

CHANGES WITH TIME OF DAY IN THE SPECIES AND NUMBERS OF BIRDS SEEN IN WANDOO WOODLAND

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Birds in four 2 ha portions of a 200 ha Wandoo *Eucalyptus wandoo* woodland were censused either in the first two hours or second two hours after sunrise. Many (39 percent) of the species were recorded in only one of the two time periods, while the numbers of half of the species also differed between the periods.

The birds in a separate four hectare portion of the woodland were censused nine times a day at hourly intervals from dawn on three days (13 January, 7 May and 10 September 1981). The species, number of species and number of individuals per species recorded, changed with the time of day. The number of species recorded was relatively constant (10) over the first four hours, then fluctuated. However, one census detected only 50 percent of the species found over nine censuses. Fifty percent of species were recorded at only one or two censuses.

Reasons for these findings and their bearing on future bird census work are discussed.

INTRODUCTION

It is widely recognized that in any bird census the number of birds and species recorded will depend on the technique used (Ratkovsky and Ratkovsky 1979, Arnold 1984, among many others), the time spent in the area (Keast 1984), the weather conditions (Ratkovsky and Ratkovsky 1979, Robbins 1981a), the number of observers (Preston 1979), and possibly the time of day (Ratkovsky 1978, Shields 1977, 1979, Pomeroy and Tengetho 1986). The number of species seen increases asymptotically with the time spent in an area. For example, Keast (1984) found that in dry sclerophyll forest in New South Wales in spring, 90 percent of the 22 species present in one hectare of the forest had called during 20 minutes of the period of maximum morning song. Ratkovsky (1978) found no significant differences in the number of species recorded in sclerophyll forest in Tasmania between 0700 and 1200 h in spring; however, the number of species recorded decreased in early afternoon and increased later.

Most of the studies cited have been concerned with the number of species seen at any one census, and not with whether the species recorded changed over a day nor whether the number of birds of a species recorded changes during the day, although Shields (1977) examined the latter aspect over a limited period of the day in New Jersey, United States. He found significant changes in the number of certain species that were recorded, and advised (Shields 1979) that the timing of censuses should be varied to allow for the differences in the diurnal activity patterns in different species. Verner and Ritter (1986), working in California, came to a similar conclusion. Robbins (1981b) analysed all the data from the North American Breeding Bird Survey from 1965 to 1979 and found large diurnal changes in activity patterns of different species. I censused 12 two-hectare sites of Wandoo woodland frequently (Arnold *et al.* 1987), varying the time of day at which a site was censused. In the same area of woodland, a four-hectare site was censused at

hourly intervals on three occasions. The data provided information on changes within a day in the number of birds and species recorded.

METHODS

In the study reported by Arnold *et al.* (1987), the sites were censused in random order in the four hours from sunrise. Four of the sites were censused 11 times between May 1980 and July 1981, comprising five visits in the first 2 h after sunrise and six visits in the second 2 h (for the other sites, the number of visits was not as evenly distributed between these two time periods). The data from these censuses provide one comparison of time of day. Weather conditions varied from census to census but not greatly within days, that is, each day was fine with light winds.

Another four hectare area (100 m × 400 m) of Wandoo woodland within the same 200 ha remnant was censused on three occasions in one year (13 January, 7 May and 10 September, 1981). On each occasion two observers recorded and mapped the birds at hourly intervals for the nine hours from dawn. The census technique described by Arnold (1984) and Arnold *et al.* (1987) was used. Each site was marked out into strips 100 m long and 12.5 m wide. The two observers walked slowly along the strips observing 12.5 m either side of them, deviating from their line when necessary to identify birds. It took the observers 30 to 40 minutes to complete each census. Identification was by sight, sound or both, and only birds that could be positively identified were recorded. The days were fine with little wind.

RESULTS

Comparison of birds recorded 0-2 and 2-4 h after sunrise

A similar number of species was recorded in each time period, but of the 31 recorded, only 19 were present in both periods. The total number of birds recorded was 29 percent higher 2-4 h after sunrise. There were large differences in the number of certain species recorded in the two periods (Table 1). Notable was that fewer Port Lincoln Parrots, Australian Magpies, Australian Ravens and bronze wing pigeons (both species) were

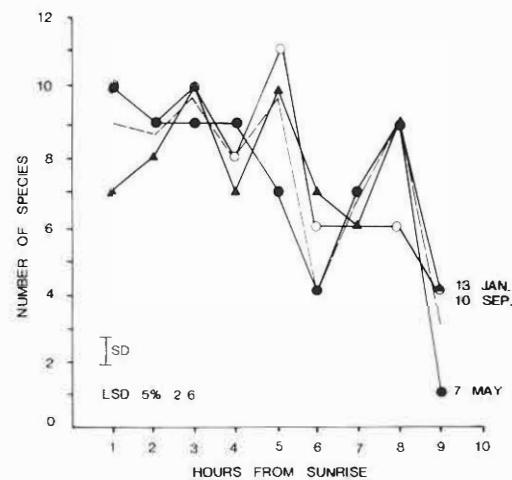


Figure 1. Changes in the number of species recorded with time since sunrise.

recorded 2-4 h after sunrise, but there were more robins, thornbills, Weebills, and Singing and Brown-headed Honeyeaters.

