A COMPARISON OF COUNTING METHODS TO OBTAIN BIRD SPECIES NUMBERS

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ABSTRACT

Stationary and walking counting methods to obtain numbers of bird species in survey work were compared under Tasmanian forest conditions. For short observation times, the stationary method was clearly inferior to walking at a brisk pace through the survey area. In unsheltered areas, windy conditions significantly reduced the number of species recorded compared with calm conditions in either fine or rainy weather. When time is short, a basic 10-minute walking unit will yield a reasonable percentage of the number of species present.

INTRODUCTION

The impetus for the present study came during a stay in New Zealand between September 1976 and April 1977, where one of us (DAR) was employed by the DSIR Applied Mathematics Division, and the other (AVR) pursued her vocation of bird observation. We came into contact with people employed to survey birds in forest areas and who were using the stationary count method advocated by Dawson & Bull (1975). As we had used a continuous walking method previously (Ratkowsky & Ratkowsky 1977), we became interested in undertaking a comparison of the two methods, in which we would consider factors such as forest type and weather. In Australia, both the stationary counting method (Driscoll 1977) and the walking method (Pattemore 1977) have been used, but neither of those authors made comparative tests of the two methods.

The present study was carried out after our return to Tasmania. Although their dominant trees are very different, both Tasmania and New Zealand have an impoverished island avifauna and information obtained in the Tasmanian forest on bird counting methods could be of relevance to New Zealand forest conditions as well. One should bear in mind the important distinction between bird observations made by amateur ornithologists and those conducted by professionals employed by government or government-funded bodies to learn about bird biology or to study the effects of forestry practices on bird populations. Time is usually of little importance to the amateur bird-watcher who is pursuing a recreational interest. The professional, on the other hand, working at public expense, often has only limited study time. It is essential therefore that counting methods be chosen which return a maximum amount of information in the available time. With these considerations in mind, the present study was directed towards obtaining information about bird numbers by considering time units of short duration, from five minutes to a maximum of thirty minutes.

An estimate of the number of birds in an area can be achieved either by counting individuals of given species, or by counting the number of different species. The counting of individuals can be achieved accurately with seabirds in a coastal seawatch situation where an unobstructed view is available (Marchant 1977), but it is our experience that this is virtually impossible in forest conditions where one must rely primarily upon aural, rather than visual, observation. In Tasmanian forest conditions, this difficulty has caused Pattemore (pers. comm.) to abandon the attempt to count individuals in favour of recording a complete species list in each 50 metre interval whilst walking along a transect length of 500 metres in wet sclerophyll forest (Pattemore 1978). The average species-frequency obtained from the ten counts was used as the basis for comparing different areas.

METHODS

The present study consists of three trials conducted consecutively. The first compares the stationary and walking methods during five minute sessions, the second involves walking counts over three different time sessions and in three different weather types, and the third examines the different effects of sheltered versus exposed environments upon half-hour walking counts along fixed transects. All trials were carried out near Hobart in the Mt Wellington Range, very familiar to the authors as a result of previous surveys (Ratkowsky & Ratkowsky 1976, 1977). Mt Wellington is 1270 m high and has a variety of environments, including dry sclerophyll forest, wet sclerophyll forest, gully communities, high elevation woodlands and treeless upper regions. No attempt was made to assess the number of individuals of a given species. A species was recorded as being present once only in a time trial irrespective of whether a single bird or a large flock was involved.

In all three trials, mostly aural but also visual identification was used, and the walking pace varied between about 3-6 km/h depending upon terrain, but was usually in the range 4-5 km/h. The trials were carried out between October and December 1977.

Trial 1: A comparison was made between 5-minute stationary counts and 5-minute walking counts. The stationary counts were made while standing or sitting quietly. The pair of counts was taken in each environment in random order.

Trial 2: In different weather types, walking counts were conducted as sessions of fifteen minutes duration with subtotals taken every five minutes. During the first five minutes, the total number of different species seen or heard was recorded. In the next five minutes, only the additional species not recorded in the first five minutes were entered. Similarly, in the last five minutes, only species not seen or heard in the previous ten minutes were entered. Results are reported as 5-minute, 10-minute and 15-minute counts. The weather was divided into three classes: (1) windy but fine (2) raining but not windy (3) calm and fine.

Trial 3: Three transects were chosen, each of which could be walked in approximately a half-hour. The first was in a dry sclerophyll forest under the lee of a mountain and thus sheltered from the prevailing westerly wind. The second transect was also in dry sclerophyll but was exposed to the prevailing wind, and the third transect was in a closed-canopy wet sclerophyll forest.

