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TEMPORAL AND SPATIAL VARIATIONS IN DENSITY OF LANDBIRDS AT AN URBAN BUSHLAND RESERVE

K. A. WOOD

7 Eastern Avenue, Mangerton, NSW 2500

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INTRODUCTION

Densities of landbirds have been estimated in heathlands (Pyke 1983), woodlands (Ford and Bell 1981; Ford *et al.* 1985; Gilmore 1985; Keast 1985; Wonarski 1985; Arnold *et al.* 1987) and forests throughout Australia (Recher *et al.* 1971; Bell 1980; Loyn 1980; Shields and Recher 1984; Wardell-Johnson 1984; Collins *et al.* 1985; Kavanagh *et al.* 1985; Pyke 1985; Shields *et al.* 1985). To perform these estimates, standard procedures were adopted (Pyke and Recher 1984; Bell and Ferrier 1985) and the surveyed plots varied in size from a circular area of 0.13 ha (Pyke

1983) to a long rectangular transect of 58 ha (Collins *et al.* 1985). Within each plot, it was implied (or assumed) that the habitat was homogeneous.

Comparisons in bird density can be made between similar habitats in different places and between different habitats. But for these comparisons to be meaningful, variations in density which occur with month of year and in particular pockets of the habitat should be considered. The aim of the present study was to quantify these variations in an urban reserve with a mosaic of different microhabitats.

STUDY AREA AND METHODS

Puckeys Reserve (Fig. 1) is a 43.5 ha coastal sand-dune and estuarine wetland located c. 2.5 km from the central business district of Wollongong. It is dominated by 8 m sand hills near the beach and relatively large patches of banksia-eucalypt forest (22% area), closed sedgeland (18% area) and grasslands (22% area). The hind dunes support *Banksia integrifolia*, *Eucalyptus botryoides*, *Leptospermum laevigatum* and a shrubby understorey (shrub layer cover 80–90%). Low areas are dominated by casuarina and paperbark forest. For the purpose of the study, eight sub-areas A–E and X–Z were recognized (Fig. 1). Area searches (Pyke and Recher 1984) were conducted in each of the twelve calendar months between July 1984 and February 1986 ($n = 12$). Surveys were commenced before 10:00 h (typically before 09:00 h) and the average time taken to survey the eight sub-areas was 6 hours (range 5–7.5 hrs). All birds seen or heard were recorded while walking slowly. "Squeaking" was frequently used to aid detection. The study area and methods have been described in detail elsewhere (Wood 1993).

RESULTS

In the terrestrial area of 37.8 ha, a total of 4 928 individuals of 62 landbird species was counted. The average number of landbird species and individuals censused in each survey was 25 (range 16–35) and 410 (range 282–495) respectively. Twenty species were present in six or more surveys.

Density variations with month of year

The overall density of all 62 landbird species ranged from 7.46 birds per ha in March 1985 to 13.1 birds per ha in February 1986 (average = 10.81 birds/ha, Table 1). Of the 20 species which were present in six or more surveys (Table 1), 11 species had a minimum density of zero (absent in at least one calendar month). The other nine