Number of species recorded over a day

Figure 1 shows that the number of species recorded fluctuated during each day. The fluctuation was more pronounced in May when the number decreased in the fifth and sixth hours and then increased in the seventh and eighth hours before declining sharply in the ninth hour. These fluctuations were statistically significant ($P < 0.05$).

The cumulative number of species recorded increased curvilinearly (Fig. 2), with the asymptote being twice the number recorded in a single census. The asymptote was reached after five to seven censuses.

Frequency of recording species during a day

The distribution of the frequency of recording a species in a day (Fig. 3) was bimodal, with half the species being recorded at only one or two censuses in a day.

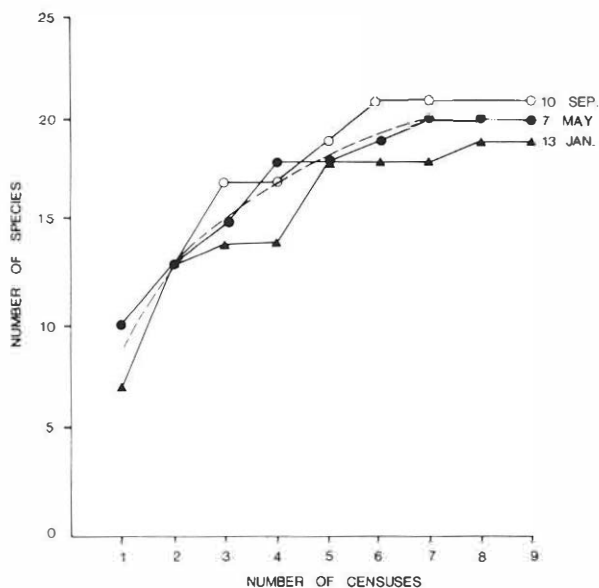


Figure 2. The cumulative number of species recorded.

Within a census, a species might be sighted one or several times, and this was related (Fig. 4) to the total number of individuals of a species recorded over the nine censuses. The relationship is curvilinear because the more abundant species were seen in larger groups.

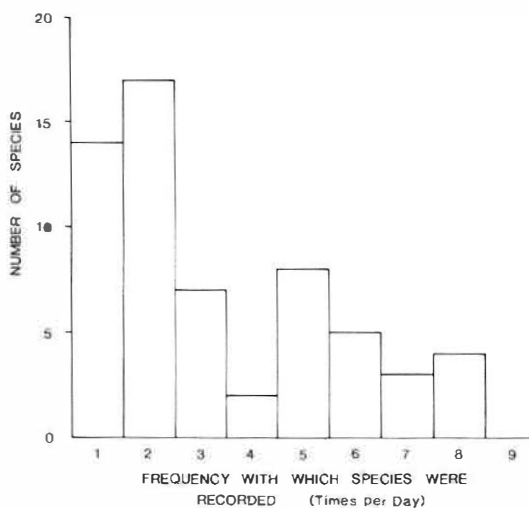


Figure 4. Relationship between the number of sightings of species in a day and the total number of birds recorded.

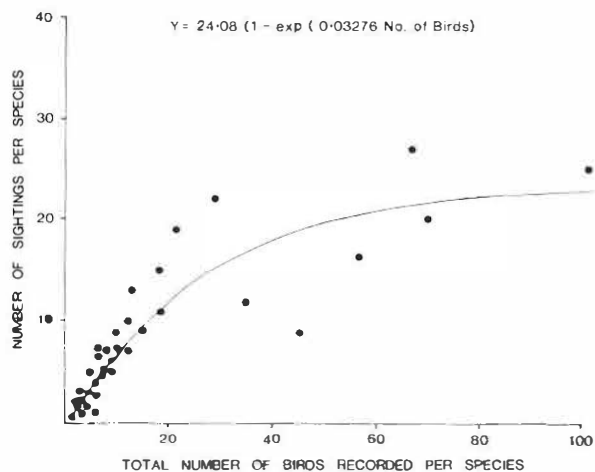


Figure 3. Frequency distribution of number of times species were recorded.