RESULTS

Trial 1: Mean values for the number of species for the 5-minute stationary count, the 5-minute walking count, the difference between them and its significance using Student's t-test, and the percentage by which 5-minute stationary is less than 5-minute walking are given in Table 1.

Trial 2: Mean values for each of the three walking times, 5-minutes, 10-minutes, and 15-minutes, are presented in Table 2 for the five vegetational zones and the three classes of weather studied. The three weather categories were: windy but fine (W); raining but not windy (R); and calm and fine (C). Rainy days unaccompanied by wind were less frequent than the other two weather categories. The coefficient of variation (CV), i.e. the standard deviation expressed as a percentage of the sample mean, is given in Table 3 for all vegetational zones and for weather types W and C, but not for R because of the small number of trials.

TABLE 1 — *Mean values for the number of species for the 5-minute* stationary count S(5), the 5-minute walking count W(5), their difference, and the percentage by which S(5) is less than W(5), Trial 1.

Vegetation Zone	Number of counts	S(5)	W(5)	W(5)−S(5)	Percent diff.
Treeless upper regions	15	1.3	2.0	0.7*	35
High elevation woodlands	19	2.7	5.7	3.0***	53
Gully communities	15	5.8	9.5	3.7***	39
Wet sclerophyll	15	4.9	8.0	3.1***	39
Dry sclerophyll	15	5.3	8.9	3.6***	40

* $p<0.05$;
*** $p<0.001$

TABLE 2 — Mean values for the number of species for three walking times in three different weather types, Trial 2.

Vegetation Zone	Weather	Number of counts	W(5)	W(10)	W(15)	E[W(15)]
High elevation woodlands	W	18	2.0	3.4	4.3	4.2
	R	6	6.0	7.8	8.8	8.9
	C	15	6.9	8.2	8.9	9.0
Wet sclerophyll (**Eucalyptus delegatensis**)	W	17	5.5	7.6	8.9	8.8
	R	6	7.8	11.0	12.5	12.9
	C	15	9.3	11.1	12.6	12.2
Wet sclerophyll (**Eucalyptus obliqua**)	W	16	8.3	11.3	12.9	13.1
	R	9	13.2	15.7	17.0	17.2
	C	15	12.7	15.7	17.3	17.5
Gully communities	W	15	9.0	12.0	13.3	13.8
	R	6	12.5	16.0	17.5	18.0
	C	15	12.6	15.6	17.3	17.4
Dry sclerophyll	W	15	7.3	9.7	11.6	11.1
	R	7	12.1	14.9	16.7	16.5
	C	15	11.1	14.8	16.0	17.0

Trial 3: Mean values for the number of species in each of the three transects are given in Table 4 for calm and windy weather, together with an assessment of the significance of the difference between means using Student's t-test.

TABLE 3 — Coefficients of variation (CV) for the results from Trial 2 for windy (W) versus calm (C) weather in the various vegetational zones.

Vegetation Zone	Weather	W(5)	W(10)	W(15)
High elevation woodlands	W	75%	54%	50%
	C	19	15	16
Wet sclerophyll (E. **delegatensis**)	W	50	51	43
	C	28	24	20
Wet sclerophyll (E. **obliqua**)	W	28	19	16
	C	16	18	20
Gully communities	W	28	20	21
	C	14	10	10
Dry sclerophyll	W	36	29	24
	C	16	16	12

TABLE 4 — Mean values for the number of species in half-hour counts in calm (C) and windy (W) conditions, and their difference C-W, Trial 3.

Transect number	Description of transect	C	W	C-W
1	Dry sclerophyll, open canopy, leeward	21.2 (9)†	20.2 (6)	1.0 (ns)
2	Dry sclerophyll, open canopy, windward	16.5 (8)	13.3 (7)	3.2 (*)
3	Wet sclerophyll, (**E. obliqua**), closed canopy	18.1 (7)	17.9 (8)	0.2 (ns)

† Number of replicates; * $p<0.05$; ns = not significant

DISCUSSION

The results of Trial 1 (Table 1) for all vegetational types show that the mean number of bird species recorded using the stationary method is significantly lower than when using the walking method. Even in the treeless upper regions where the mean number of species observed per 5-minute session was only 2.0 with the walking method, the percentage deficiency using the stationary method compared with walking is 35%. The deficiency is remarkably constant in gully communities, wet sclerophyll and dry sclerophyll, being about 40% in all these vegetational zones. The clear superiority of walking compared with stationary counting for obtaining the number of bird species is evident from these results.