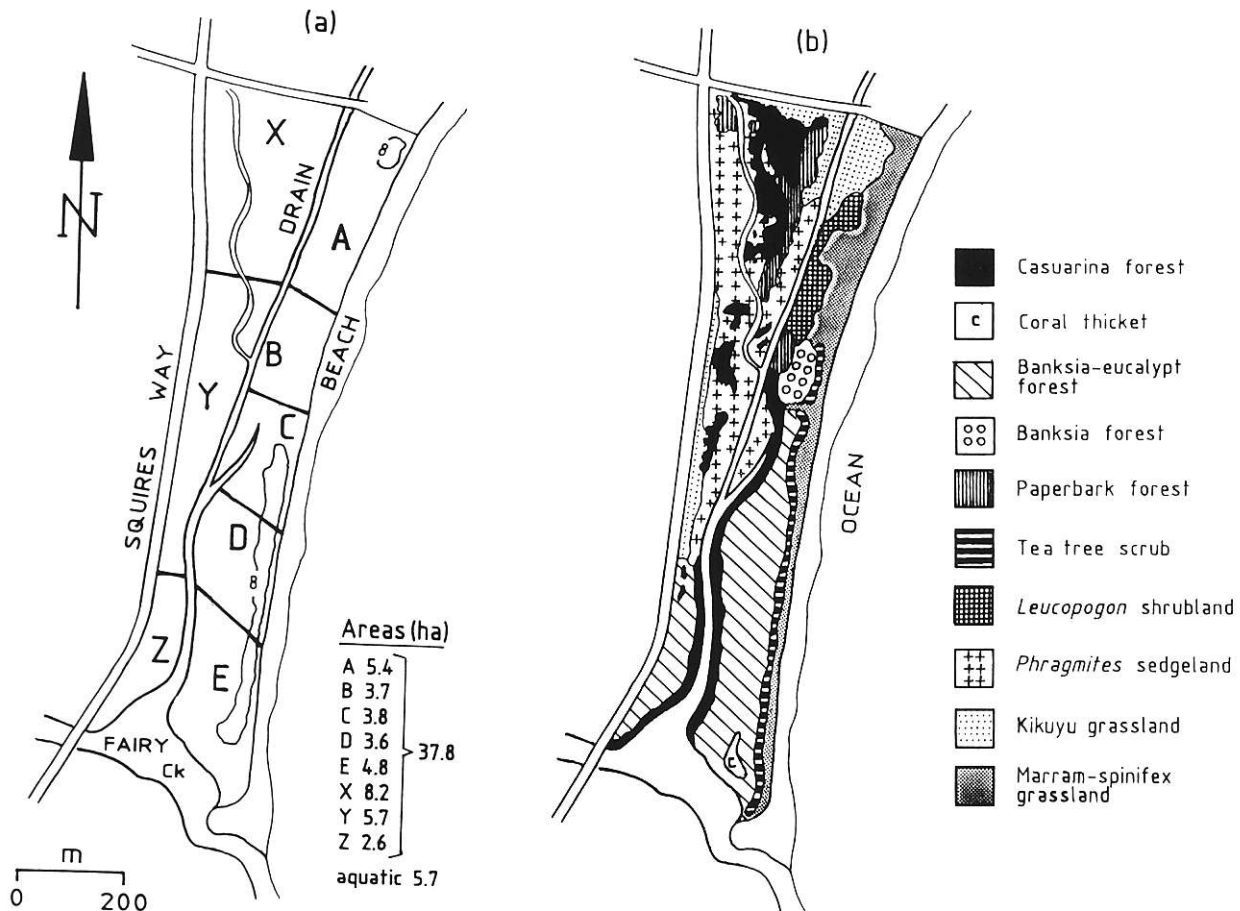


Figure 1. Puckeys Reserve showing (a) geography, sub-areas, 8 m contour above mean sea level, and (b) vegetation communities.

species were present in every survey. Among those species, the largest monthly variations in density were 0.77 to 5.16 birds/ha for New Holland Honeyeater *Phylidonyris novaehollandiae*, 0.69 to 3.62 birds/ha for Silvereye *Zosterops lateralis*, 1.24 to 2.35 birds/ha for Superb Fairy-wren *Malurus cyaneus* and 0.32 to 1.4 birds/ha for White-browed Scrubwren *Sericornis frontalis*. For these four species the density ranges expressed as a percentage of the average (refer Table 1) were: New Holland Honeyeater 27–179 per cent, Silvereye 40–209 per cent, Superb Fairy-wren 72–137 per cent, White-browed Scrubwren 34–149 per cent.

Density variations with microhabitat

The influence of microhabitat on density is shown in Table 2. Thirteen species were recorded with highest densities in banksia-eucalypt forests in sub-areas C, D or E and six other species had highest densities in sub-area Z which was also predominantly banksia-eucalypt forest. None of the landbird species in Table 2 had highest densities in grasslands (sub-area A), sedgeland (sub-area Y) or mixed casuarina forest-sedgeland (sub-area X).

Only two species, Superb Fairy-wren and New Holland Honeyeater were recorded in all sub-areas. Their highest densities were 11.54 birds per ha in sub-area Z and 20 birds per ha in sub-area E respectively. For these two species, the range of highest densities between microhabitats was 0.74 to 11.54 birds per ha (a ratio of 15.6 to 1) for the former species and 0.56 to 20 birds per ha (a ratio of 36 to 1) for the latter. Other species with a wide range of highest densities were Silvereye (range 0–14.79 birds/ha) and Red-whiskered Bulbul *Pyconotus jocosus* (range 0–4.17 birds/ha).

DISCUSSION

This study was conducted with an awareness of biases in the survey method (Keast 1984; Pyke and Recher 1984) and a need to minimize biases where possible. It showed that monthly variations in density were substantial. Such variations could be due to availability of food, such as nectar (Collins and Briffa 1982; Ford 1983; Pyke and Recher 1988), changes in social organization of the species present (McFarland and Ford 1991), different patterns of residency (Pyke *et al.* 1989)

TABLE 1

Overall density (birds/ha) of 20 landbird species (and all landbirds) in the terrestrial area of Puckeys Reserve (37.8 ha) during area searches in each calendar month. Maximum values are shown in parenthesis, minimum values are underlined, unless zero.