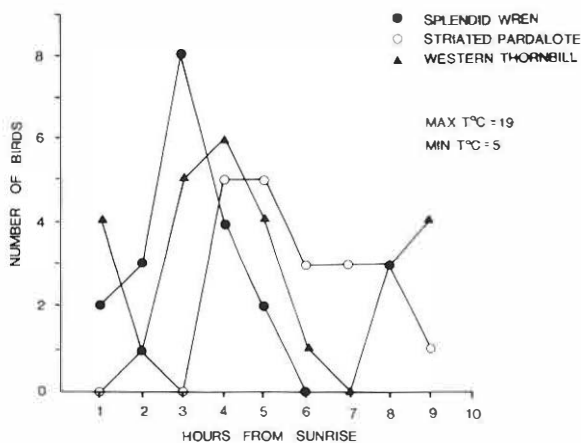


Figure 5. Changes during a day in the recorded number of Splendid Fairy-wrens, Striated Pardalotes and Western Thornbills.

Variation within the day in number of birds recorded per species

The number of individuals of a species varied greatly from census to census within a day, as illustrated in Figure 5. From zero to eight Splendid Fairy-wrens were recorded on that day, with the numbers recorded following a distinct pattern. Variations were even greater for species that were seen in parties, for example, Yellow-rumped Thornbills; for this species the number recorded in those censuses, when it was found, ranged from 1 to 32 birds on the January census day.

DISCUSSION

These results support those of other workers in that a single visit to a site will detect less than 50 percent of the species using the site in a day, and that censusing at a fixed time after sunrise will give a biased estimate of the number of birds of particular species that are using the site. The problems are that some species, like parrots, magpies and ravens, used the area largely for resting during part of the day. These species feed largely on adjacent farmland and, presumably, that is why their numbers were lower later in the

TABLE 1

Comparison of mean number of birds of different species recorded in four sites from 0-2 h after dawn with the number recorded 2-4 h after dawn. Species arranged in order of increasing magnitude of change, regardless of direction.

Species	0-2 h	2-4 h	Change
Golden Whistler <i>Pachycephala pectoralis</i>	0.3	0.4	+0.1
Silvewren <i>Zosterops lateralis</i>	0.3	0.4	+0.1
Striated Pardalote <i>Pardalonus striatus</i>	1.1	1.0	-0.1
Splendid Fairy-wren <i>Malurus splendens</i>	0.5	0.6	+0.1
Southern Boobook <i>Ninox novaeseelandiae</i>	0.3	0.2	-0.1
Red-capped Robin <i>Petroica goodenovii</i>	1.8	2.0	+0.2
Western Gerygone <i>Gerygone fusca</i>	1.6	1.4	-0.2
Redthroat <i>Pyrholaemus brunneus</i>	0	0.2	+0.2
Laughing Kookaburra <i>Dacelo novaeguineae</i>	0	0.2	+0.2
Richard's Pipit <i>Anthus novaeseelandiae</i>	0	0.2	+0.2
Brown Honeyeater <i>Lichmera indistincta</i>	3.9	4.2	+0.3
Western Yellow Robin <i>Eopsaltria griseogularis</i>	0	0.4	+0.4
White-naped Honeyeater <i>Melithreptus lunatus</i>	0	0.4	+0.4
Fan-tailed Cuckoo <i>Cuculus pyrrhophanus</i>	0	0.4	+0.4
Elegant Parrot <i>Neophema elegans</i>	0	0.4	+0.4
Scarlet Robin <i>Petroica multicolor</i>	0.3	0.8	+0.5
Grey Shrike-thrush <i>Colluricincla harmonica</i>	0.3	0.8	+0.5
Grey Fantail <i>Rhipidura fuliginosa</i>	2.6	3.2	+0.6
Bronzewing pigeon <i>Phaps elegans</i> + <i>P. chalcoptera</i>	1.6	0.6	-1.0
Rufous Whistler <i>Pachycephala rufiventris</i>	1.1	2.2	+1.1
Western Thornbill <i>Acanthiza inornata</i>	1.1	2.2	+1.1
Singing Honeyeater <i>Meliphaga virescens</i>	0.3	1.4	+1.1
Tree Martin <i>Cecropsis nigricans</i>	0	1.2	+1.2
Little Wattlebird <i>Anthochaera chrysoptera</i>	1.3	0	-1.3
Weebill <i>Smicronis brevirostris</i>	1.6	3.4	+1.6
Australian Magpie <i>Gymnorhina tibicen</i>	1.8	0	-1.8
Brown-headed Honeyeater <i>Melithreptus brevirostris</i>	0	2.0	+2.0
Australian Raven <i>Corvus coronoides</i>	2.1	0	-2.1
Yellow-rumped Thornbill <i>Acanthiza chrysorrhoa</i>	5.0	8.0	+3.0
Port Lincoln Parrot <i>Barnardius zonarius</i>	5.3	1.6	-3.7
Varied Sittella <i>Daphaenositta chrysoptera</i>	0	5.0	+5.0