Since Dawson & Bull (1975) reported no difference between the number of individuals obtained from walking versus stationary methods, it is of interest to re-examine their results. Their study compared three methods: in the first, the observer walked at a slow pace (0.8 km/h) for a period of two hours and took subtotals every 15 minutes; in the second, the observer remained stationary and recorded birds over a period of five minutes and then walked 200 m without counting to the new position; in the third, the procedure was the same as the second method except that each count was taken over a period of ten minutes. One can convert the mean number of birds per count reported in their Table 1 to the mean number that may be expected in a 2-hour session of counting, so that the results will reflect a constant effort in terms of total time allotted to counting. Dawson & Bull (1975) have estimated that the approximate number of counts that could be completed in two hours is eight sub-totals walking, ten five-minute stationary counts and seven ten-minute stationary counts, the last two methods requiring time to move between stations. Table 5 of the present work presents the converted mean numbers of five species of birds that would be recorded, on average, for a two-hour effort.

TABLE 5 — Mean number of birds expected in two hours of counting, converted from Dawson & Bull (1975).

Species	Walking (8 counts)	5-minutes stationary (10 counts)	10-minutes stationary (7 counts)
Bellbird	16.5	17.4	15.0
Tit	9.6	5.3	5.6
Silvereye	13.4	10.3	10.4
Fantail	7.2	5.5	5.0
Warbler	18.8	11.7	12.1
Total (all species)	65.5	50.2	48.1

Two points emerge very clearly from Table 5. Firstly, excepting the Bellbird, the walking method yields more birds than either stationary method despite the fact that a very slow walking pace was used (less than one-fifth of the pace of the present study). Secondly, there is close agreement between the mean number of birds observed in a given total time for the two stationary methods. As 2000 m would have been traversed in two hours using 5-minute counts compared with only 1400 m using 10-minute counts, the agreement suggests that covering a greater distance tends to compensate for a shorter observation time. Thus, both distance and time are important and may be effectively combined in the walking method, thereby explaining the superiority of walking to stationary methods.

The results of Trial 2 (Table 2), show the effect of weather and time of walking upon the average number of species observed in each zone. A smaller number of species is consistently recorded under windy conditions than under calm but fine conditions, or in windless rain, these latter two conditions producing virtually identical numbers of species. Table 3 lists the coefficients of variation (CV) for the number of species recorded in Trial 2 for windy versus calm conditions and enables the internal variability within each sample to be examined in more detail. In calm conditions, the CVs are low and are contained within a rather narrow range (10-28%), reflecting the fact that bird species numbers can be obtained with greater precision in windless conditions. In wind, the CVs increase in all zones but are lowest in the more closed environments, i.e. the gully communities and the sclerophyll forest dominated by *Eucalyptus obliqua*. The dry sclerophyll forest, with its more open structure, is next highest in variability, followed by the wet sclerophyll forest dominated by *Eucalyptus delegatensis*, which is situated at moderately high elevation and is exposed to high winds. The upper woodlands, which have a fairly open structure and which are prone to the full force of the wind, have the highest CVs (50-75%).

The effect of shelter upon the results obtained in windy versus calm conditions was further examined in Trial 3, where a longer time period (approximately 30 minutes) was used. The results of this trial (Table 4) demonstrate that, in a sheltered forest, whether due to landform (Transect 1) or to a closed canopy (Transect 3), no significant difference in bird species numbers is obtained. In the open-canopy forest unprotected by landform (Transect 2), the effect of windy conditions is to reduce the number of species recorded, despite the half-hour observation period. Nevertheless, the observed difference of 3.2 species is smaller than that obtained in dry sclerophyll for the shorter counting times of Trial 2 (Table 2).

We now turn to the question of determining the optimum time to use for a counting session. Taking calm conditions as a standard for comparison, the results given in Table 2 show that the 10-minute walk session increases the number of species relative to the 5-minute walk session by an amount ranging from 1.3 to 3.7, depending upon the vegetational zone. Similarly, the 15-minute walk session brings about a further increase, but the range of the increase is only 0.7 to 1.7, indicating that successive extra five-minute sessions bring increases of decreasing magnitude. Previous workers have found a quantitative relationship between number of species recorded and time of observation. For example, Preston (1960) found that when the duration of observation periods was successively doubled, the number of breeding species added to the list with each successive doubling of time tended to remain constant. Caughley (1965) showed that this was generally true for birds irrespective of whether they are breeding or not. We can examine whether this finding applies to the results of Table 2 by predicting the expected mean value for 15-minute counts, denoted here by E[W(15)], and comparing it with the observed mean value, W(15). Following Caughley (1965), using the observed mean count for the first time unit, W(5), and the observed increment in the count obtained by doubling the time, W(10) - W(5), then the expected count for the third time unit, i.e. at 15 minutes, can be predicted from the following equation:

$$E[W(15)] = W(5) + [W(10) - W(5)] \lg 3,$$

where lg signifies logarithm to the base 2.