Species*	Jul. 1984	Oct. 1984	Dec. 1984	Mar. 1985	Apr. 1985	May 1985	Jun. 1985	Aug. 1985	Sep. 1985	Nov. 1985	Jan. 1986	Feb. 1986	Average density
Spotted Turtle-dove	0.11	0	0.13	0.05	0	0.05	0.08	0.11	0.19	(0.29)	0.24	0.13	0.11
Fan-tailed Cuckoo	0.03	0.05	0.03	0	0.05	0.05	0.08	0.05	(0.11)	0.03	0	0.03	0.04
Horsefield's Bronze-cuckoo	0.03	0.05	0.03	0	0.03	0	0.05	0	(0.11)	0.08	0	0	0.03
Red-whiskered Bulbul	0.05	0.11	0.85	0.05	0.19	0.08	0	0.11	0.08	0.74	(1.4)	1.14	0.40
Eastern Yellow Robin	0.21	0.32	0.26	0.21	0.11	0.03	0.08	0.19	0.26	(0.37)	0.16	0.32	0.21
Grey Fantail	0	(0.19)	0	0.03	0.03	0	0	0	0.13	(0.19)	0.13	0	0.06
Eastern Whipbird	0.03	0.19	0.13	0.16	0.08	0.03	0.03	0.11	0.19	(0.21)	0.13	0.11	0.11
Golden-headed Cisticola	0.34	0.34	0.21	0.03	0.24	0.21	0.29	0.05	0.03	(0.42)	0.13	0.32	0.22
Superb Fairy-wren	1.32	1.35	2.28	1.83	1.59	1.59	1.24	1.27	2.01	(2.35)	1.75	2.09	1.72
Variegated Fairy-wren	0.24	0.50	0.37	0	0.19	0	0.08	0.11	0.05	0	0.56	(0.66)	0.23
Southern Emu-wren	0.05	0.13	0.19	0.24	0.13	0.19	0.16	0.05	0.13	0.05	0.26	(0.40)	0.17
White-browed Scrubwren	(1.40)	1.22	1.03	0.87	0.90	0.69	0.32	0.93	1.40	1.38	1.03	1.08	0.94
Yellow Thornbill	0.11	(0.69)	0.53	0.40	0.32	0.58	0.56	0.42	0.40	0.50	0.37	0.42	0.44
Little Wattlebird	0.16	0.03	0	0	0	0	0.11	0.08	(0.32)	0.08	0.08	0.16	0.08
Lewin's Honeyeater	0.11	0.03	0.05	0	(0.32)	0.21	0.13	0.19	0.05	0.08	0	0.16	0.11
New Holland Honeyeater	3.73	1.64	1.35	2.12	5.05	(5.16)	4.05	3.60	2.78	1.22	0.77	3.17	2.89
Eastern Spinebill	0.05	0.03	0.08	0	0	0.08	0.13	(0.16)	0	0	0.03	0	0.05
Spotted Pardalote	0.08	0.05	0	0	0.19	0.13	(0.24)	0.16	0.05	0.13	0	0.05	0.09
Silvereye	1.19	1.61	2.94	0.87	1.19	1.88	1.06	0.69	1.64	(3.62)	2.91	1.11	1.73
Red-browed Firetail	0	0.08	0	0.45	0.93	(1.35)	0.48	0.21	0.16	0.11	0.26	1.24	0.44
All 62 landbird species	9.05	10.40	11.38	7.46	11.51	12.78	9.44	8.92	12.09	12.94	10.66	(13.10)	10.81

*Scientific names are given in Table 2.

TABLE 2

Highest density (birds/ha) of 20 landbird species in sub-areas A–E and X–Z at Puckeys Reserve during area searches in each calendar month between July 1984 and February 1986. Maximum values for each species are shown in parenthesis, minimum values are underlined, unless zero.