morning. Other species, like the Yellow-rumped Thornbill and Brown-headed Honeyeater, foraged over a larger area than four hectares in the course of nine hours and so are not always present. Some species were resident and territorial (robins, Splendid Fairy-wren, Grey Shrike-thrush), but their territories were not wholly within the area so that they also could be absent for part of the day. In addition to the effects of the daily movement of birds on the numbers actually present, there is the problem of changes in detectability during the day. This was certainly the case with the Splendid Fairy-wren, Striated Pardalote and Rufous Treecreeper, which were usually detected by their calls rather than on visual contact. Thus the change in the number of wrens recorded during the day in September (Fig. 5) was probably partly due to a change in their detectability and partly to movements in and out of the area. Reference to the maps showed that they were in two different groups in different parts of the four hectare census area. One group was detected as being 2, 3, 3 and 4 in number in the first four censuses. The second group was not recorded in the first or second censuses, but as 5, 2 and 2 in the third, fourth and fifth censuses. This latter group was close to one edge of the area and could have moved in and out of the censused area. Failure to record any wrens in the last four censuses suggests that they either stopped calling or had moved out of the census area at that time of day.

The diurnal activity patterns of different species varies: thus the thornbills and Weebills in the four sites studied appeared to be more active 2-4 h after sunrise and so more were detected than 0-2 h after sunrise. Thus repeated censusing at different times of the day is necessary within a season to obtain accurate estimates (for example, ± 10 percent of the mean) of the number of species and the number of individuals of each species in an area, since seasonal changes usually occur in this type of woodland (Arnold *et al.* 1987). This is in agreement with Shields (1979) and Verner and Ritter (1986). Whether less variation would have been obtained if a larger census area had been used is unknown, but is worth examining, provided the scale of heterogeneity of habitat allows this. In typical Wandoo woodland, the habitat heterogeneity is such that four hectares are a large area of uniform habitat.

More birds are recorded using the 'area search' technique than when using the variable circular plot technique (Arnold 1984). If the latter technique is used, then it would be even more important to census more frequently to obtain accurate estimates of species richness and of number of individuals per species. The same argument applies if bird density is low. The whole question of frequency and timing of censuses depends on the objective of the census work, and this must be clear before decisions on frequency and method are made. These results indicate that five censuses at different times of the day are needed to record more than 90 percent of the species in a site during a particular time.

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REFERENCES

- Arnold, G. W. (1984). Comparison of numbers and species of birds in wandoo woodland obtained by two census methods. *In Methods of Censusing Birds in Australia*. Ed. by Davies, S. J. J. F. *Dept. Cons. and Envir. Perth WA. Bull.* 153: 15-18.
- Arnold, G. W., Maller, R. A. and Litchfield, R. (1987). Comparison of bird populations in remnants of wandoo woodland and in adjacent farmland. *Aust. Wildl. Res.* 14: 331-341.
- Keast, A. (1984). Assessment of community compositional species richness in contrasting habitats. *In Methods of Censusing Birds in Australia*. Ed. by Davies, S. J. J. F. *Dept. Cons. and Envir. Perth WA. Bull.* 153: 19-24.
- Pomeroy, D. E. and Tengetcha, B. (1986). A method of analysing bird distributions. *Afr. J. Ecol.* 24: 243-253.
- Preston, F. W. (1979). The invisible birds. *Ecology* 60: 451-454.
- Ratkovsky, A. V. (1978). The effect of time of day on bird activity. *Tas. Nat.* 55: 11-12.
- Ratkovsky, A. V. and Ratkovsky, D. A. (1979). A comparison of counting methods to obtain bird species numbers. *Notornis* 26: 53-61.
- Robbins, C. S. (1981a). Bird activity levels related to weather. *In Estimating Numbers of Terrestrial Birds*. Ed. by Ralph, C. J. and Scott, J. M. *Studies of Avian Birds No. 6*. Pp. 301-310.
- Robbins, C. S. (1981b). Effect of time of day on bird activity. *In Estimating Numbers of Terrestrial Birds*. Ed. by Ralph, C. J. and Scott, J. M. *Studies of Avian Birds No. 6*. Pp. 275-286.
- Shields, W. M. (1977). The effect of time of day on avian census results. *Auk* 94: 380-383.
- Shields, W. M. (1979). Avian census techniques: an analytical review. *In The role of insectivorous birds in forest ecosystems*. Ed. by Dickson, J. G., Conner, R. N., Flect, R. R., Kroll, J. C. and Jackson, J. A. Academic Press, New York. Pp. 23-51.
- Verner, J. and Ritter, L. V. (1986). Hourly variation in morning point counts of birds. *Auk* 103: 117-124.