drier habitats. The remaining resident woodland-dependent species are the Black-chinned Honeyeater, Jacky Winter, White-browed Babbler, White-bellied Cuckoo-shrike, Restless Flycatcher and possibly the Southern Whiteface. The current status of the Diamond Firetail is undetermined. The species was recorded a number of times from 1990 to 1992, including three records in this study. The species subsequently disappeared before its status could be determined. It was not recorded for eight years, until a sighting of one bird was made in November 2000, and another single bird in April 2001.

Three of the four species (the Buff-rumped Thornbill is the exception) that have disappeared from this study site are of conservation concern in the temperate woodlands of Australia and have been identified as being in decline in woodlands in Victoria (Robinson 1994), the Adelaide region of South Australia (Paton *et al.* 1994) and the temperate agricultural zone of New South Wales (Barrett *et al.* 1994; Reid 1999). Dow (1996) noted 'evidence of declines in local populations' of all four species in Queensland.

There are important similarities among the Speckled Warbler, Hooded Robin, Buff-rumped Thornbill and Southern Whiteface. They are all ground nesters and/or ground feeders and prefer habitats of an open nature with a sparse grassy ground layer with coarse woody debris. All (with the exception of the whiteface) require at least a few shrubs to nest either in or under. These similarities suggest that similar factors have contributed to their disappearance. Paton *et al.* (1994), Robinson and Traill (1996) and Reid (1999) noted that many of the species declining in temperate woodlands were ground feeders. Freudenberger (1999) found that the Speckled Warbler and Hooded Robins were the most sensitive of woodland birds in the Canberra area and that they occurred only in relatively structurally complex habitats.

The habitat quality of the remnant has changed little since the beginning of the study, apart from the harvesting of a pine plantation (and replacement with indigenous and non-indigenous native trees). Hedge Wattle thickets have invaded some areas that were open and grassy, but some older Hedge Wattle thickets have become more open. There have been no major weed invasion events and habitats that once supported these species have not changed noticeably. For example, the areas of Heathy Woodland at this site are similar to nearby patches of this vegetation type that still support Speckled Warblers.

The changes in the resident population identified here were elucidated from 54 monthly transects and a further

seven years of regular observations. Were the changes here a short-term phenomenon, a response to climatic conditions in the area? This possibility and the chance of recolonization of currently absent resident species from nearby remnants (as the White-browed Scrubwren appeared to achieve during the study) will be investigated by further transects in the remnant. This additional survey commenced in 2000 and will continue indefinitely.

Regular visits by the author to two nearby woodland remnants have confirmed that Hooded Robins, Speckled Warblers, Southern Whitefaces and Buff-rumped Thornbills are still present in the district (Table 4). The Nook Flora Reserve is 1.5 kilometres from the study site and the Jallukar State Forest is 7 kilometres away. It is interesting to note that two species identified by Reid (1999) as declining woodland species, the Brown Treecreeper and Painted Button-quail, are both residents in The Nook Flora Reserve and Jallukar State Forest but were not recorded at the study site despite the presence of similar habitat.

The larger size of the two nearby remnants listed in Table 4 may result in a greater capacity to continue to support these birds of concern. Freudenberger (1999) found that larger remnant size was a positive factor in the likelihood of detection of Speckled Warblers and Hooded Robins in the Canberra district. The small size of the remnant studied here increases the vulnerability of species with small populations and poor dispersal abilities. The actual reason for the disappearance of the three species from the study site may have been disease, predation or a minor habitat change but the small size of the remnant has reduced the possibility of the population recovering.

#### *Benefits of a long-term study*

A shorter survey (e.g. 12 months) of this remnant would not have detected a number of the trends that were ultimately recorded. A 12-month survey beginning in September 1989 would not have observed the importance of the remnant for large numbers of nectarivores. The flowering levels of River Red Gum and Scent-bark vary greatly from year to year at this site (pers. obs.). The large numbers of Purple-crowned and Musk Lorikeets and Eastern Spinebills in response to eucalypt flowering did not occur until the second year of study. The study site is evidently suitable habitat for the rare Painted Honeyeater; a pair stayed for nearly three months from October 1991, more than two years after study began.

This study identified the composition of the resident population and detected seasonal changes in abundance among several species. Influxes of large numbers of several species were identified, illustrating the temporal importance of the remnant for these species. Significantly, the study established 'resident' status for species (Hooded Robin, Buff-rumped Thornbill, Speckled Warbler) that are no longer present. This recent loss of formerly resident species is one example of a continental decline of woodland birds as the long-term effects of habitat loss come into effect (Robinson and Traill 1996). Most remnants such as this will continue to lose species if land management in these landscapes is not altered to alleviate the problem (Robinson and Traill 1996; Reid 1999).

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