Species	A 5.4 ha	B 3.7 ha	C 3.8 ha	D 3.6 ha	E 4.8 ha	X 8.2 ha	Y 5.7 ha	Z 2.6 ha
Spotted Turtle-dove <i>Streptopelia chinensis</i>	0	0	(0.79)	0.56	0.63	0.49	0.35	0.38
Fan-tailed Cuckoo <i>Cuculus pyrrhophanus</i>	0	0.27	(0.53)	0.28	0.42	0.12	0	0.38
Horsefield's Bronze Cuckoo <i>Chrysococcyx basalis</i>	0	0.27	0.26	(0.56)	0.21	0.12	0.18	0.38
Red-whiskered Bulbul <i>Pyconotus jocosus</i>	0	0.27	2.63	3.61	(4.17)	1.46	0.70	3.85
Eastern Yellow Robin <i>Eopsaltria australis</i>	0	0.81	0.79	0.83	0.42	0.61	0.35	(1.54)
Grey Fantail <i>Rhipidura fuliginosa</i>	0	0.54	0.53	0.28	0.63	0.24	0	(0.77)
Eastern Whipbird <i>Psophodes olivaceus</i>	0	0	0.53	0.56	0.21	0.49	0.35	(1.15)
Golden-headed Cisticola <i>Cisticola exilis</i>	0.93	0.27	(1.58)	0	0	0.98	1.40	0
Superb Fairy-wren <i>Malurus cyaneus</i>	<u>0.74</u>	3.78	6.58	4.44	5.21	1.95	1.75	(11.54)
Variegated Fairy-wren <i>Malurus lamberti</i>	0	2.16	1.84	2.22	0	0.85	0.70	(4.62)
Southern Emu-wren <i>Stipiturus malachurus</i>	0	0.81	0.79	0.56	0	0.49	1.40	(1.54)
White-browed Scrubwren <i>Sericornis frontalis</i>	0	1.35	3.68	2.22	(3.96)	1.71	1.05	3.08
Yellow Thornbill <i>Acanthiza nana</i>	0	0	1.05	(3.33)	1.04	0.85	0.88	2.69
Little Wattlebird <i>Anthochaera chrysoptera</i>	0	(1.08)	0.53	0.83	0.63	0	0.18	0.38
Lewin's Honeyeater <i>Meliphaga lewinii</i>	0	0	0.26	1.11	(2.29)	0.24	0	0.77
New Holland Honeyeater <i>Phylidonyris novaehollandiae</i>	<u>0.56</u>	12.16	5.79	10.00	(20.00)	3.05	7.02	12.31
Eastern Spinebill <i>Acanthorhynchus tenuirostris</i>	0	0	0	(1.39)	0.42	0.37	0	0.38
Spotted Pardalote <i>Pardalotus punctatus</i>	0	0	(1.32)	1.11	1.04	0	0	1.15
Silveryeye <i>Zosterops lateralis</i>	0	4.05	7.11	8.33	(14.79)	3.05	1.75	8.46
Red-browed Firetail <i>Emblema temporalis</i>	0	0	0.53	2.50	(6.67)	3.29	0	3.46

or recruitment of juveniles into the population. The results presented suggest that for density estimates to be meaningful, they should be qualified as either single measurements in a particular month, or as average, maximum and minimum values, calculated from multiple measurements over a nominated period of time.

Spatial variations in density were also substantial and could be due to partitioning of resources

(Ford and Paton 1976; Paton 1986; Brooker *et al.* 1990) or species adaptation for particular niches (Pyke 1980; Cameron 1985; Ford *et al.* 1986; Recher 1989). In suburban Brisbane, Catterall *et al.* (1989) found that most forest birds were habitat specialists. At Puckeys Reserve, most landbirds were also habitat specialists, linked to the various microhabitats for food, nesting or protection (Wood 1993). Numbers of honeyeaters increased substantially in autumn and winter

when banksia and coral trees were rich with nectar (Wood 1993). It is therefore not surprising that the highest densities of New Holland Honeyeaters (20 birds/ha) and Silvereyes (14.79 birds/ha) were recorded in sub-area E, the only portion of the reserve with both banksia and coral trees. The highest reported densities for these species are 50 birds per ha for the New Holland Honeyeater (Paton 1986) and 25 birds per ha for the Silvereye (Kikkawa and Wilson 1983).

Recher (1985) graphed the results of studies in a variety of large-scale (broadly homogeneous) plots throughout south-eastern Australia and showed that bird densities (all species combined) in different plots with similar habitats were variable. He suggested that densities should be used as indices of abundance rather than rigorous absolute values. In the present study, there was a wide range of densities for particular species in the various microhabitats of a small plot. It therefore seems likely that fine-scale differences in bird densities, of all species combined and particular species, might occur in large-scale plots which are broadly homogeneous. This possibility, as well as the likelihood of monthly variation, should be considered when bird densities are estimated or compared.

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