Values of E[W(15)] are listed in the last column of Table 2 and the agreement between these predicted values and the observed values at 15 minutes, W(15), are excellent. As the basic time period of five minutes in the present study is vastly less than the basic time period of one day used by Caughley (1965) for his bird counts conducted both in Australia and New Zealand, it appears that Preston's rule applies for widely different basic time periods.

Using the total number of species known from our previous study to be present in these zones (Ratkowsky & Ratkowsky 1977), an estimate can be made of the fraction the entries in Table 2 represent of the maximum possible number of birds that would be recorded by devoting a very long time to counting. The maximum number of species recorded in each zone excluding very rare sightings, and the corresponding means from Trial 2 for calm weather expressed as a percentage of this maximum, are given in Table 6.

TABLE 6 — Maximum number of bird species present and estimated percentages of this maximum observed in Trial 2 in calm weather.

Vegetation Zone	Maximum Number of species (Earlier survey)	W(5)	W(10)	W(15)
Upper woodlands	20	35%	41%	45%
Wet sclerophyll (E. **delegatensis**)	26	36	43	48
Wet sclerophyll (E. **obliqua**)	40	32	39	43
Gully communities	22	57	71	79
Dry sclerophyll	37	30	40	43

The percentages in Table 6 show that gully communities are markedly different from the other vegetational zones. More than half of the 22 species regularly inhabiting the gullies can be observed, on the average, in a single 5-minute walking session through the environment. Use of a 10-minute interval increases the estimated percentage to 71%, a very high proportion of the total number of species present. This may be due to the uniformity of the gully communities, and to the relatively small area that they occupy. Given a fixed time interval, the remaining four vegetational zones are remarkable for the extent of the agreement between their recorded percentages of maximum observable species numbers. These habitats cover a much wider area of the Mt Wellington Range than do the gully communities, and are much more diverse. This could account for their much lower recorded percentages of species present.

The optimum length of time interval to use for observation depends upon a variety of circumstances and factors. Probably the most important is the time the observer has available to spend in the field throughout the course of the project. If a person lives close to the survey area, frequent excursions are recommended, as this increases the likelihood of recording a large number of species. However, a remote survey area or limited observation time will impose restrictions upon the survey method. The results of the present survey indicate that the 10-minute walking count is the basic unit to be considered. The number of such 10-minute counts to use per area, zone or environment would have to be determined after consideration of local factors such as steepness and roughness of the terrain, the extent of the area to be surveyed, and personal factors such as the ability and fitness of the observer. The reason for choosing the 10-minute walking count as the basic unit comes about from examining Tables 2 and 3.

A survey party committed to perform a study in a limited number of days will have to make allowances for the vagaries of weather. Under windy conditions, the CV is generally less the longer the counting time, and this argues in favour of a longer count to give a greater measure of reliability to the results obtained. It has already been remarked that in calm weather the 5-minute count gives a surprisingly high percentage of the maximum bird species present. The 10-minute count increases the percentage and at the same time increases the reliability by reducing the CV. Increasing the observation period to 15 minutes is probably not justified because of the relatively small increase in bird species numbers.

CONCLUSIONS

1) Walking methods are clearly superior to stationary methods for the short times of observation and the conditions considered in this study.
2) Windy conditions significantly reduce the number of bird species recorded in time intervals of up to 15 minutes. Rainy calm conditions yield as many observations as are obtained under fine calm conditions.
3) Longer time sessions for observation can reduce the difference between the numbers of species obtained in windy and calm conditions in exposed environments, and can even eliminate it in sheltered environments.
4) In calm conditions, the coefficient of variation for the recorded number of bird species is low and does not depend markedly upon the nature of the environment. In windy conditions, the variability is lowest in closed or sheltered environments and becomes very much higher in situations exposed to the full force of the wind.
5) Where limited time is available to conduct a survey, the 10-minute walking session is recommended.

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